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Impacts of Small Column Ion Exchange Streams on DWPF Glass Formulation: KT01, KT02, KT03, and KT04-Series Glass Compositions

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EXECUTIVE SUMMARY

Four series of glass compositions were selected, fabricated, and characterized as part of a study to determine the impacts of the addition of Crystalline Silicotitanate (CST) and Monosodium Titanate (MST) from the Small Column Ion Exchange (SCIX) process on the Defense Waste Processing Facility (DWPF) glass waste form and the applicability of the DWPF process control models. The KT01 and KT02-series of glasses were chosen to allow for the identification of the influence of the concentrations of major components of the glass on the retention of TiO_2. The KT03 series of glasses was chosen to allow for the identification of these influences when higher Nb_2O_5 and ZrO_2 concentrations are included along with TiO_2. The KT04 series of glasses was chosen to investigate the properties and performance of glasses based on the best available projections of actual compositions to be processed at the DWPF (i.e., future sludge batches including the SCIX streams).

The X-ray Diffraction (XRD) results showed no titanium containing phases in the KT01-series glasses, regardless of whether they had been air quenched or slowly cooled. The target TiO_2 concentration had to be increased to 12 wt % in glass in the KT02-series before any compositional impacts on TiO_2 retention (e.g., the formation of titanium containing crystals) were apparent. Titanium containing crystalline phases formed in the slowly cooled versions of all of the KT02 compositions except for the low Al_2O_3 concentration glass, the low Fe_2O_3 concentration glass, the high Na_2O concentration glass, and the high K_2O concentration glass. The impacts of these components will need additional investigation before drawing further conclusions. However, one should keep in mind that the 12 wt % TiO_2 concentrations in these glasses are unrealistic for DWPF processing with the SCIX and Salt Waste Processing Facility (SWPF) streams. Further characterization of the KT02-series glasses was not performed because of their unusually high TiO_2 concentrations. Spinels were identified in some of the KT03 glasses after slow cooling. The spinels did not adversely impact the durability of the glasses but have the potential to impact liquidus temperature determinations since spinel is the primary crystalline phase predicted by the current model. The KT04-series glasses were amorphous regardless of heat treatment.

All of the glasses studied were considerably more durable than the benchmark Environmental Assessment (EA) glass. The measured Product Consistency Test (PCT) responses were compared with the predicted values from the current DWPF durability model. One of the KT01-series and two of the KT03-series glasses had measured PCT responses that were outside the lower bound of the durability model. All three of these glasses had intentionally high K_2O concentrations (to evaluate the impact of K_2O on TiO_2 retention), which may indicate a lack of applicability for the durability model in this composition region. However, this is likely of little practical importance since K_2O concentrations of this magnitude (more than 9 wt %) are unrealistic for actual compositions to be processed at the DWPF. All of the KT04 glasses had durabilities that were predictable regardless of heat treatment or compositional view.

All but two of the KT01, KT03, and KT04-series glasses had measured viscosities that were predictable using the current DWPF viscosity model. The viscosities of two of the high K_2O concentration glasses fell above the upper confidence intervals for the model prediction. These glasses have K_2O concentrations that are above the DWPF viscosity model development range for K_2O. Another high K_2O concentration glass had a measured viscosity that was well predicted by the current DWPF model. While these results point to lack of applicability for the DWPF viscosity model for increased K_2O concentrations, it is again important to note that these K_2O concentrations are unrealistic for actual DWPF processing. In general, the measured viscosity

values of the KT01, KT03, and KT04-series glasses are well predicted by the current DWPF viscosity model.

The results of liquidus temperature (T_L) measurements for the KT01-series glasses were mixed with regard to the predictability of the T_L for each glass. All of the measured T_L values were higher than the model predicted values, although most fell within the 95% confidence intervals. Four of the KT01 glasses had measured T_L values that were above the upper 95% confidence bounds on the predicted values. The concentrations of some of the components in these glasses, particularly TiO_2, fall outside the region of applicability of the current T_L model. These results indicate that the model may need to be adjusted in order to more correctly predict the T_L of glasses when the SCIX streams are incorporated, although further data are necessary for a more complete assessment. Liquidus temperature measurements for the KT03 and KT04-series glasses are underway.

Overall, the results presented in this report show a reasonable ability to incorporate the anticipated SCIX streams into the DWPF-type glass compositions studied, with TiO_2 concentrations of 4-5 wt % in glass. The durability and viscosity models satisfactorily predicted the measured values for the study glasses with the exception of a small number of extreme compositions. The liquidus temperature model may need to be adjusted to correctly predict the liquidus temperatures of glasses including the SCIX streams based on the data measured. Additional experiments are currently underway. Once completed, all of the measured data will be reviewed and compared to model predictions to determine whether the validation range of the DWPF process control models can be confidently extended, or whether refitting of the models will be necessary.

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LIST OF ABBREVIATIONS

AD	Analytical Development
ANOVA	ANalysis Of VAriance
ARM	Approved Reference Material
CCC	Canister Centerline Cooled
CST	Crystalline Silicotitanate
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
HLW	High Level Waste
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectroscopy
LM	Lithium-Metaborate Fusion
M&TE	Measurement and Test Equipment
MAR	Measurement Acceptability Region
MSP	Modular Salt Processing
MST	Monosodium Titanate
PCCS	Product Composition Control System
PCT	Product Consistency Test
PF	Sodium Peroxide Fusion
PSAL	Process Science Analytical Laboratory
RF	Resorcinol Formaldehyde
RMF	Rotary Micro Filtration
SCIX	Small Column Ion Exchange
SME	Slurry Mix Evaporator
SRAT	Sludge Receipt and Adjustment Tank
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
SWPF	Salt Waste Processing Facility
THERMO	Thermodynamic Hydration Energy Reaction MOdel
T_L	Liquidus Temperature
XRD	X-ray Diffraction

1.0 Introduction

1.1 Background

The Savannah River Site (SRS) Tank Farm will begin a process referred to as Small Column Ion Exchange (SCIX) to disposition salt solution in fiscal year 2014. In the first step of the process, salt solution retrieved from various waste tanks will be struck with Monosodium Titanate (MST) to remove key actinides. The salt solution will then be processed using Rotary Micro Filtration (RMF) to remove the MST and any insoluble solids. The MST and insoluble solids will accumulate on the bottom of Tank 41. The filtrate from RMF will be fed to ion exchange columns, also in Tank 41, to remove the ^{137}Cs using Crystalline Silicotitanate (CST) resin. The decontaminated salt solution from SCIX will be sent to the Saltstone Facility for immobilization in grout. The ^{137}Cs-laden CST resin will be sluiced and ground for particle size reduction, then sent to the Defense Waste Processing Facility (DWPF) for immobilization in glass. These processes mirror the current disposition paths for streams associated with the Salt Waste Processing Facility (SWPF), which is under construction.

The MST and insoluble solids from Tank 41 will periodically be transferred to a sludge batch preparation tank (e.g., Tank 42 or Tank 51) as part of the High Level Waste (HLW) sludge batch preparation process for DWPF. The ground, ^{137}Cs-laden CST material (hereafter referred to simply as CST) from SCIX will be periodically transferred to Tank 40 prior to being processed at DWPF. Periodic additions of CST to Tank 40 would result in a changing composition of each sludge batch as it is processed since Tank 40 serves as the feed tank for the DWPF. Work is currently in progress to determine the feasibility of dropping the ground CST into Tank 41. If ground CST can be dropped into Tank 41 (depending on heat loading issues, among others), the CST would be sent to Tank 42 or Tank 51 using an existing transfer line. Therefore, the studies of SCIX impacts on DWPF glass formulation will encompass scenarios where the CST is sent to either Tank 40 or a sludge batch preparation tank.

This work was initiated by a DWPF Technical Task Request[1] and is performed following a Task Technical and Quality Assurance Plan.[2]

1.2 Potential Impacts of SCIX on DWPF Glass Formulation

The MST and CST from the SCIX process will significantly increase the concentrations of Nb_2O_5, TiO_2, and ZrO_2 in the DWPF feed. Other constituents of MST and CST – Na_2O and SiO_2 – are already present in high concentrations in DWPF glass; thus their influences are well understood. The increased concentrations of Nb_2O_5, TiO_2, and ZrO_2 will likely have some impact on the properties and performance of the DWPF glass product. Properties such as the liquidus temperature, viscosity, and rate of melting of the glass may be impacted. The performance of the glass, particularly its chemical durability as it pertains to repository acceptance requirements, may also be impacted. The DWPF uses a set of semi-empirical and first-principles models referred to as the Product Composition Control System (PCCS)[3] to predict the properties and performance of a glass based on its composition since it is not possible to measure these attributes during processing. The objective of this study is to evaluate the impacts of the SCIX streams on the properties and performance of the DWPF glass product and on the applicability of the current process control models.

Previous studies have provided data on the potential impacts of MST and CST specifically on DWPF-type glasses. Edwards and Harbour completed a series of studies on the coupling of CST and MST with Purex and HM sludges for DWPF processing in 1999.[4-8] A total of 25 glass compositions were fabricated and characterized for durability, viscosity, and liquidus temperature. All of the glasses had very good measured durability values, although there were minor issues with the predictions of the durability model and the majority of the glasses failed the homogeneity constraint.[8] The glasses generally had estimated liquidus temperatures that would be acceptable for DWPF processing. The viscosities of the glasses produced with CST and the Purex sludge were acceptable for processing but not well predicted. The viscosities of the glasses fabricated with CST and HM sludge were too high for processing but were better predicted.

A later report by Peeler and Edwards provided paper study evaluations of the projected impact of a similar Modular Salt Processing (MSP) strategy using CST or eluant from Resorcinol Formaldehyde (RF) resin on DWPF processing.[9] This study again noted that the compositions were outside the validation ranges for many of the PCCS models, although the current models continued to be used for the evaluation. Using updated sludge and salt processing composition projections, this study found that no options for producing an acceptable glass composition were available when CST or RF were sent to Tank 40. However, direct transfer of RF or CST to DWPF appeared to be viable options in terms of producing an acceptable glass. Transfer of the CST to Tank 51 also appeared to be a viable option, with the caveat that the PCCS models be updated to incorporate higher concentrations of the CST components.

Fox and Edwards recently performed a paper study evaluation using updated projections for sludge batch compositions and SCIX CST and MST addition rates.[10] This study found that, as a result of the updated composition projections, several viable options were predicted to be available for incorporation of the SCIX streams into either Tank 40 or a sludge batch preparation tank. Transfer of the CST to a sludge batch preparation tank was the preferred option since it allowed more compositional flexibility for frit development while maintaining sufficient projected operating windows. The report again identified several assumptions and limitations associated with the current PCCS models, and recommended that these be further evaluated.

The following sections provide more detailed descriptions of the potential impacts of incorporation of the SCIX streams on the properties and performance of DWPF glass, and the models that are used to predict these attributes.

1.3 Liquidus Temperature

The liquidus temperature (T_L) of a glass is the maximum temperature at which the formation of glass liquid and the formation of crystals are at equilibrium. Liquidus temperature is an important parameter in operation of the DWPF melter since the bulk formation of crystals in the melt pool can cause non-recoverable process problems. If not controlled, crystallization in the melt could potentially occur very rapidly and throughout the entire volume of the melter. The crystalline phases formed can have a melting temperature much higher than the temperature of the melt pool and, thus, be impossible to dissolve back into the glass. This same crystalline material once formed in the melt pool can potentially clog the pour spout and interfere with Joule heating. Finally, crystals can also cause an undesirable increase in viscosity of the glass. To avoid detrimental crystallization in the DWPF melter, PCCS limits the predicted liquidus temperature to a maximum of 1050 °C. This provides a 100 °C margin of safety below the nominal melt pool temperature of 1150 °C before crystallization of spinels is predicted to occur.[a]

[a] Note that a reduction in the magnitude of the T_L margin (or increase in the allowable predicted T_L) was proposed at the time the current model was developed,[11] and has recently been proposed again,[12] to allow DWPF access to higher waste loadings.

While several models for predicting the liquidus temperature of a glass melt have been reported (a detailed review is provided by Jantzen and Brown[13]), a unique model was developed at the Savannah River National Laboratory (SRNL) relevant to the complex nature of DWPF-type glass compositions.[11,13,14] This semi-empirical model is currently incorporated in PCCS to predict the spinel liquidus temperature from glass composition.[3] Spinels are expected to be the primary crystalline phase in DWPF glasses. The model assumes that pyroxene-like melt phase complexes or precursors control the heterogeneous volume crystallization of spinels. The basis of the model is mechanistic, based on known speciation of cations in the crystalline pyroxene and nepheline lattices, and including a mathematical representation of the freezing point depression equation. Coefficients within the model were determined through a least squares fit of a carefully reviewed and qualified data set. These data represent 105 individual glasses with compositions that are relevant to DWPF processing. A region of compositional applicability, shown in Table 1-1, was defined along with the model as a result of its semi-empirical nature. Measured values for compositions outside this range must be collected and evaluated against the model predicted values to determine further applicability.

Table 1-1. Component Ranges (wt %) Describing the Region of Applicability of the Liquidus Temperature Model. (from Brown et al.[11])

	Al_2O_3	B_2O_3	CaO	Cr_2O_3	FeO	Fe_2O_3	$(\Sigma Fe)_2O_3$	K_2O	Li_2O
Maximum	14.162	12.652	2.007	0.3008	6.901	16.977	17.60	3.8846	6.1576
Minimum	0.99	4.893	0.3053	0	0.0161	3.427	3.452	0	2.4901
	MgO	**MnO**	**Na_2O**	**NiO**	**SiO_2**	**TiO_2**	**U_3O_8**	**ZrO_2**	**Total†**
Maximum	2.6502	3.25	14.901	3.045	58.230	1.8549	5.1387	0.97	94.5479
Minimum	0.470	0.7392	5.989	0.0379	41.795	0	0	0	81.5746

†The shaded components are included in the current liquidus temperature model. As indicated in the Total column, they constitute between approximately 81.6 and 94.5 wt % of the model glasses.

The DWPF liquidus temperature model was also examined with non-model data to provide insight into the applicability of the model to these systems.[11] Predicted spinel liquidus temperatures for 155 non-model glasses, within the composition ranges shown in Table 1-2, were compared with their measured values. The results, detailed by Brown et al., showed significant prediction biases for many of the glasses, although the model did appear to describe the general trend of liquidus temperature as a function of composition.[11] Brown et al. recommended that if compositions outside the composition space of the model glasses (Table 1-1) become likely for DWPF processing, the model may have to be adjusted considering such components as CaO, Na_2O, SiO_2, and ZrO_2.[11] Note that an individual component limit of 0.3 wt % for Cr_2O_3 is used in PCCS,[3] so it was excluded from this list.

Table 1-2. Component Ranges (wt %) Describing the 155 Selected Non-Model Glasses Used in Evaluating the DWPF Liquidus Model. (from Brown et al.[11])

	Al_2O_3	B_2O_3	CaO	Cr_2O_3	$(\Sigma Fe)_2O_3$	K_2O	Li_2O	MgO
Maximum	13.68	12.00	5.5	1.20	16.19	4.00	7.50	6.02
Minimum	1.68	4.90	0	0	3.80	0	0	0
	MnO	**Na_2O**	**NiO**	**SiO_2**	**TiO_2**	**U_3O_8**	**ZrO_2**	
Maximum	3.14	22.74	3.00	60.00	5.00	5.53	6.24	
Minimum	0	6.26	0	29.98	0	0	0	

One of the objectives of the current study is to determine whether the current spinel liquidus temperature model will remain applicable to DWPF glass when the SCIX streams are added. The addition of these streams will increase the concentrations of TiO_2 and ZrO_2 beyond the current model applicability ranges for these components (Table 1-1). This study will, through the generation of additional data, determine whether the current model is indeed applicable over these broader composition ranges, or whether the model coefficients (and particularly the distribution of ZrO_2 among the melt precursors) need to be re-fit when the new data are considered. The types of crystallization that occur in the glasses when the SCIX streams are included will also be determined. A considerable change in the methodology used to model liquidus temperature would be necessary if the addition of the SCIX streams move the projected composition of the DWPF glass into a region where spinels are no longer the primary crystalline phase.

1.4 Viscosity

The viscosity of the glass, or its resistance to flow, is a critical parameter for DWPF processing. Viscosity impacts the melting rate of the feed, the rate of bubble release, the devitrification rate, convection and heat transfer, the rate of refractory corrosion and erosion, the ability to pour canisters, and the quality of the poured glass.[15] To avoid detrimental impacts of the glass having a viscosity that is either too high or too low, a viscosity constraint of 20-110 poise at the nominal melt temperature of 1150 °C was chosen for DWPF operation.[16,17] The viscosity of the glass in the melter cannot be easily measured during operation, so a model that predicts the viscosity of a glass melt using its composition and melt temperature was developed for the DWPF in 1991.[18,19] The model is based on glass structural considerations, and assumes that a pure SiO_2 glass is fully polymerized (i.e., consists only of bridging oxygen bonds).[15] Each mole of alkali oxide and each mole of Fe_2O_3 added to the glass are assumed to create two non-bridging oxygen bonds, and each mole of B_2O_3 is assumed to create one non-bridging oxygen bond. Each mole of Al_2O_3 is assumed to create two bridging oxygen bonds. These assumptions are expressed as a calculated non-bridging oxygen term, which is then related to the viscosity-temperature dependence of the Vogel-Fulcher-Tammann equation.[15,20,21] The model was developed using the target compositions[a] and measured viscosities of 41 glass compositions. A later study identified some bias in this first model.[15] The coefficients of the model were therefore revised using the measured, rather than target compositions of 33 of the original 41 glass compositions. Eight of the original glass compositions were eliminated due to disparate compositions and inhomogeneity.[15] The ranges of temperatures, viscosities, and compositions over which the DWPF viscosity model was developed are given in Table 1-3. The report noted that there was no need for CaO or ZrO_2 terms in the model over the composition ranges used in development (Table 1-3). It was suggested that glass compositions with more than 3.5 wt % CaO or more than 2 wt % ZrO_2 may necessitate the development of terms for these components, since they can significantly impact the viscosity of a glass at higher concentrations.[21]

[a] Measured composition data for these glasses were not available at the time the 1991 model was developed.

Table 1-3. Temperature, Viscosity, and Composition Ranges (wt %) for the DWPF Viscosity Model. (from Jantzen[15])

Parameter	Maximum Value	Minimum Value
Temperature (°C)	1491	873
Viscosity (poise)	1122.02	10.23
$Fe^{+2}/\Sigma Fe$	0.47	0.00
Al_2O_3	13.90	0.00
B_2O_3	12.20	6.41
BaO	0.20	0.00
CaO	1.47	0.00
Cr_2O_3	0.09	0.00
Cs_2O	0.15	0.00
CuO	0.33	0.00
Cu_2O	0.30	0.00
FeO	7.14	0.00
Fe_2O_3	14.20	0.00
K_2O	5.73	0.00
La_2O_3	0.36	0.00
Li_2O	6.96	2.59
MgO	2.92	0.49
MnO	3.26	0.00
Na_2O	15.80	5.80
NiO	2.97	0.00
SiO_2	77.04	45.60
SrO	0.07	0.00
TiO_2	1.78	0.00
ZnO	0.00	0.00
ZrO_2	0.99	0.00
Sum of Oxides	100.28	98.23

The revised DWPF viscosity model was validated using data from approximately 170 glasses whose compositions fell within the ranges given in Table 1-4. In general, the model showed good applicability over this broader range of glass compositions.[15] The study also evaluated data for uranium-containing glasses and determined that a uranium term is not needed in the revised DWPF viscosity model as long as U_3O_8 concentrations in glass remain ≤5.76 wt %.[15] Note that glasses containing up to 3.1 wt % TiO_2 were included in this portion of the study, which appeared to have little or no impact on viscosity, although these data were not used for model validation (Table 1-4).[15]

Table 1-4. Temperature, Viscosity, and Composition Ranges (wt %) for Validation of the DWPF Viscosity Model. (from Jantzen[15])

Parameter	Maximum Value	Minimum Value
Temperature (°C)	1350	803.35
Viscosity (poise)	11,000	8.9
$Fe^{+2}/\Sigma Fe$	0.71	0.00
Al_2O_3	17.74	0.81
B_2O_3	13.25	4.90
BaO	0.5	0.00
CaO	3.2	0.02
CdO	1.18	0.00
Ce_2O_3	0.67	0.00
CoO	0.10	0.00
Cr_2O_3	0.82	0.00
Cs_2O	0.24	0.00
CuO	0.23	0.00
Cu_2O	0.20	0.00
FeO	8.62	0.00
Fe_2O_3	17.74	1.90
K_2O	3.86	0.00
La_2O_3	1.12	0.00
Li_2O	6.60	0.87
MgO	4.80	0.00
MnO	3.31	0.03
MoO_3	0.51	0.00
Na_2O	16.8	6.41
Nd_2O_3	2.01	0.00
NiO	3.01	0.00
P_2O_5	1.01	0.00
PbO	0.19	0.00
Pr_6O_{11}	0.02	0.00
Rh_2O_3	0.02	0.00
RuO_2	0.06	0.00
SO_4	0.59	0.00
Sb_2O_3	0.01	0.00
SiO_2	60.39	40.50
Sm_2O_3	0.02	0.00
SrO	0.18	0.00
TiO_2	1.43	0.00
V_2O_5	0.01	0.00
Y_2O_3	0.23	0.00
ZnO	0.21	0.00
ZrO_2	2.00	0.00
Sum of Oxides	104.75	95.07

One of the objectives of the current study is to determine whether the current DWPF viscosity model will remain applicable to DWPF glass when the SCIX streams are added. The addition of these streams will increase the concentrations of TiO_2 and ZrO_2 beyond the current model applicability ranges for these components (Table 1-3). This study will, through the generation of additional data, determine whether the current model is indeed applicable over these broader composition ranges, or whether the model coefficients need to be re-fit when the new data are considered. As noted during development of the current viscosity model, the higher ZrO_2 concentrations expected from the SCIX streams may necessitate the incorporation of a term for ZrO_2 into the non-bridging oxygen expression that is incorporated in the model.

1.5 Chemical Durability

DWPF uses the Thermodynamic Hydration Energy Reaction MOdel (THERMO) to predict the chemical durability of a glass from its composition and redox.[22] The model was developed using data from the ASTM Product Consistency Test (PCT) Method-A.[23] The durability of each Slurry Mix Evaporator (SME) batch at the DWPF must have a predicted PCT response that is at least two standard deviations more durable than the Environmental Assessment (EA) glass benchmark for repository acceptance.[22]

THERMO expresses the thermodynamic tendency of the components of a glass to hydrate, and each species has an individual thermodynamic hydration equation written for it.[22] The hydrated species for each reaction were chosen to be consistent with those that form in neutral to basic solutions as predicted on known Eh-pH (Pourbaix) diagrams and as shown by experimental data.[22] THERMO was developed for completely amorphous glasses to avoid issues with mixed mechanism modeling, since crystalline phases can leach via different routes than the glass matrix. A free energy of hydration term, or ΔG_i, has been developed for each of the components of a typical DWPF-type glass.[a] The summation of these terms, weighted by their molar concentrations in a glass, gives the overall tendency of a glass to hydrate expressed as a preliminary glass dissolution estimator, ΔG_p.[22]

Although specific data sets were used for development and validation of THERMO,[22,25] concentration ranges of the components of these glasses are not explicitly provided. In practice, the predictability of the durability of glasses for each sludge macrobatch is experimentally verified prior to vitrification at the DWPF. Therefore, it is one of the objectives of the current study to determine whether THERMO continues to satisfactorily predict the PCT response of DWPF-type glasses when the SCIX streams are included. The PCT will be performed on the glasses fabricated in the laboratory, and the measured results will be compared with the predictions from THERMO.

1.6 TiO_2 Concentration Limits

The concentration of TiO_2 in DWPF glass is controlled by an individual limit in PCCS of 2.0 wt %. The original TiO_2 concentration limit was set at 1.0 wt % for DWPF glass[26] based on studies of the impact of TiO_2 on crystallization.[27,28] Work by Plodinec showed that TiO_2 increased liquidus temperature, increased viscosity (and led to non-Newtonian behavior), increased crystalline content after slow cooling (which could lead to decreased chemical durability), and sharply decreased the melt rate of the DWPF-type glass compositions studied.[27-29] Other studies have cautioned that the relatively high density of Ti may cause Ti-rich spinels to settle to the bottom of the melt pool.[30]

In 2003, a request was made to reevaluate the DWPF TiO_2 limit in order to allow higher TiO_2 concentrations in glass.[31] Data developed during an evaluation of the incorporation of CST and

[a] Note that a ΔG_i term for niobium has not yet been incorporated into PCCS since concentrations of Nb_2O_5 in DWPF glass to date have not been of significance. The addition of the SCIX streams will increase the concentration of Nb_2O_5 above this value. To address this, a recent study has provided an updated ΔG_i term for Nb_2O_5 that can be incorporated into PCCS as part of the preparations to receive the SCIX streams.[24]

MST into 25 DWPF-type glasses served as the basis of the reevaluation.[8,29] The data indicated that DWPF-type glasses with TiO_2 concentrations up to 5.5 wt % can be produced that do not compromise durability even after slow cooling, which addressed some of the concerns in the work by Plodinec.[29] The data also showed that the liquidus temperature of these glasses was below the DWPF limit. However, the review recommended that, since the model development range for the current liquidus temperature model only spans TiO_2 concentrations from 0 to 1.8549 wt % (Table 1-1), glasses with TiO_2 concentrations outside this range should not be processed until additional data are used to either refine the model or extend the model's validation range.[29]

One of the objectives of the current study is to again revisit the TiO_2 concentration limit for DWPF glass production. The concentration of TiO_2 in glass will have to be increased significantly beyond 2 wt % in order to incorporate the SCIX streams based on recent composition projections.[10] As described earlier, the impacts of increased TiO_2 concentrations on the applicability of the current DWPF viscosity and liquidus temperature models will be evaluated. The impacts of TiO_2 on crystallization during slow cooling will also be studied, since TiO_2 is known to act as a seed for crystallization in many glass systems.[32]

The studies by Plodinec identified reductions in melt rate when TiO_2 concentrations were increased.[27,28] Lorier and Jantzen recommended that further melt rate studies be performed if TiO_2 concentrations greater than 1 wt % are necessary in DWPF glass.[29] While not within the scope of this report, melt rate impacts of these higher concentrations will be determined as part of the evaluation of potential impacts of incorporating SCIX streams in DWPF glass.

2.0 Experimental Procedure

2.1 Selection of Glass Compositions

2.1.1 *KT01- and KT02-series*

Two series of glass compositions, identified as the KT01-series and the KT02-series, were developed for the first portion of the study described in this report. Composition projections developed during the paper study evaluation of the addition of the SCIX streams were used as the basis for the two series.[10] Compositions for sludge batches 8 through 17 were projected in the paper study report, both with and without the addition of material from the SWPF.[a] The projections with CST going to Tank 40 were used, including the beginning, middle, and end compositions for each sludge batch, since the composition of the material in Tank 40 would change over time as CST is added and as material is transferred to the DWPF. This resulted in six cases for each of the ten sludge batches (i.e., the beginning, middle, and end of processing, both with and without the SWPF streams), giving a total of sixty sludge compositions. For the purposes of this study, each of the sludge compositions was then combined with Frit 418 at 40 wt % waste loading.[b] The averages of the sixty values for each sludge and frit component (including the CST constituents) were used as a baseline glass composition. The minimum and maximum concentrations of each component were also considered. These values are given in Table 2-1.

[a] Note that the projected values used in this study have been revised slightly from those that appear in the paper study report, although they remain very similar.
[b] Frit 418 is not necessarily an optimal frit for any of the projected sludge compositions, nor were attempts made to ensure that the resulting glasses were acceptable for DWPF processing based on PCCS model predictions. Frit 418 was chosen simply to provide a uniform frit composition for all of the sludge projections included in the study.

Table 2-1. Projected Average, Minimum, and Maximum Concentrations (wt %) of HLW Glass Components in Out-Year Processing at DWPF with SCIX and SWPF Streams.

Oxide	Average	Minimum	Maximum
Al_2O_3	5.69	4.19	8.42
B_2O_3	4.80	4.80	4.80
BaO	0.08	0.06	0.11
CaO	1.01	0.73	1.28
Ce_2O_3	0.21	0.07	0.39
Cr_2O_3	0.11	0.07	0.16
CuO	0.03	0.02	0.05
Fe_2O_3	12.05	8.24	16.08
K_2O	0.07	0.05	0.13
La_2O_3	0.08	0.04	0.12
Li_2O	4.80	4.80	4.80
MgO	0.15	0.10	0.22
MnO	1.30	0.33	2.54
Na_2O	15.03	13.07	16.41
Nb_2O_5	0.43	0.01	1.67
NiO	0.36	0.10	0.76
PbO	0.12	0.05	0.20
SO_4^{2-}	0.08	0.01	0.19
SiO_2	47.52	45.96	49.24
ThO_2	0.23	0.00	1.15
TiO_2	2.74	0.74	5.00
U_3O_8	2.53	0.23	7.32
ZnO	0.05	0.02	0.09
ZrO_2	0.52	0.18	1.40

The KT01-series compositions were then derived from this baseline glass composition (the average values in Table 2-1) with the intent of investigating the impact of individual glass components on the retention of TiO_2. The concentrations of Al_2O_3, B_2O_3, Fe_2O_3, K_2O,[a] Li_2O, Na_2O, and SiO_2 were adjusted from the baseline composition to determine whether these changes would affect the ability of the glass to accommodate increased TiO_2 concentrations. The minimum and maximum values for these components, as shown in Table 2-1, were used for the adjustments from the baseline composition. In the case of B_2O_3 and Li_2O, which come only from the frit, the concentrations were adjusted to represent an increase in concentration of 50% (relative) for these components within the frit. The U_3O_8 and ThO_2 components were removed so that the glasses could be handled in a non-radioactive laboratory. The concentration of TiO_2 was forced to an elevated value of 8 wt % for each composition. The remaining components were then normalized to give a total of 100 wt %. These steps resulted in 13 glass compositions for the KT01-series, as shown in Table 2-2.

A similar process was used to develop compositions for the KT02-series glasses. The intent was to again identify any impact of individual glass components on the retention of TiO_2. The only difference from the KT01-series was the increase in TiO_2 concentrations from 8 wt % to 12 wt %

[a] The concentration of K_2O was increased significantly beyond it's maximum value in the glass composition range (Table 2-1) since K_2O has been reported to improve TiO_2 retention in glass.[32] A substitution of K_2O for approximately 60% of the total Na_2O and Li_2O on a molar basis was used to develop the K_2O concentration. It is noted that while these K_2O concentrations were chosen to more clearly show any impact on TiO_2 retention, they are impractically high for actual processing.

for each of the glass compositions, with a subsequent normalization of the other components to 100 wt %. The compositions of the KT02-series glasses are given in Table 2-3. The KT02-series glasses were not characterized as thoroughly as the KT01-series glasses since their TiO_2 concentrations were quite high. As will be described below, X-ray Diffraction (XRD) was used to identify any obvious changes in the crystallization behavior of these glasses after the CCC when TiO_2 concentrations were high, but chemical properties were not determined. Note that the KT01 and KT02 compositions do not necessarily pass the current PCCS constraints since they were developed for research and development efforts, rather than for specific DWPF compositions.

Table 2-2. Target Compositions (wt %) of the KT01-Series Glasses.

Oxide	KT01-LA	KT01-HA	KT01-LF	KT01-HF	KT01-LN	KT01-HN	KT01-LS	KT01-HS
Al_2O_3	4.19	8.42	5.78	5.24	5.65	5.41	5.57	5.18
B_2O_3	4.75	4.52	4.88	4.42	4.77	4.57	4.70	4.37
BaO	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
CaO	1.00	0.95	1.03	0.93	1.00	0.96	0.99	0.92
Ce_2O_3	0.21	0.20	0.22	0.19	0.21	0.20	0.21	0.19
Cr_2O_3	0.11	0.10	0.11	0.10	0.11	0.10	0.11	0.10
CuO	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Fe_2O_3	11.92	11.34	8.24	16.08	11.97	11.46	11.81	10.97
K_2O	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07
La_2O_3	0.08	0.07	0.08	0.07	0.08	0.07	0.08	0.07
Li_2O	4.75	4.52	4.88	4.42	4.77	4.57	4.70	4.37
MgO	0.15	0.14	0.15	0.14	0.15	0.15	0.15	0.14
MnO	1.28	1.22	1.32	1.20	1.29	1.24	1.27	1.18
Na_2O	14.86	14.14	15.26	13.84	13.07	16.41	14.73	13.67
Nb_2O_5	0.43	0.41	0.44	0.40	0.43	0.41	0.42	0.39
NiO	0.36	0.34	0.37	0.34	0.36	0.35	0.36	0.33
PbO	0.12	0.11	0.12	0.11	0.12	0.11	0.11	0.11
SO_4^{2-}	0.07	0.07	0.08	0.07	0.08	0.07	0.07	0.07
SiO_2	46.98	44.72	48.27	43.75	47.19	45.19	45.96	49.24
TiO_2	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
ZnO	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
ZrO_2	0.52	0.49	0.53	0.48	0.52	0.50	0.51	0.48

Table 2-2. Target Compositions (wt %) of the KT01-Series Glasses. (continued)

Oxide	KT01-LL	KT01-HL	KT01-LB	KT01-HB	KT01-HK
Al_2O_3	5.53	5.38	5.53	5.38	4.97
B_2O_3	4.67	4.54	4.80	7.20	4.20
BaO	0.08	0.08	0.08	0.08	0.07
CaO	0.98	0.96	0.98	0.96	0.89
Ce_2O_3	0.21	0.20	0.21	0.20	0.19
Cr_2O_3	0.11	0.10	0.11	0.10	0.10
CuO	0.03	0.03	0.03	0.03	0.03
Fe_2O_3	11.72	11.39	11.72	11.39	10.54
K_2O	0.07	0.07	0.07	0.07	18.38
La_2O_3	0.08	0.07	0.08	0.07	0.07
Li_2O	4.80	7.20	4.67	4.54	1.28
MgO	0.15	0.14	0.15	0.14	0.13
MnO	1.26	1.23	1.26	1.23	1.14
Na_2O	14.61	14.20	14.61	14.20	7.09
Nb_2O_5	0.42	0.41	0.42	0.41	0.38
NiO	0.35	0.34	0.35	0.34	0.32
PbO	0.11	0.11	0.11	0.11	0.10
SO_4^{2-}	0.07	0.07	0.07	0.07	0.07
SiO_2	46.19	44.92	46.19	44.92	41.56
TiO_2	8.00	8.00	8.00	8.00	8.00
ZnO	0.05	0.05	0.05	0.05	0.05
ZrO_2	0.51	0.49	0.51	0.49	0.46

Table 2-3. Target Compositions (wt %) of the KT02-Series Glasses.

Oxide	KT02-LA	KT02-HA	KT02-LF	KT02-HF	KT02-LN	KT02-HN	KT02-LS	KT02-HS
Al_2O_3	4.19	8.42	5.50	4.96	5.36	5.12	5.09	4.69
B_2O_3	4.53	4.30	4.64	4.19	4.53	4.32	4.30	3.96
BaO	0.08	0.07	0.08	0.07	0.08	0.07	0.07	0.07
CaO	0.95	0.91	0.98	0.88	0.95	0.91	0.91	0.83
Ce_2O_3	0.20	0.19	0.20	0.18	0.20	0.19	0.19	0.17
Cr_2O_3	0.10	0.10	0.11	0.10	0.10	0.10	0.10	0.09
CuO	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Fe_2O_3	11.37	10.80	8.24	16.08	11.36	10.86	10.78	9.94
K_2O	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06
La_2O_3	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.06
Li_2O	4.53	4.30	4.64	4.19	4.53	4.32	4.30	3.96
MgO	0.14	0.14	0.15	0.13	0.14	0.14	0.14	0.13
MnO	1.23	1.16	1.26	1.13	1.23	1.17	1.16	1.07
Na_2O	14.18	13.46	14.54	13.11	13.07	16.41	13.45	12.39
Nb_2O_5	0.41	0.39	0.42	0.38	0.41	0.39	0.39	0.36
NiO	0.34	0.33	0.35	0.32	0.34	0.33	0.33	0.30
PbO	0.11	0.10	0.11	0.10	0.11	0.11	0.10	0.10
SO_4	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06
SiO_2	44.84	42.58	45.97	41.45	44.80	42.80	45.96	49.24
TiO_2	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
ZnO	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04
ZrO_2	0.49	0.47	0.51	0.46	0.49	0.47	0.47	0.43

Table 2-3. Target Compositions (wt %) of the KT02-Series Glasses. (continued)

Oxide	KT02-LL	KT02-HL	KT02-LB	KT02-HB	KT02-HK
Al_2O_3	5.28	5.12	5.28	5.12	4.97
B_2O_3	4.45	4.32	4.80	7.20	4.20
BaO	0.08	0.07	0.08	0.07	0.07
CaO	0.94	0.91	0.94	0.91	0.89
Ce_2O_3	0.20	0.19	0.20	0.19	0.19
Cr_2O_3	0.10	0.10	0.10	0.10	0.10
CuO	0.03	0.03	0.03	0.03	0.03
Fe_2O_3	11.18	10.86	11.18	10.86	10.54
K_2O	0.07	0.07	0.07	0.07	18.38
La_2O_3	0.07	0.07	0.07	0.07	0.07
Li_2O	4.80	7.20	4.45	4.32	1.28
MgO	0.14	0.14	0.14	0.14	0.13
MnO	1.21	1.17	1.21	1.17	1.14
Na_2O	13.94	13.53	13.94	13.53	7.09
Nb_2O_5	0.40	0.39	0.40	0.39	0.38
NiO	0.34	0.33	0.34	0.33	0.32
PbO	0.11	0.11	0.11	0.11	0.10
SO_4	0.07	0.07	0.07	0.07	0.07
SiO_2	44.07	42.80	44.07	42.80	41.56
TiO_2	12.00	12.00	12.00	12.00	12.00
ZnO	0.05	0.05	0.05	0.05	0.05
ZrO_2	0.49	0.47	0.49	0.47	0.46

2.1.2 *KT03-series*

The KT03-series of compositions was developed to further investigate the potential impacts of the addition of the SCIX streams on glass properties. The average glass composition given in Table 2-1 was again used, with adjusted values (minimums and maximums) for the concentrations of Al_2O_3, B_2O_3, Fe_2O_3, K_2O, Li_2O, Na_2O, and SiO_2 to identify any impacts of these individual components on the behavior of TiO_2 in the glass. The TiO_2 concentrations were fixed at an elevated value of 8 wt %. The other major constituents of CST, Nb_2O_5 and ZrO_2, were fixed at elevated concentrations of 3 wt % and 2.5 wt %, respectively, to identify any interactive effects with TiO_2. The resulting target compositions for the KT03-series glasses are given in Table 2-4. Note that the last two glasses in the series, KT03-HK and KT03-MK, include elevated concentrations of K_2O. The K_2O concentrations in these glasses were developed using a molar substitution for Li_2O and Na_2O in amounts of approximately 60% and 30%, respectively. The concentrations of Nb_2O_5, TiO_2, and ZrO_2 in these glasses are slightly reduced as a result of the normalization of the remaining oxides after the substitution with K_2O. Note that the KT03 compositions do not necessarily pass the current PCCS constraints since they were developed for research and development efforts, rather than for specific DWPF compositions.

Table 2-4. Target Compositions (wt %) of the KT03-Series Glasses.

Oxide	KT03-LA	KT03-HA	KT03-LF	KT03-HF	KT03-LN	KT03-HN	KT03-LS
Al_2O_3	4.19	8.42	5.46	4.91	5.32	5.08	5.01
B_2O_3	4.50	4.27	4.61	4.15	4.49	4.28	4.23
BaO	0.08	0.07	0.08	0.07	0.08	0.07	0.07
CaO	0.95	0.90	0.97	0.87	0.95	0.90	0.89
Ce_2O_3	0.20	0.19	0.20	0.18	0.20	0.19	0.19
Cr_2O_3	0.10	0.10	0.11	0.09	0.10	0.10	0.10
CuO	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Fe_2O_3	11.29	10.71	8.24	16.08	11.27	10.76	10.62
K_2O	0.07	0.07	0.07	0.06	0.07	0.07	0.07
La_2O_3	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Li_2O	4.50	4.27	4.61	4.15	4.49	4.28	4.23
MgO	0.14	0.14	0.15	0.13	0.14	0.14	0.13
MnO	1.22	1.15	1.25	1.12	1.22	1.16	1.14
Na_2O	14.08	13.35	14.43	12.98	13.07	16.41	13.24
Nb_2O_5	3.00	3.00	3.00	3.00	3.00	3.00	3.00
NiO	0.34	0.32	0.35	0.31	0.34	0.33	0.32
PbO	0.11	0.10	0.11	0.10	0.11	0.10	0.10
SO_4	0.07	0.07	0.07	0.07	0.07	0.07	0.07
SiO_2	44.52	42.23	45.63	41.06	44.44	42.41	45.96
TiO_2	8.00	8.00	8.00	8.00	8.00	8.00	8.00
ZnO	0.05	0.05	0.05	0.05	0.05	0.05	0.05
ZrO_2	2.50	2.50	2.50	2.50	2.50	2.50	2.50

Table 2-4. Target Compositions (wt %) of the KT03-Series Glasses. (continued)

Oxide	KT03-HS	KT03-LL	KT03-HL	KT03-LB	KT03-HB	KT03-HK	KT03-MK
Al_2O_3	4.60	5.24	5.08	5.24	5.08	4.76	5.00
B_2O_3	3.89	4.42	4.29	4.80	7.20	4.02	4.22
BaO	0.07	0.08	0.07	0.08	0.07	0.07	0.07
CaO	0.82	0.93	0.90	0.93	0.90	0.85	0.89
Ce_2O_3	0.17	0.19	0.19	0.19	0.19	0.18	0.19
Cr_2O_3	0.09	0.10	0.10	0.10	0.10	0.09	0.10
CuO	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Fe_2O_3	9.76	11.09	10.77	11.09	10.77	10.08	10.59
K_2O	0.06	0.07	0.07	0.07	0.07	18.74	9.85
La_2O_3	0.06	0.07	0.07	0.07	0.07	0.06	0.07
Li_2O	3.89	4.80	7.20	4.42	4.29	1.04	2.65
MgO	0.12	0.14	0.14	0.14	0.14	0.13	0.13
MnO	1.05	1.20	1.16	1.20	1.16	1.09	1.14
Na_2O	12.16	13.83	13.43	13.83	13.43	6.39	9.96
Nb_2O_5	3.00	3.00	3.00	3.00	3.00	2.71	2.85
NiO	0.30	0.34	0.33	0.34	0.33	0.30	0.32
PbO	0.09	0.11	0.10	0.11	0.10	0.10	0.10
SO_4	0.06	0.07	0.07	0.07	0.07	0.06	0.07
SiO_2	49.24	43.74	42.46	43.74	42.46	39.75	41.76
TiO_2	8.00	8.00	8.00	8.00	8.00	7.24	7.60
ZnO	0.04	0.05	0.05	0.05	0.05	0.04	0.05
ZrO_2	2.50	2.50	2.50	2.50	2.50	2.26	2.38

2.1.3 *KT04-series*

The basis for the KT04-series compositions was changed from the average glass composition used previously (Table 2-1) to projections of individual sludge batches incorporating the SCIX streams. These projections were again very similar to those provided in the paper study report,[10] with minor refinements.[a] The most recent projections for sludge batches 8 through 17 were used,[33] and CST additions to Tank 40 were projected at the accelerated DWPF processing rate of 75 Sludge Receipt and Adjustment Tank (SRAT) batches per year with the SWPF streams included. Note that the sludge projections did not include sulfate concentrations. The final SRAT batch composition for each sludge batch was used, since these cases represent the maximum concentrations of CST in the sludge. The resulting ten sludge composition projections are given in Table 2-5. Each projection is identified by the relevant sludge batch and SRAT batch number.

[a] The method used to calculate the number of SRAT batches required to process each sludge batch was modified, which resulted in minor changes to the projected compositions.

Table 2-5. Projected Compositions (wt %) of the Final SRAT Batches of Sludge Batches 8 through 17 Used to Develop the KT04-Series Glass Compositions.

Oxide	SB08-69	SB09-79	SB10-80	SB11-70	SB12-71	SB13-66	SB14-74	SB15-91	SB16-38	SB17-35
Al_2O_3	14.25	12.68	10.85	12.29	17.00	17.86	12.51	10.96	12.14	12.51
BaO	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
CaO	2.30	2.31	2.32	2.12	2.32	2.43	1.98	1.76	2.11	2.16
Ce_2O_3	0.70	0.70	0.62	0.53	0.35	0.27	0.17	0.17	0.44	0.54
Cr_2O_3	0.22	0.22	0.22	0.22	0.33	0.33	0.33	0.22	0.22	0.23
CuO	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.10
Fe_2O_3	29.72	28.22	27.86	30.08	23.87	22.28	20.88	19.97	27.31	30.27
K_2O	0.09	0.09	0.09	0.09	0.18	0.27	0.18	0.18	0.18	0.09
La_2O_3	0.26	0.18	0.18	0.18	0.18	0.09	0.09	0.09	0.18	0.18
MgO	0.37	0.37	0.37	0.38	0.38	0.25	0.25	0.25	0.25	0.26
MnO	4.73	4.17	4.37	2.64	2.54	2.93	1.64	2.10	1.27	0.90
Na_2O	25.08	27.05	27.47	26.69	26.56	26.30	25.62	27.15	24.50	23.42
Nb_2O_5	2.54	2.68	2.66	2.61	2.67	2.53	2.66	2.83	1.88	1.75
NiO	0.86	0.48	0.77	0.39	0.29	0.39	1.42	1.32	1.15	1.08
PbO	0.40	0.32	0.32	0.24	0.16	0.16	0.16	0.16	0.33	0.33
SiO_2	3.43	4.68	5.15	6.74	8.08	7.96	6.55	5.72	3.04	2.31
ThO_2	0.43	1.54	2.14	0.60	0.00	0.00	0.00	0.00	0.00	0.00
TiO_2	10.67	10.69	10.64	10.91	11.03	10.80	10.79	10.79	10.72	10.04
U_3O_8	1.41	0.80	1.16	0.54	1.25	2.32	11.97	13.54	12.13	11.87
ZnO	0.00	0.09	0.09	0.19	0.09	0.19	0.19	0.09	0.09	0.10
ZrO_2	2.27	2.47	2.46	2.32	2.46	2.36	2.35	2.47	1.78	1.70

A single frit composition was identified that produced a PCCS Measurement Acceptability Region (MAR) acceptable glass at a target waste loading of 40 wt % with each of the sludge composition projections given in Table 2-5. The composition of this frit, which was labeled Frit 0607, is given in Table 2-6. The U_3O_8 and ThO_2 components were removed from the sludge projections to support non-radioactive experiments. Each of the re-normalized sludge compositions was then combined with Frit 0607 at a waste loading of 40 wt % to give the target glass compositions for the KT04-series shown in Table 2-7.

Table 2-6. Composition of Frit 0607 (wt %).

B_2O_3	Li_2O	Na_2O	SiO_2
10	6	5	79

Table 2-7. Target Compositions (wt %) for the KT04-Series Glasses.

Oxide	KT04-01	KT04-02	KT04-03	KT04-04	KT04-05	KT04-06	KT04-07	KT04-08	KT04-09	KT04-10
Al_2O_3	5.80	5.19	4.49	4.97	6.89	7.31	5.69	5.07	5.53	5.68
B_2O_3	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
BaO	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
CaO	0.94	0.95	0.96	0.86	0.94	1.00	0.90	0.81	0.96	0.98
Ce_2O_3	0.29	0.29	0.26	0.22	0.14	0.11	0.08	0.08	0.20	0.25
Cr_2O_3	0.09	0.09	0.09	0.09	0.13	0.14	0.15	0.10	0.10	0.10
CuO	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Fe_2O_3	12.11	11.56	11.53	12.17	9.67	9.12	9.49	9.24	12.43	13.74
K_2O	0.04	0.04	0.04	0.04	0.07	0.11	0.08	0.08	0.08	0.04
La_2O_3	0.11	0.07	0.07	0.07	0.07	0.04	0.04	0.04	0.08	0.08
Li_2O	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60	3.60
MgO	0.15	0.15	0.15	0.15	0.15	0.10	0.11	0.11	0.11	0.12
MnO	1.93	1.71	1.81	1.07	1.03	1.20	0.74	0.97	0.58	0.41
Na_2O	13.22	14.08	14.36	13.80	13.76	13.77	14.64	15.56	14.15	13.63
Nb_2O_5	1.04	1.10	1.10	1.06	1.08	1.03	1.21	1.31	0.85	0.79
NiO	0.35	0.20	0.32	0.16	0.12	0.16	0.65	0.61	0.52	0.49
PbO	0.16	0.13	0.13	0.10	0.07	0.07	0.07	0.07	0.15	0.15
SiO_2	48.80	49.32	49.53	50.13	50.67	50.66	50.38	50.04	48.79	48.45
TiO_2	4.35	4.38	4.40	4.41	4.47	4.42	4.90	4.99	4.88	4.56
ZnO	0.00	0.04	0.04	0.08	0.04	0.08	0.08	0.04	0.04	0.04
ZrO_2	0.92	1.01	1.02	0.94	1.00	0.97	1.07	1.14	0.81	0.77

2.2 Glass Fabrication

Each of the study glasses was prepared from the proper proportions of reagent-grade metal oxides, carbonates, and boric acid in 200 g batches. The raw materials were thoroughly mixed and placed into platinum/gold, 250 ml crucibles. The batch was placed into a high-temperature furnace at the melt temperature of 1150 °C. The crucible was removed from the furnace after an isothermal hold for 1 hour. The glass was poured onto a clean, stainless steel plate and allowed to air cool (quench). The glass pour patty was used as a sampling stock for the various property measurements described below.

Approximately 25 g of each glass was heat-treated to simulate cooling along the centerline of a DWPF-type canister[34] to gauge the effects of thermal history on the product performance. This cooling schedule is referred to as the CCC heat treatment. Visual observations of both quenched and CCC glasses were documented.[a]

2.3 Compositional Analysis

To confirm that the as-fabricated glasses met the target compositions, a representative sample from each quenched glass in the KT01, KT03, and KT04-series was submitted to the Process Science Analytical Laboratory (PSAL) for chemical analysis under the auspices of an analytical plan.[35-37] The KT02-series glasses were not measured. Two dissolution techniques, sodium peroxide fusion (PF) and lithium-metaborate fusion (LM), were used to prepare the glass samples, in duplicate, for analysis. Each of the samples was analyzed, twice for each element of interest, by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES). Glass standards (Batch 1) were also intermittently measured to assess the performance of the ICP-AES instrument over the course of these analyses.

2.4 X-Ray Diffraction Analysis

Representative samples of each quenched and CCC glass were submitted to Analytical Development (AD) for XRD analysis. Samples were run under conditions providing a detection limit of approximately 0.5 vol %. That is, if crystals (or unincorporated batch material) were present at 0.5 vol % or greater, the diffractometer would not only be capable of detecting the crystals but would also allow a qualitative determination of the type of crystal(s) present. Otherwise, a characteristically high background signal (amorphous hump) devoid of crystalline peaks indicates that the glass product is free of crystallization, suggesting either a completely amorphous product or that the degree of crystallization is below the detection limit.

2.5 Product Consistency Test

The PCT Method-A[23] was performed in triplicate on each KT01, KT03, and KT04-series quenched and CCC glass to assess chemical durability. Also included in the experimental test matrix was the EA benchmark glass,[38] the Approved Reference Material (ARM) glass,[22] and blanks from the sample cleaning batch. Samples were ground, washed, and prepared according to the standard procedure.[23] Fifteen milliliters of Type-I ASTM water were added to 1.5 g of glass in stainless steel vessels. The vessels were closed, sealed, and placed in an oven at 90 ± 2 °C where the samples were maintained at temperature for 7 days. Once cooled, the resulting solutions were sampled (filtered and acidified), then labeled and analyzed by PSAL under the auspices of an analytical plan.[39-41] Samples of a multi-element, standard solution were also included in the analytical plan as a check on the accuracy of the ICP-AES instrument used for

[a] See notebook SRNL-NB-2010-00027.

these measurements. Normalized release rates were calculated based on the target and measured compositions using the average of the common logarithms of the leachate concentrations.

2.6 Viscosity

The viscosity of select glasses was measured following Procedure A of the ASTM C 965 standard.[42] Harrop and Orton high temperature rotating spindle viscometers were used with platinum crucibles and spindles. The viscometers were specially designed to operate with small quantities of glass to support measurements of radioactive glasses when necessary.[43,44] A well characterized standard glass was used to determine the appropriate spindle constants.[44,45] Measurements were taken over a range of temperatures from 1050 to 1250 °C in 50 °C intervals. Measurements at 1150 °C were taken at three different times during the procedure to provide an opportunity to identify the effects of any crystallization or volatilization that may have occurred during the test. The data were fit to a Fulcher equation[20,21] to provide a measured viscosity value at the nominal DWPF melt temperature of 1150 °C.

2.7 Liquidus Temperature

The liquidus temperatures (T_L) of select study glasses were determined using the isothermal heat treatment method.[46] The temperature profile of the furnace was carefully determined and periodically verified.[47] All thermocouples and temperature measurement devices were calibrated and periodically verified by the SRNL Measurement and Test Equipment (M&TE) program. A standard glass composition was incorporated into the test glass matrix as a method of verifying the measured data.[a] Polished samples of each quenched glass were observed via optical microscopy prior to T_L measurement to determine whether any preexisting crystals were present. Quenched glasses that were found to contain crystals were excluded from testing. The study glasses were ground, washed, dried, and heat treated in platinum boats with tight fitting lids following the procedure.[46] The glasses were air quenched after being removed from the furnace, then sectioned and polished for microscopy.[48] Any bulk crystallization that occurred during the isothermal heat treatments was identified by optical microscopy. The procedure was repeated over various temperatures to determine the T_L to within a narrow range of tolerance.

Liquidus temperatures were determined for the KT01-series glasses. Liquidus temperatures for the KT02-series glasses were not measured due to their unrealistically high TiO_2 concentrations. In the interest of reducing the time necessary for the measurements, the T_L for the KT03 and KT04-series glasses were estimated. The isothermal heat treatment method described above was continued, although a smaller number of heat treatments were performed in order to estimate the T_L for each glass over a broader range of temperature while supporting comparisons with the model predicted T_L values. Liquidus temperature estimates for the KT03 and KT04-series glasses are not yet complete, and the results will be reported in a separate technical report.

3.0 Results and Discussion

3.1 Homogeneity

The homogeneity of each glass sample was assessed via XRD and visual observations. The results will be discussed below for each series of glasses. The potential impacts of any crystallization that was identified will be discussed during the later description of the measured properties of the glasses (i.e., viscosity, liquidus temperature, etc.).

[a] The glass standard is identified as 'Unknown Glass A' from the Pacific Northwest National Laboratory liquidus temperature round robin study.

3.1.1 *KT01-Series*

Visual observations of the quenched versions of the KT01-series glasses identified no visible crystallization.[a] All of the quenched glasses were found to be amorphous by XRD. Visual observations of the CCC versions of the KT01-series glasses identified minor surface crystallization, indicated by a dull or hazy appearance. Crystallization within the bulk of the glass was only observed for compositions KT01-HL and KT01-HF. XRD results were in agreement with the visual observations, with crystallization being identified in compositions KT01-HL and KT01-HF. Composition KT01-HL contained magnetite ($Fe^{2+}Fe_2^{2+}O_8$) and lithium silicate (Li_2SiO_3), likely due to the elevated concentration of Li_2O in this glass (see Table 2-2). Composition KT01-HF contained magnetite, likely because of the elevated concentration of Fe_2O_3 in this glass.

3.1.2 *KT02-Series*

Visual observations of the quenched versions of the KT02-series glasses identified some minor surface crystallization on some of the glasses, visible as a small number of light brown streaks. All of the quenched glasses were amorphous by XRD, indicating that the volume fraction of the observed surface crystallization was very small. Visual observations of the CCC versions of the KT02-series identified varying degrees of surface crystallization on all of the glasses. Most of the glasses were also crystallized in the bulk, with the exception of compositions KT02-LA, KT02-LF, KT02-HN, and KT02-HK. The XRD results for the CCC glasses were in agreement with these observations: crystalline phases were identified in all of the glasses except for compositions KT02-LA, KT02-LF, KT02-HN, and KT02-HK.

The KT02 compositions were selected to explore the impact of varying the concentrations of the major components of the glass on the retention of TiO_2 (see Section 2.1.1). The XRD results for the KT02 glasses are summarized in Table 3-1, which offers some insight into the impact of compositional changes on the propensity for titanium to crystallize out of the glass. As mentioned earlier, all of the quenched glasses were XRD amorphous. Titanium containing crystalline phases formed in all of the compositions except for the low Al_2O_3 concentration glass, the low Fe_2O_3 concentration glass, the high Na_2O concentration glass, and the high K_2O concentration glass.[b] In general, the impacts of these components will need additional investigation before drawing further conclusions (i.e., a larger number of compositions should be fabricated and characterized since the effects of an individual component are likely to be strongly influenced by overall composition).

[a] See laboratory notebook SRNL-NB-2010-00027 for a complete record of the visual observations and XRD data.
[b] The CCC version of glass KT02-LS contained an unidentified phase that may or may not contain TiO_2. Further characterization of this glass is in progress to identify this phase.

Table 3-1. Summary of XRD Results for the KT02-Series Glasses.

Glass ID	Composition Note	Heat Treatment	XRD Results
KT02-HA	High Al_2O_3	quenched	amorphous
		CCC	$LiFeTiO_4$, unidentified phase
KT02-LA	Low Al_2O_3	quenched	amorphous
		CCC	amorphous
KT02-HB	High B_2O_3	quenched	amorphous
		CCC	$LiFeTiO_4$, unidentified phase
KT02-LB	Low B_2O_3	quenched	amorphous
		CCC	$LiFeTiO_4$, unidentified phase
KT02-HF	High Fe_2O_3	quenched	amorphous
		CCC	$LiFeTiO_4$, Fe_9TiO_{15}
KT02-LF	Low Fe_2O_3	quenched	amorphous
		CCC	amorphous
KT02-HL	High Li_2O	quenched	amorphous
		CCC	$LiFeTiO_4$, Li_2SiO_3
KT02-LL	Low Li_2O	quenched	amorphous
		CCC	$LiFeTiO_4$, unidentified phase
KT02-HN	High Na_2O	quenched	amorphous
		CCC	amorphous
KT02-LN	Low Na_2O	quenched	amorphous
		CCC	$LiFeTiO_4$, unidentified phase
KT02-HS	High SiO_2	quenched	amorphous
		CCC	Rutile (TiO_2), Hematite (Fe_2O_3)
KT02-LS	Low SiO_2	quenched	amorphous
		CCC	unidentified phase
KT02-HK	High K_2O	quenched	amorphous
		CCC	amorphous

3.1.3 *KT03-Series*

Visual observations of the quenched versions of the KT03-series glasses identified no visible crystallization, and the XRD results indicated that all of the quenched glasses were amorphous. Visual observations of the CCC versions of the glasses indicated surface crystallization on all of the compositions. The XRD results for the CCC glasses showed that four of the compositions, KT03-LN, KT03-LB, KT03-LL, and KT03-HF, contained magnetite and trevorite ($NiFe_2O_4$). Two of the glasses were highly devitrified: KT03-HL contained trevorite ($NiFe_2O_4$) and KT03-HA contained magnetite with another unidentified phase.

3.1.4 *KT04-Series*

Visual observations of the quenched versions of the KT04-series glasses identified no visible crystallization, and the XRD results indicated that all of the quenched glasses were amorphous. Visual observations of the CCC versions of the glasses indicated a very minor amount of surface crystallization on some of the compositions. All of the CCC glasses were amorphous by XRD.

3.2 Chemical Composition

In this section, the measured versus targeted compositions of the study glasses are presented and compared. Measurements for samples of the Batch 1 standard glass that were included in the analytical plans along with the study glasses are also discussed. The elemental concentrations were converted to oxide concentrations by multiplying the values for each element by the gravimetric factor for the corresponding oxide. During this process, an elemental concentration that was determined to be below the detection limit of the analytical procedures used was reduced to half of that detection limit as the oxide concentration was determined. In the sections that follow, the analytical sequences of the measurements are explored, the measurements of the standard are investigated, the measurements for each glass are reviewed, the average chemical compositions for each glass are determined, and comparisons are made between the measurements and the targeted compositions of the glasses.

3.2.1 *KT01-Series*

Table A-1 and Table A-2 in Appendix A provide the elemental concentration measurements from the KT01 glasses that were prepared using LM, and Table A-3 in Appendix A provides the measurements from the samples of these glasses prepared using PF. Measurements for samples of the standard Batch 1 glass that were included in the analytical plan along with the study glasses are also provided in these tables. Exhibit A-1 in Appendix A provides plots in analytical sequence of the sample measurements generated by PSAL for each oxide over both preparation methods. The plots are in analytical sequence with different symbols and colors being used to represent each of the study glasses and the standard glass. In general, there does not appear to be any gross patterns or trends due to the analytical sequence. However, there is an obvious issue with the measured TiO_2 concentration for the samples from glass KT01-HA. It appears that TiO_2 was omitted from the batching process for this glass. A second version of this glass was batched and identified as KT01-HA2. The corrected glass was included in the analytical work with the KT03-series, as described in the analytical plans for that series.[36,40] The original KT01-HA glass was discarded for all measurements. Further opportunity for a review of the measurements for each glass is provided in the discussions that follow.

Exhibit A-2 in Appendix A provides plots of the oxide concentration measurements by Glass ID (including the Batch 1 standard) by analytical solution or Lab ID for both preparation methods for the KT01-series. The different symbols and colors being used to represent the glasses are discernable in this exhibit. These plots show the individual measurements across the duplicates of each preparation method and the two ICP-AES calibrations for each glass for each oxide. The results are grouped by analytical block and arranged by targeted concentration to facilitate the interpretation of the measurements. A review of the plots presented in these exhibits reveals the repeatability of the four individual values for each oxide for each glass. There appears to be good repeatability of these measurements for each of the oxides for each of the glasses, with the exception of KT01-HA. The lack of TiO_2 in this glass pushes the measured concentrations of most of the other oxides above their target values. Again, this glass was discarded and replaced with KT01-HA2, which will be discussed as part of the KT03-series data. The data suggest no other significant issues in the batching of the KT01 glasses or in the analytical process used to provide representative measurements of their compositions.

Exhibit A-3 in Appendix A provides statistical analyses of the results for the Batch 1 standard that was included with the KT01 glasses by analytical block/sub-block for each oxide of interest over both preparation methods. The results include analysis of variance (ANOVA) investigations looking for statistically significant differences among the means of these groups for each of the oxides. The reference values for the oxide concentrations of the standard are given in the header for each set of measurements in the exhibit. The results from the statistical tests for the Batch 1 standard included with the KT01 glasses may be summarized as follows: Al_2O_3, BaO, CaO, Cr_2O_3, Fe_2O_3, K_2O, Li_2O, MgO, MnO, NiO, SiO_2, and TiO_2 have measurements that indicate an

ICP-AES calibration effect on the block averages at the 5% significance level. While statistically significant, the practical impact of these calibration effects is minimal.

All of the measurements for each oxide for each KT01 glass (i.e., all of the measurements in Appendix A Table A-1, Table A-2, and Table A-3) were averaged to determine a representative chemical composition for each glass. A sum of oxides was also computed for each glass based upon the measured values. Exhibit A-4 in Appendix A provides plots showing results for each glass for each oxide to help highlight the comparisons among the measured and targeted values. Some observations from the plots of Exhibit A-4 are offered: The K_2O concentration for glass KT01-HK is slightly below the target. The concentrations of BaO, Ce_2O_3, La_2O_3, Na_2O, NiO, PbO, SiO_2, and ZrO_2 were slightly low for most of the KT01 glasses, as was the sum of oxides. The concentration of Nb_2O_5 was slightly high for all of the KT01 glasses. The SO_4 measurements were hindered by the detection limit of the instrument. The composition of glass KT01-HA is erroneous due to the lack of TiO_2, as discussed earlier. In general, there appear to have been only minor difficulties in meeting the targeted concentrations for the KT01 glasses.

Table A-4 in Appendix A provides a summary of the average measured compositions as well as the targeted compositions and the associated differences and relative differences. Note that the targeted sum of oxides for the Batch 1 standard does not sum to 100% due to an incomplete coverage of the oxides in this glass. All of the sums of oxides for the KT01 glasses fall within the PCCS acceptable interval of 95 to 105 wt%. Entries in Table A-4 show the relative differences between the measured values and the targeted values. These differences are shaded when they are greater than or equal to 5%. Overall, these comparisons between the measured and targeted compositions again suggest only minor difficulties in hitting the targeted compositions for the KT01 glasses.

3.2.2 *KT03-Series*

Table B-1 and Table B-2 in Appendix B provide the elemental concentration measurements from the KT03 glasses that were prepared using LM, and Table B-3 in Appendix B provides the measurements from the samples of these glasses prepared using PF. Measurements for samples of the standard Batch 1 glass that were included in the analytical plan along with the study glasses are also provided in these tables. Exhibit B-1 in Appendix B provides plots in analytical sequence of the sample measurements generated by PSAL for each oxide over both preparation methods. The plots are in analytical sequence with different symbols and colors being used to represent each of the study glasses and the standard glass. In general, there does not appear to be any gross patterns or trends due to the analytical sequence. Further opportunity for a review of the measurements for each glass is provided in the discussions that follow.

Exhibit B-2 in Appendix B provides plots of the oxide concentration measurements by Glass ID (including the Batch 1 standard) by analytical solution or Lab ID for both preparation methods for the KT03-series. The different symbols and colors being used to represent the glasses are discernable in this exhibit. These plots show the individual measurements across the duplicates of each preparation method and the two ICP-AES calibrations for each glass for each oxide. The results are grouped by analytical block and arranged by targeted concentration to facilitate the interpretation of the measurements. A review of the plots presented in these exhibits reveals the repeatability of the four individual values for each oxide for each glass. There appears to be good repeatability of these measurements for each of the oxides for each of the glasses. Some minor issues are apparent, including a high concentration of BaO in glass KT03-LA. There is a minor amount of scatter in the Cr_2O_3 values, with a possible preparation issue for glass KT03-HK. There is a possible calibration issue with the Na_2O measurements for glass KT03-LN. Concentrations of Nb_2O_5 are slightly low for several of the glasses. There are possible preparation issues for the NiO measurements for glasses KT03-HA and KT03-HN. The ZrO_2 concentrations are slightly low for most of the glasses. Despite these minor issues, the data suggest no significant problems in the batching of the KT03 glasses or in the analytical process used to provide representative measurements of their compositions. Note that there were no issues with the corrected version of the KT01 series glass KT01-HA2. This version of the glass will therefore be used in support of further characterization of that composition.

Exhibit B-3 in Appendix B provides statistical analyses of the results for the Batch 1 standard that was included with the KT03 glasses by analytical block/sub-block for each oxide of interest over both preparation methods. The results include ANOVA investigations looking for statistically significant differences among the means of these groups for each of the oxides. The reference values for the oxide concentrations of the standard are given in the header for each set of measurements in the exhibit. The results from the statistical tests for the Batch 1 standard included with the KT03 glasses may be summarized as follows: Al_2O_3, BaO, CaO, Ce_2O_3, Cr_2O_3, Li_2O, MgO, and NiO have measurements that indicate an ICP-AES calibration effect on the block averages at the 5% significance level. While statistically significant, the practical impact of these calibration effects is minimal.

All of the measurements for each oxide for each KT03 glass (i.e., all of the measurements in Appendix B, Table B-1, Table B-2, and Table B-3) were averaged to determine a representative chemical composition for each glass. A sum of oxides was also computed for each glass based upon the measured values. Exhibit B-4 in Appendix B provides plots showing results for each glass for each oxide to help highlight the comparisons among the measured and targeted values. Some observations from the plots of Exhibit B-4 are offered: The Al_2O_3 concentration is slightly high for glass KT03-HF. The BaO concentration is high for glass KT03-LA. The CaO concentration is slightly high for most of the glasses. There is minor scatter in the Cr_2O_3, NiO, and SiO_2 values. The Fe_2O_3, MnO, Nb_2O_5, TiO_2, and ZrO_2 concentrations are slightly low for some of the glasses. The K_2O concentration is slightly low for glass KT03-HK. The MgO concentration is slightly low for glass KT03-MK and the Batch 1 standard. The SO_4 measurements were hindered by the detection limit of the instrument. In general, there appear to have been only minor difficulties in meeting the targeted concentrations for the KT03 glasses and glass KT01-HA2.

Table B-4 in Appendix B provides a summary of the average measured compositions as well as the targeted compositions and the associated differences and relative differences. Note that the targeted sum of oxides for the Batch 1 standard does not sum to 100% due to an incomplete coverage of the oxides in this glass. All of the sums of oxides for the KT03 glasses fall within the PCCS acceptable interval of 95 to 105 wt%. Entries in Table B-4 show the relative differences between the measured values and the targeted values. These differences are shaded when they are greater than or equal to 5%. Overall, these comparisons between the measured and targeted compositions again suggest only minor difficulties in hitting the targeted compositions for the KT03 glasses and glass KT01-HA2.

3.2.3 *KT04-Series*

Table C-1 and Table C-2 in Appendix C provide the elemental concentration measurements from the KT04 glasses that were prepared using LM, and Table C-3 in Appendix C provides the measurements from the samples of these glasses prepared using PF. Measurements for samples of the standard Batch 1 glass that were included in the analytical plan along with the study glasses are also provided in these tables. Exhibit C-1 in Appendix C provides plots in analytical sequence of the sample measurements generated by PSAL for each oxide over both preparation methods. The plots are in analytical sequence with different symbols and colors being used to represent each of the study glasses and the standard glass. In general, there does not appear to be any gross patterns or trends due to the analytical sequence. Further opportunity for a review of the measurements for each glass is provided in the discussions that follow.

Exhibit C-2 in Appendix C provides plots of the oxide concentration measurements by Glass ID (including the Batch 1 standard) by analytical solution or Lab ID for both preparation methods for the KT04-series. The different symbols and colors being used to represent the glasses are discernable in this exhibit. These plots show the individual measurements across the duplicates of each preparation method and the two ICP-AES calibrations for each glass for each oxide. The results are grouped by analytical block and arranged by targeted concentration to facilitate the interpretation of the measurements. A review of the plots presented in these exhibits reveals the repeatability of the four individual values for each oxide for each glass. There appears to be good repeatability of these measurements for each of the oxides for each of the glasses. Some minor issues are apparent, including minor calibration differences for B_2O_3, Li_2O, Na_2O, and SiO_2 for some of the glasses. Despite these minor issues, the data suggest no significant problems in the batching of the KT04 glasses or in the analytical process used to provide representative measurements of their compositions.

Exhibit C-3 in Appendix C provides statistical analyses of the results for the Batch 1 standard that was included with the KT04 glasses by analytical block/sub-block for each oxide of interest over both preparation methods. The results include ANOVA investigations looking for statistically significant differences among the means of these groups for each of the oxides. The reference values for the oxide concentrations of the standard are given in the header for each set of measurements in the exhibit. The results from the statistical tests for the Batch 1 standard included with the KT04 glasses may be summarized as follows: BaO, Cr_2O_3, K_2O, Li_2O, and ZrO_2 have measurements that indicate an ICP-AES calibration effect on the block averages at the 5% significance level. While statistically significant, the practical impact of these calibration effects is minimal.

All of the measurements for each oxide for each KT04 glass (i.e., all of the measurements in Appendix C Table C-1, Table C-2, and Table C-3) were averaged to determine a representative chemical composition for each glass. A sum of oxides was also computed for each glass based upon the measured values. Exhibit C-4 in Appendix C provides plots showing results for each glass for each oxide to help highlight the comparisons among the measured and targeted values. Some observations from the plots of Exhibit C-4 are offered: The Al_2O_3 concentrations are slightly above target. The B_2O_3, Fe_2O_3, SiO_2, and ZrO_2 concentrations are slightly low for all of the glasses. The CaO, Li_2O, and Na_2O concentrations are slightly high for some of the glasses. There is minor scatter in the Cr_2O_3 values. The concentrations of Nb_2O_5, NiO, and PbO are slightly low for some of the glasses. In general, there appear to have been only minor difficulties in meeting the targeted concentrations for the KT04 glasses.

Table C-4 in Appendix C provides a summary of the average measured compositions as well as the targeted compositions and the associated differences and relative differences. Note that the targeted sum of oxides for the Batch 1 standard does not sum to 100% due to an incomplete coverage of the oxides in this glass. All of the sums of oxides for the KT04 glasses fall within the PCCS acceptable interval of 95 to 105 wt%. Entries in Table C-4 show the relative differences between the measured values and the targeted values. These differences are shaded when they are greater than or equal to 5%. Overall, these comparisons between the measured and targeted compositions again suggest only minor difficulties in hitting the targeted compositions for the KT04 glasses.

3.3 Durability

The measurements generated by the PCTs are presented and reviewed in the following sections. For each series of glasses below, the analytical sequence of the measurements is explored, the measurements of the standards are investigated and used to assess the overall accuracy of the ICP-AES measurement process, the measurements for each glass are reviewed, plots are provided that explore the effects of heat treatment on the PCTs for these glasses, the PCTs are normalized using the compositions (targeted and measured) discussed in Section 3.2, and the normalized PCTs are compared to durability predictions for these compositions generated from the current DWPF models.[3]

One of the quality control checkpoints for the PCT procedure is solution mass loss over the course of the seven day test. None of the vessels in the KT01, KT03, or KT04 PCTs had any issues with mass loss. The ratio of leachant volume to the mass of ground glass was also confirmed to be correct for each vessel. All of the measurements of the ARM glass fell within the control ranges.[22]

3.3.1 *KT01-Series*

Table D-1 in Appendix D provides the elemental leachate concentration measurements determined by the PSAL for the solution samples generated by the PCTs for the KT01 glasses. The values were adjusted for the dilution factors: the values for the study glasses, the blanks, and the ARM glass in Table D-1 were multiplied by 1.6667 to determine the values in parts per million and the values for EA were multiplied by 16.6667. Table D-1 also provides the resulting ppm measurements.

Exhibit D-1 in Appendix D provides plots of the leachate (ppm) concentrations in analytical sequence as generated by the PSAL for all of the data from the KT01 PCTs. Different colors and symbols are used for each of the study glasses and standards. No issues are seen in these plots.

Exhibit D-2 in Appendix D provides analyses of the PSAL measurements of the samples of the multi-element standard solution by analytical set and ICP-AES calibration block for the KT01-series. An ANOVA investigating for statistically significant differences among the block averages for these samples for each element of interest is included in the exhibit. A statistically significant (at a 5% level) difference among the averages of these measurements was indicated for Li and Si. However, no attempt was made to bias correct for these effects since averaging the measured concentrations for each set of triplicates in the PCT helps to minimize the impact of any potential ICP-AES bias effects.

Exhibit D-3 in Appendix D provides plots of the leachate concentrations for each type of submitted sample: the study glasses by heat treatment and the standards (EA, ARM, the multi-element solution standard, and blanks). The common logarithm plots allow for the assessment of the repeatability of the measurements, which suggest only minor scatter in the triplicate values for some analytes for some of the glasses.

The PCT leachate concentrations were normalized using the target and measured cation compositions of the glasses to obtain g/L leachate concentrations following the procedure.[23] Exhibit D-4 in Appendix D provides scatter plots for these results and offers an opportunity to investigate the consistency in the leaching across the elements for the KT01 glasses. All combinations of the normalizations of the PCTs (i.e., those generated using the targeted and measured compositional views) and both heat treatments are represented in the series of scatter plots. Consistency in the leaching across the elements is typically demonstrated by a high degree of linear correlation among the values for pairs of these elements. The smallest correlation in this plot is that for Na and Si with a value of ~82%, indicating relatively linear correlations for all of the element pairs.

Table D-2 in Appendix D summarizes the normalized PCTs for the KT01 glasses. The PCTs are listed by heat treatment and compositional view for each glass. The KT01 glasses all had NL [B] values that were well below the 16.695 g/L value of the benchmark EA glass. The highest NL [B] value was for glass KT01-HL, the high Li_2O composition, with values of 1.2 g/L and 1.5 g/L for the quenched and CCC versions of this glass, respectively, normalized to the measured composition.

Exhibit D-5 in Appendix D provides plots showing comparisons of the normalized PCT responses for the two heat treatments for each glass. A review of these plots shows only minor differences in normalized release for the KT01 glasses as a function of heat treatment. Glass KT01-HL shows an increase in normalized release for Li and Si after the CCC heat treatment, although these values remain far below those of the benchmark EA glass. The difference in PCT response is likely due to the presence of lithium silicate (Li_2SiO_3) identified in the CCC version of KT01-HL (see Section 3.1.1).

The predictability of the KT01 PCT responses was evaluated using the DWPF durability model. The predicted PCT values, determined using the targeted and measured compositions of the KT01 glasses, were compared with the normalized PCT responses. Exhibit D-6 in Appendix D provides plots of the DWPF models for B, Li, Na, and Si that relate the logarithm of the normalized PCT value (for each element of interest) to a linear function of a free energy of hydration term (ΔG_p, in kcal/100 g glass) derived from all of the compositional views and heat treatments of the KT01 glasses. Prediction limits at a 95% confidence for an individual PCT result are also plotted along with the linear fit. The EA and ARM results are indicated on these plots as well. All but one of the KT01 glasses fall within the prediction limits of the DWPF model. Glass KT01-HK (the high K_2O concentration composition) has a PCT response that falls below the lower prediction limit; however, the PCT response of this glass remains considerably lower than that of the benchmark EA glass.

3.3.2 *KT03-Series*

Table E-1 in Appendix E provides the elemental leachate concentration measurements determined by the PSAL for the solution samples generated by the PCTs for the KT03 glasses. Note that the corrected version of glass KT01-HA, labeled KT01-HA2, is also included with the PCT analyses of the KT03-series glasses. The values were adjusted for the dilution factors: the values for the study glasses, the blanks, and the ARM glass in Table E-1 were multiplied by 1.6667 to determine the values in parts per million and the values for EA were multiplied by 16.6667. Table E-1 also provides the resulting ppm measurements.

Exhibit E-1 in Appendix E provides plots of the leachate (ppm) concentrations in analytical sequence as generated by the PSAL for all of the data from the KT03 PCTs. Different colors and symbols are used for each of the study glasses and standards. No issues are seen in these plots.

Exhibit E-2 in Appendix E provides analyses of the PSAL measurements of the samples of the multi-element standard solution by analytical set and ICP-AES calibration block for the KT03-series. An ANOVA investigating for statistically significant differences among the block averages for these samples for each element of interest is included in the exhibit. No statistically significant (at a 5% level) difference among the averages of these measurements was indicated.

Exhibit E-3 in Appendix E provides plots of the leachate concentrations for each type of submitted sample: the study glasses by heat treatment and the standards (EA, ARM, the multi-element solution standard, and blanks). The common logarithm plots allow for the assessment of the repeatability of the measurements, which suggest very little scatter in the triplicate values for some analytes for some of the glasses.

The PCT leachate concentrations were normalized using the target and measured cation compositions of the glasses to obtain g/L leachate concentrations following the procedure.[23] Exhibit E-4 in Appendix E provides scatter plots for these results and offers an opportunity to investigate the consistency in the leaching across the elements for the KT03 glasses. The smallest correlation in this plot is that for Na and Si with a value of ~68%. This non-linearity will not have a significant impact on the outcome of the study since all of the glasses are highly durable.

Table E-2 in Appendix E summarizes the normalized PCTs for the KT03 glasses. The PCTs are listed by heat treatment and compositional view for each glass. The KT03 glasses all had NL [B] values that were well below the 16.695 g/L value of the benchmark EA glass. The highest NL [B] value was for the quenched version of glass KT03-HK, the high K_2O composition, with a value of 1.4 g/L normalized to the measured composition.

Exhibit E-5 in Appendix E provides plots showing comparisons of the normalized PCT responses for the two heat treatments for each glass. A review of these plots shows only minor differences in normalized release for the KT03 glasses as a function of heat treatment. Glass KT03-HK shows a decrease in normalized release for B and Na and an increase in normalized release for Si after the CCC heat treatment. Glass KT03-HL shows an increase in normalized release for Li and Si after the CCC heat treatment. The differences in these PCT responses with heat treatment may be due to crystallization (see Section 3.1.3), although normalized releases for both of these glasses remain far below those of the benchmark EA glass.

The predictability of the KT03 PCT responses was evaluated using the DWPF durability model. The predicted PCT values, determined using the targeted and measured compositions of the KT03 glasses, were compared with the normalized PCT responses. Exhibit E-6 in Appendix E provides plots of the DWPF models for B, Li, Na, and Si that relate the logarithm of the normalized PCT value (for each element of interest) to the ΔG_p term derived from all of the compositional views and heat treatments of the KT03 glasses. Note that glass KT01-HA2 is also included in these plots. Prediction limits at a 95% confidence for an individual PCT result are also plotted along with the linear fit. The EA and ARM results are indicated on these plots as well. All but two of the KT03 glasses fall within the prediction limits of the DWPF model. Glasses KT03-HK and KT03-MK have PCT responses that fall below the lower prediction limit; however, the PCT responses of these glasses remain considerably lower than that of the benchmark EA glass. As seen in the KT01 plots (Section 3.3.1), there is an issue with the predictability of these high K_2O concentration glasses. However, this lack of model applicability may be of little practical importance since K_2O concentrations of this magnitude are unlikely for actual compositions to be processed at the DWPF.

3.3.3 *KT04-Series*

Table F-1 in Appendix F provides the elemental leachate concentration measurements determined by the PSAL for the solution samples generated by the PCTs for the KT04 glasses. The values were adjusted for the dilution factors: the values for the study glasses, the blanks, and the ARM glass in Table F-1 were multiplied by 1.6667 to determine the values in parts per million and the values for EA were multiplied by 16.6667. Table F-1 also provides the resulting ppm measurements.

Exhibit F-1 in Appendix F provides plots of the leachate (ppm) concentrations in analytical sequence as generated by the PSAL for all of the data from the KT04 PCTs. Different colors and symbols are used for each of the study glasses and standards. No issues are seen in these plots.

Exhibit F-2 in Appendix F provides analyses of the PSAL measurements of the samples of the multi-element standard solution by analytical set and ICP-AES calibration block for the KT04-series. An ANOVA investigating for statistically significant differences among the block averages for these samples for each element of interest is included in the exhibit. No statistically significant (at a 5% level) difference among the averages of these measurements was indicated.

Exhibit F-3 in Appendix F provides plots of the leachate concentrations for each type of submitted sample: the study glasses by heat treatment and the standards (EA, ARM, the multi-element solution standard, and blanks). The common logarithm plots allow for the assessment of the repeatability of the measurements, which suggest only minor scatter in the triplicate values for some analytes for some of the glasses.

The PCT leachate concentrations were normalized using the target and measured cation compositions of the glasses to obtain g/L leachate concentrations following the procedure.[23] Exhibit F-4 in Appendix F provides scatter plots for these results and offers an opportunity to investigate the consistency in the leaching across the elements for the KT04 glasses. The smallest correlation in this plot is that for B and Si with a value of ~98%, indicating very linear correlations for all of the element pairs.

Table F-2 in Appendix F summarizes the normalized PCTs for the KT04 glasses. The PCTs are listed by heat treatment and compositional view for each glass. The KT04 glasses all had NL [B] values that were well below the 16.695 g/L value of the benchmark EA glass, and in fact all below 1.0 g/L. The highest NL [B] value was for glass KT04-03, with values of 0.61 g/L and 0.62 g/L for the quenched and CCC versions of this glass, respectively, normalized to the measured composition.

Exhibit F-5 in Appendix F provides plots showing comparisons of the normalized PCT responses for the two heat treatments for each glass. A review of these plots shows only minor differences in normalized release for the KT04 glasses as a function of heat treatment, with no significant differences observed. This can likely be attributed to the lack of measurable bulk crystallization in the KT04 glasses (see Section 3.1.4).

The predictability of the KT04 PCT responses was evaluated using the DWPF durability model. The predicted PCT values, determined using the targeted and measured compositions of the KT04 glasses, were compared with the normalized PCT responses. Exhibit F-6 in Appendix F provides plots of the DWPF models for B, Li, Na, and Si that relate the logarithm of the normalized PCT value (for each element of interest) to the ΔG_p term derived from all of the compositional views and heat treatments of the KT04 glasses. Prediction limits at a 95% confidence for an individual PCT result are also plotted along with the linear fit. The EA and ARM results are indicated on these plots as well. All of the KT04 glasses fall within the prediction limits of the DWPF model, regardless of compositional view or heat treatment, indicating good predictability for these compositions.

3.4 Viscosity

Viscosity data were collected for all of the glasses in the KT01, KT03, and KT04-series. Note that data for the corrected version of composition KT01-HA, labeled KT01-HA2, are used in this discussion. The measured viscosity at 1150 °C was determined by fitting the data for each glass to the Fulcher equation.[20,21] Complete data from the fitting of Fulcher equations are given in Appendix G for the KT01-series glasses, Appendix H for the KT03-series glasses, and Appendix I for the KT04-series glasses. The results of the Fulcher fits were used to calculate a measured viscosity value for each glass at 1150 °C. These values are given in Table J-1 of Appendix J. The measured values are displayed graphically versus the model predicted values in Exhibit J-1 and Exhibit J-2 in Appendix J, and below in Figure 3-1.

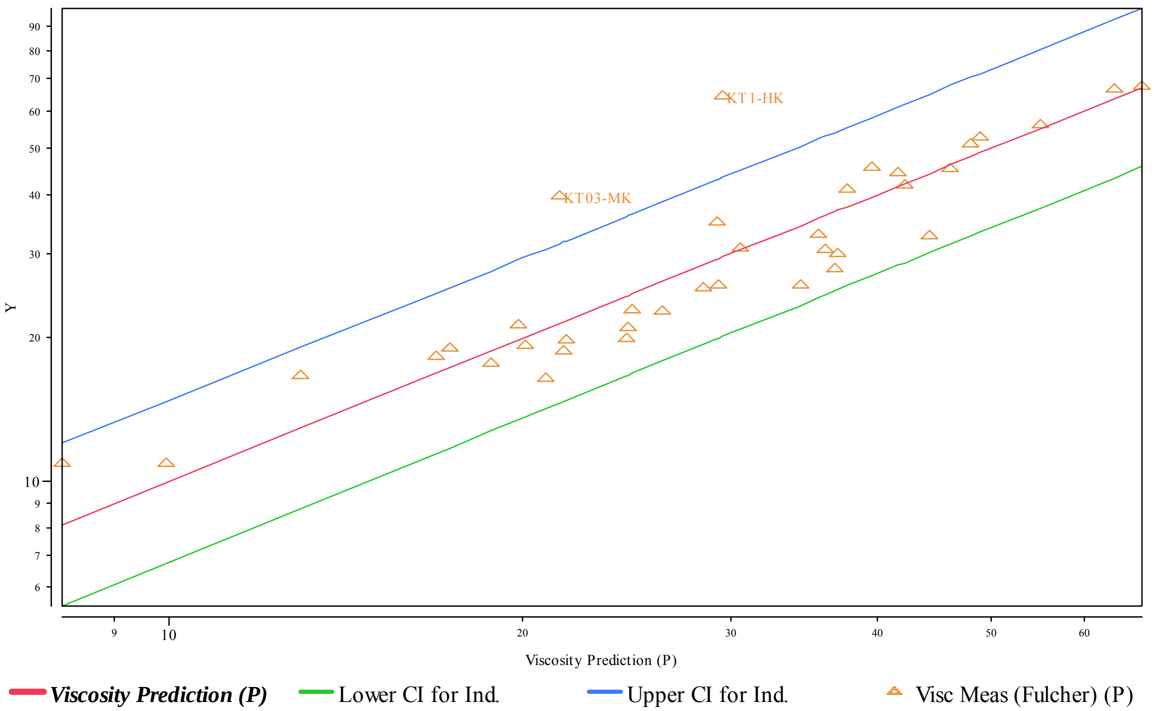

Figure 3-1. Measured Versus Predicted Viscosities at 1150 °C for the KT01, KT03, and KT04-Series Glasses, Based on the Measured Compositions.

Figure 3-1 shows that all but two of the KT01, KT03, and KT04-series glasses had measured viscosities that were predictable using the current DWPF viscosity model (based on the measured compositions). The two glasses with viscosities that fall above the upper confidence intervals for the model prediction are the high K_2O concentration glasses KT01-HK and KT03-MK. These glasses have measured K_2O concentrations of 16.4 and 9.9 wt %, respectively. These concentrations are above the DWPF viscosity model development range 0 to 5.73 wt % K_2O (see Table 1-3). Interestingly, the KT03-HK composition, with a measured K_2O concentration of 17.6 wt %, had a measured viscosity that was well predicted by the current DWPF model. While these results point to a lack of applicability for the DWPF viscosity model for increased K_2O concentrations, it is important to note that these high K_2O concentration glasses were developed to determine potential impacts of K_2O on the retention of TiO_2 and that their K_2O concentrations are impractically high for actual DWPF processing. Overall, the measured viscosity values of the KT01, KT03, and KT04-series glasses are well predicted by the current DWPF viscosity model.

3.5 Liquidus Temperature

Liquidus temperatures were measured for the KT01-series glasses. Glass KT01-HK was excluded from the measurements since a small amount of bulk crystallization was visible in the glass by optical microscopy after quenching from 1150 °C. Liquidus temperature estimates for glass KT01-HA2 and the KT03 and KT04-series glasses are still underway. Measured liquidus temperatures for the KT01-series glasses are presented in Figure 3-2 and compared with the predicted values from the DWPF model (based on the measured compositions of the glasses).

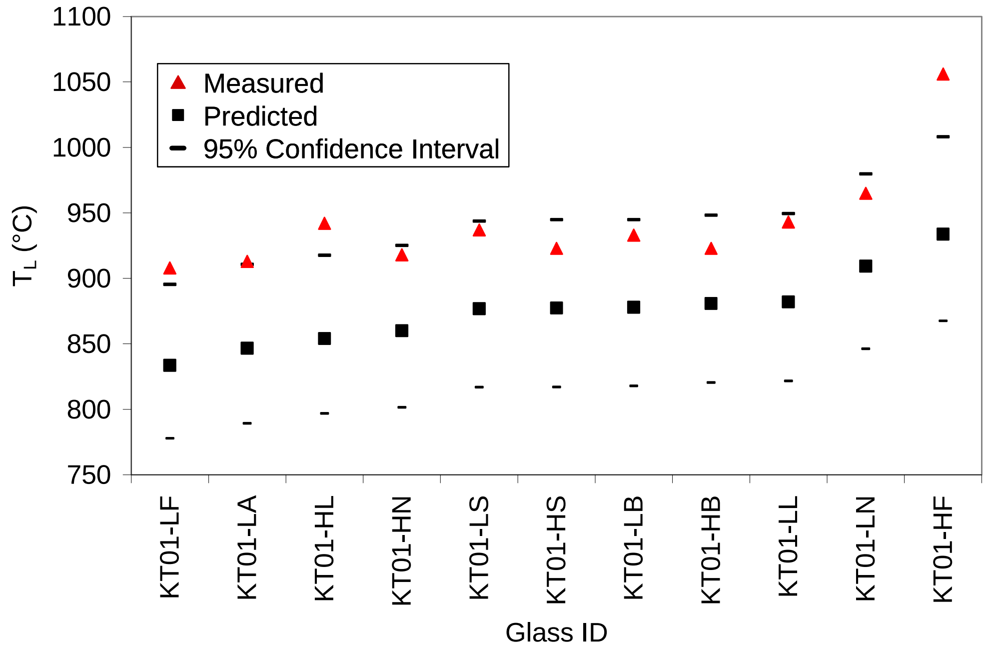

Figure 3-2. Predicted and Measured Liquidus Temperatures for the KT01-Series Glasses, Based on the Measured Compositions.

The results in Figure 3-2 are mixed with regard to the predictability of the T_L for each glass. All of the measured T_L values are higher than the model predicted values, although most fall within the 95% confidence intervals. Compositions KT01-LF, KT01-LA, KT01-HL, and KT01-HF have measured T_L values that are above the upper 95% confidence bounds on the predicted values. The concentrations of some of the components in these glasses, particularly TiO_2, fall outside the region of applicability of the current T_L model (Table 1-1). These results indicate that the model may need to be adjusted in order to more correctly predict the T_L of glasses when the SCIX streams are incorporated, although further data are necessary (and are currently being collected) for a more complete assessment.

4.0 Summary

Four series of glass compositions were selected, fabricated, and characterized as part of a study to determine the impacts of the addition of CST and MST from the SCIX process on the DWPF glass waste form and the applicability of the DWPF process control models. The KT01 and KT02-series of glasses were chosen to allow for the identification of the influence of the concentrations of major components of the glass on the retention of TiO_2. The KT03 series of glasses was chosen to allow for the identification of these influences when higher Nb_2O_5 and ZrO_2 concentrations are included along with TiO_2. The KT04 series of glasses was chosen to investigate the properties and performance of glasses based on the best available projections of actual compositions to be processed at the DWPF (i.e., future sludge batches including the SCIX streams).

The glasses were fabricated in the laboratory without the radioactive components. They were characterized using XRD to identify crystallization, ICP-AES to verify chemical compositions, and the PCT to measure durability. The viscosity and liquidus temperature of several of the glasses were also measured.

The XRD results showed no titanium containing phases in the KT01-series glasses, regardless of whether they had been air quenched or slowly cooled. The target TiO_2 concentration had to be increased to 12 wt % in glass in the KT02-series before any compositional impacts on TiO_2 retention (e.g., the formation of titanium containing crystals) were apparent. Titanium containing crystalline phases formed in the slowly cooled versions of all of the KT02 compositions except for the low Al_2O_3 concentration glass, the low Fe_2O_3 concentration glass, the high Na_2O concentration glass, and the high K_2O concentration glass. The impacts of these components will need additional investigation before drawing further conclusions (i.e., a larger number of compositions should be fabricated and characterized). However, one should keep in mind that the 12 wt % TiO_2 concentrations in these glasses are unrealistic for DWPF processing with the SCIX streams and material from SWPF. Spinels were identified in some of the KT03 glasses after the CCC heat treatment. The spinels did not adversely impact the durability of the glasses but will be important for liquidus temperature determinations. The KT04-series glasses were amorphous regardless of heat treatment.

No issues were found upon review of the chemical composition measurements. Glass KT01-HA was identified as having been incorrectly batched. This composition was replaced for subsequent analyses with a corrected version, identified as KT01-HA2.

No issues were found upon review of the PCT measurements. All of the glasses studied were considerably more durable than the benchmark EA glass. The measured PCT responses were compared with the predicted values from the current DWPF durability model. One of the KT01-series and two of the KT03-series glasses had measured PCT responses that were outside the lower bound of the durability model. All three of these glasses had intentionally high K_2O concentrations (to evaluate the impact of K_2O on TiO_2 retention), which may indicate a lack of applicability for the durability model in this composition region. However, this is likely of little practical importance since K_2O concentrations of this magnitude are unrealistic for actual compositions to be processed at the DWPF. All of the KT04 glasses had durabilities that were predictable regardless of heat treatment or compositional view.

All but two of the KT01, KT03, and KT04-series glasses had measured viscosities that were predictable using the current DWPF viscosity model (based on the measured compositions). The viscosities of two of the high K_2O concentration glasses, KT01-HK and KT03-MK, fell above the upper confidence intervals for the model prediction. These glasses have K_2O concentrations that are above the DWPF viscosity model development range for K_2O. Another high K_2O concentration glass, the KT03-HK composition, had a measured viscosity that was well predicted by the current DWPF model. While these results point to a lack of applicability for the DWPF viscosity model for increased K_2O concentrations, it is again important to note that these K_2O concentrations are unrealistic for actual DWPF processing. Overall, the measured viscosity values of the KT01, KT03, and KT04-series glasses are well predicted by the current DWPF viscosity model.

The results of T_L measurements for the KT01-series glasses were mixed with regard to the predictability of the T_L for each glass. All of the measured T_L values were higher than the model predicted values, although most fell within the 95% confidence intervals. Compositions KT01-LF, KT01-LA, KT01-HL, and KT01-HF had measured T_L values that were above the upper 95% confidence bounds on the predicted values. The concentrations of some of the components in these glasses, particularly TiO_2, fall outside the region of applicability of the current T_L model. These results indicate that the model may need to be adjusted in order to more correctly predict the T_L of glasses when the SCIX streams are incorporated, although further data are necessary for a more complete assessment. Liquidus temperature measurements for the KT03 and KT04-series glasses are underway.

5.0 Recommendations and Path Forward

Overall, the results presented in this report show an ability to incorporate the anticipated SCIX streams into the DWPF-type glass compositions studied. Additional experiments are needed to determine whether to extend the validation range of the DWPF process control models or whether refitting of the models will be necessary. Liquidus temperature measurements are continuing for the KT03 and KT04 glasses, and should be performed for any additional compositions developed for this study.

Several additional sets of experimental glasses are being fabricated and characterized to provide further information on potential impacts of the SCIX streams on DWPF glass, including:

- A study of glass compositions previously shown to crystallize titanium containing phases at lower TiO_2 concentrations
- A study of glass compositions covering a broader range of potential sludge compositions that remain acceptable for processing by the current DWPF process control models
- A study of glass compositions incorporating noble metals, which may serve as nucleation sites for titanium containing crystalline phases
- A study of glass compositions containing uranium and thorium, which may impact the retention of TiO_2 or other glass properties

At the completion of these studies, all of the data generated will be reviewed with regard to applicability of the DWPF PCCS model and recommendations will be made as to whether the validation ranges of the current models can be extended, or whether some or all of the models need to be refit to allow for the incorporation of the SCIX streams. As changes are made to the projected sludge compositions and the volume of the SCIX material, additional evaluations should be performed.

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Appendix A. Data Supporting the Chemical Composition Measurements of the KT01-Series Glasses

Table A-1 PSAL Chemical Composition Measurements of the KT01-Series of Glasses Using LM Preparation Method (Part 1).

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Ba (wt%)	Ca (wt%)	Ce (wt%)	Cr (wt%)	Cu (wt%)	K (wt%)	La (wt%)	Mg (wt%)
Batch 1	1	1	1	BCHLM111	0.124	0.836	<0.010	0.076	0.305	2.94	<0.010	0.812
KT1-HS	1	1	2	P05LM21	0.062	0.671	0.148	0.065	0.029	0.064	0.050	0.080
KT1-LL	1	1	3	P10LM21	0.064	0.702	0.159	0.073	0.032	0.055	0.054	0.087
KT1-LF	1	1	4	P04LM21	0.069	0.726	0.166	0.078	0.029	0.064	0.056	0.092
KT1-LL	1	1	5	P10LM11	0.066	0.702	0.159	0.076	0.031	0.052	0.055	0.091
KT1-HS	1	1	6	P05LM11	0.062	0.650	0.146	0.067	0.028	0.056	0.051	0.083
KT1-HN	1	1	7	P02LM21	0.065	0.668	0.158	0.082	0.033	0.073	0.053	0.087
KT1-HF	1	1	8	P09LM11	0.061	0.667	0.148	0.071	0.027	0.056	0.050	0.082
Batch 1	1	1	9	BCHLM112	0.126	0.827	<0.010	0.079	0.302	3.01	<0.010	0.825
KT1-LF	1	1	10	P04LM11	0.070	0.716	0.166	0.078	0.029	0.061	0.056	0.093
KT1-LN	1	1	11	P06LM11	0.070	0.712	0.168	0.080	0.031	0.054	0.057	0.094
KT1-HN	1	1	12	P02LM11	0.066	0.655	0.157	0.083	0.032	0.072	0.052	0.088
KT1-HF	1	1	13	P09LM21	0.063	0.668	0.151	0.072	0.027	0.054	0.051	0.084
KT1-LN	1	1	14	P06LM21	0.069	0.694	0.166	0.080	0.030	0.054	0.057	0.094
KT1-HK	1	1	15	P01LM11	0.061	0.609	0.144	0.078	0.034	13.8	0.048	0.076
KT1-HK	1	1	16	P01LM21	0.062	0.613	0.146	0.083	0.035	14.0	0.049	0.079
Batch 1	1	1	17	BCHLM113	0.127	0.808	<0.010	0.079	0.298	3.03	<0.010	0.847
Batch 1	1	2	1	BCHLM121	0.123	0.839	<0.010	0.075	0.306	2.93	<0.010	0.807
KT1-LF	1	2	2	P04LM12	0.067	0.741	0.171	0.074	0.031	0.067	0.055	0.088
KT1-HN	1	2	3	P02LM12	0.063	0.674	0.160	0.078	0.034	0.078	0.052	0.083
KT1-HF	1	2	4	P09LM22	0.062	0.687	0.155	0.069	0.028	0.059	0.051	0.080
KT1-HS	1	2	5	P05LM12	0.060	0.675	0.151	0.063	0.029	0.062	0.049	0.078
KT1-HN	1	2	6	P02LM22	0.062	0.689	0.161	0.078	0.035	0.080	0.052	0.082
KT1-LN	1	2	7	P06LM12	0.067	0.741	0.171	0.076	0.032	0.060	0.056	0.088
KT1-LL	1	2	8	P10LM12	0.063	0.729	0.162	0.073	0.033	0.058	0.055	0.086
Batch 1	1	2	9	BCHLM122	0.121	0.855	<0.010	0.075	0.309	3.03	<0.010	0.787
KT1-LL	1	2	10	P10LM22	0.064	0.710	0.160	0.071	0.033	0.058	0.054	0.085
KT1-HK	1	2	11	P01LM12	0.059	0.621	0.146	0.075	0.036	13.2	0.048	0.073
KT1-LF	1	2	12	P04LM22	0.067	0.740	0.166	0.074	0.030	0.068	0.055	0.088
KT1-HF	1	2	13	P09LM12	0.059	0.679	0.149	0.067	0.028	0.060	0.050	0.078
KT1-HS	1	2	14	P05LM22	0.061	0.673	0.147	0.064	0.029	0.067	0.050	0.079
KT1-LN	1	2	15	P06LM22	0.067	0.717	0.168	0.076	0.031	0.059	0.056	0.089
KT1-HK	1	2	16	P01LM22	0.062	0.638	0.149	0.079	0.036	13.4	0.048	0.075
Batch 1	1	2	17	BCHLM123	0.122	0.838	<0.010	0.075	0.303	2.99	<0.010	0.803
Batch 1	2	1	1	BCHLM211	0.123	0.844	<0.010	0.075	0.308	2.86	<0.010	0.807
KT1-LB	2	1	2	P12LM11	0.066	0.708	0.169	0.073	0.034	0.061	0.055	0.088
KT1-HL	2	1	3	P13LM11	0.062	0.698	0.159	0.069	0.028	0.058	0.053	0.085
KT1-LA	2	1	4	P07LM21	0.063	0.743	0.163	0.069	0.034	0.081	0.052	0.085
KT1-LB	2	1	5	P12LM21	0.063	0.721	0.168	0.071	0.035	0.062	0.055	0.085
KT1-LS	2	1	6	P11LM21	0.063	0.725	0.168	0.067	0.029	0.063	0.052	0.086
KT1-LA	2	1	7	P07LM11	0.067	0.721	0.171	0.073	0.034	0.070	0.054	0.090
KT1-HB	2	1	8	P08LM21	0.063	0.685	0.162	0.070	0.034	0.056	0.053	0.085
Batch 1	2	1	9	BCHLM212	0.121	0.848	<0.010	0.074	0.308	2.83	<0.010	0.802
KT1-HL	2	1	10	P13LM21	0.063	0.698	0.160	0.069	0.029	0.057	0.053	0.085
KT1-HB	2	1	11	P08LM11	0.062	0.698	0.161	0.069	0.035	0.057	0.053	0.085
KT1-HA	2	1	12	P03LM11	0.068	0.732	0.176	0.075	0.036	0.058	0.058	0.094
KT1-LS	2	1	13	P11LM11	0.065	0.719	0.170	0.069	0.029	0.062	0.052	0.087
KT1-HA	2	1	14	P03LM21	0.068	0.730	0.176	0.078	0.035	0.058	0.058	0.095
Batch 1	2	1	15	BCHLM213	0.125	0.830	<0.010	0.077	0.306	2.75	<0.010	0.818
Batch 1	2	2	1	BCHLM221	0.119	0.857	<0.010	0.072	0.310	2.89	<0.010	0.788
KT1-HB	2	2	2	P08LM22	0.061	0.692	0.162	0.068	0.036	0.059	0.053	0.082
KT1-LA	2	2	3	P07LM12	0.067	0.729	0.171	0.071	0.036	0.073	0.055	0.087
KT1-HA	2	2	4	P03LM22	0.066	0.748	0.174	0.075	0.038	0.063	0.058	0.090
KT1-LS	2	2	5	P11LM22	0.064	0.726	0.167	0.066	0.031	0.065	0.052	0.084
KT1-HA	2	2	6	P03LM12	0.066	0.741	0.174	0.072	0.038	0.062	0.057	0.090
KT1-HL	2	2	7	P13LM12	0.061	0.705	0.159	0.067	0.030	0.062	0.053	0.082
KT1-HB	2	2	8	P08LM12	0.062	0.700	0.160	0.068	0.037	0.061	0.053	0.083
Batch 1	2	2	9	BCHLM222	0.119	0.864	<0.010	0.072	0.311	2.92	<0.010	0.789
KT1-LS	2	2	10	P11LM12	0.063	0.723	0.168	0.066	0.031	0.067	0.052	0.083
KT1-LB	2	2	11	P12LM22	0.063	0.714	0.167	0.069	0.036	0.064	0.055	0.083
KT1-LA	2	2	12	P07LM22	0.063	0.738	0.161	0.067	0.036	0.083	0.052	0.083
KT1-LB	2	2	13	P12LM12	0.064	0.716	0.168	0.070	0.036	0.065	0.055	0.084
KT1-HL	2	2	14	P13LM22	0.062	0.702	0.158	0.067	0.031	0.060	0.053	0.082
Batch 1	2	2	15	BCHLM223	0.120	0.846	<0.010	0.073	0.306	2.89	<0.010	0.801

Table A-2. PSAL Chemical Composition Measurements of the KT01-Series of Glasses Using LM Preparation Method (Part 2).

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Mn (wt%)	Na (wt%)	Nb (wt%)	Ni (wt%)	Pb (wt%)	S (wt%)	Si (wt%)	Ti (wt%)	Zn (wt%)	Zr (wt%)
Batch 1	1	1	1	BCHLM111	1.32	6.54	<0.010	0.532	<0.010	<0.100	23.4	0.418	<0.010	0.066
KT1-HS	1	1	2	P05LM21	0.906	10	0.295	0.225	0.085	<0.100	22.8	4.67	0.039	0.328
KT1-LL	1	1	3	P10LM21	0.967	10.5	0.313	0.249	0.094	<0.100	21.1	4.69	0.048	0.354
KT1-LF	1	1	4	P04LM21	1.02	11	0.33	0.264	0.095	<0.100	22.3	4.54	0.041	0.372
KT1-LL	1	1	5	P10LM11	0.963	10.4	0.32	0.257	0.098	<0.100	21.1	4.64	0.04	0.361
KT1-HS	1	1	6	P05LM11	0.9	9.69	0.301	0.234	0.088	<0.100	22.6	4.66	0.036	0.333
KT1-HN	1	1	7	P02LM21	0.949	11.7	0.308	0.26	0.096	<0.100	20.9	4.69	0.039	0.347
KT1-HF	1	1	8	P09LM11	0.921	9.88	0.294	0.229	0.088	<0.100	20.2	4.66	0.035	0.334
Batch 1	1	1	9	BCHLM112	1.33	6.44	<0.010	0.542	<0.010	<0.100	23.6	0.418	<0.010	0.066
KT1-LF	1	1	10	P04LM11	1.01	10.9	0.332	0.268	0.098	<0.100	22.6	4.59	0.043	0.376
KT1-LN	1	1	11	P06LM11	0.983	9.31	0.335	0.269	0.1	<0.100	21.9	4.67	0.044	0.376
KT1-HN	1	1	12	P02LM11	0.928	11.6	0.306	0.26	0.097	<0.100	20.7	4.6	0.038	0.348
KT1-HF	1	1	13	P09LM21	0.914	9.86	0.301	0.234	0.091	<0.100	20.5	4.68	0.036	0.342
KT1-LN	1	1	14	P06LM21	0.992	9.29	0.333	0.266	0.1	<0.100	22.1	4.65	0.052	0.373
KT1-HK	1	1	15	P01LM11	0.866	5.14	0.286	0.235	0.086	<0.100	19.3	4.68	0.033	0.315
KT1-HK	1	1	16	P01LM21	0.877	5.29	0.288	0.243	0.089	<0.100	19.7	4.71	0.034	0.316
Batch 1	1	1	17	BCHLM113	1.33	6.25	<0.010	0.55	<0.010	<0.100	23.4	0.414	<0.010	0.067
Batch 1	1	2	1	BCHLM121	1.3	6.46	<0.010	0.527	<0.010	<0.100	23.5	0.398	<0.010	0.065
KT1-LF	1	2	2	P04LM12	1.01	10.9	0.322	0.258	0.095	<0.100	22.8	4.64	0.041	0.374
KT1-HN	1	2	3	P02LM12	0.922	11.8	0.295	0.251	0.094	<0.100	21	4.66	0.036	0.345
KT1-HF	1	2	4	P09LM22	0.916	9.86	0.288	0.226	0.089	<0.100	20.8	4.76	0.034	0.34
KT1-HS	1	2	5	P05LM12	0.901	9.87	0.29	0.225	0.085	<0.100	22.9	4.74	0.034	0.331
KT1-HN	1	2	6	P02LM22	0.942	12	0.297	0.25	0.093	<0.100	20.9	4.74	0.036	0.344
KT1-LN	1	2	7	P06LM12	0.987	9.41	0.323	0.259	0.096	<0.100	21.9	4.74	0.042	0.372
KT1-LL	1	2	8	P10LM12	0.966	10.5	0.309	0.249	0.093	<0.100	21.4	4.78	0.038	0.359
Batch 1	1	2	9	BCHLM122	1.31	6.5	<0.010	0.526	<0.010	<0.100	23.7	0.409	<0.010	0.066
KT1-LL	1	2	10	P10LM22	0.942	10.6	0.3	0.245	0.093	<0.100	21.2	4.65	0.047	0.353
KT1-HK	1	2	11	P01LM12	0.848	5.3	0.275	0.228	0.085	<0.100	19.1	4.58	0.031	0.314
KT1-LF	1	2	12	P04LM22	1.01	11.2	0.315	0.256	0.092	<0.100	22.3	4.54	0.038	0.369
KT1-HF	1	2	13	P09LM12	0.901	9.96	0.281	0.221	0.086	<0.100	19.9	4.67	0.033	0.329
KT1-HS	1	2	14	P05LM22	0.898	9.93	0.282	0.222	0.084	<0.100	22.7	4.69	0.038	0.326
KT1-LN	1	2	15	P06LM22	0.985	9.44	0.32	0.259	0.098	<0.100	21.7	4.65	0.05	0.37
KT1-HK	1	2	16	P01LM22	0.872	5.47	0.278	0.234	0.086	<0.100	19.2	4.71	0.032	0.316
Batch 1	1	2	17	BCHLM123	1.32	6.49	<0.010	0.522	<0.010	<0.100	23.6	0.405	<0.010	0.066
Batch 1	2	1	1	BCHLM211	1.28	6.54	<0.010	0.531	<0.010	<0.100	23.1	0.397	<0.010	0.065
KT1-LB	2	1	2	P12LM11	0.973	10.6	0.324	0.253	0.1	<0.100	21.5	4.52	0.039	0.37
KT1-HL	2	1	3	P13LM11	0.932	10.2	0.311	0.244	0.09	<0.100	20.5	4.6	0.035	0.349
KT1-LA	2	1	4	P07LM21	0.966	10.7	0.317	0.243	0.092	<0.100	21.5	4.58	0.04	0.36
KT1-LB	2	1	5	P12LM21	0.966	10.6	0.323	0.246	0.097	<0.100	21.6	4.54	0.038	0.368
KT1-LS	2	1	6	P11LM21	0.969	10.8	0.325	0.248	0.095	<0.100	21.5	4.63	0.036	0.367
KT1-LA	2	1	7	P07LM11	0.978	11.4	0.334	0.263	0.1	<0.100	21.7	4.61	0.039	0.375
KT1-HB	2	1	8	P08LM21	0.927	10.3	0.312	0.246	0.092	<0.100	20.8	4.56	0.038	0.355
Batch 1	2	1	9	BCHLM212	1.3	6.41	<0.010	0.525	<0.010	<0.100	23.1	0.381	<0.010	0.066
KT1-HL	2	1	10	P13LM21	0.963	10.3	0.309	0.244	0.091	<0.100	21.1	4.7	0.035	0.348
KT1-HB	2	1	11	P08LM11	0.941	10.3	0.301	0.24	0.09	<0.100	20.6	4.47	0.039	0.352
KT1-HA	2	1	12	P03LM11	1.04	11.3	0.332	0.267	0.106	<0.100	22.4	<0.010	0.04	0.388
KT1-LS	2	1	13	P11LM11	0.991	10.7	0.321	0.25	0.098	<0.100	20.9	4.54	0.037	0.37
KT1-HA	2	1	14	P03LM21	1.03	11.4	0.334	0.24	0.106	<0.100	22.3	<0.010	0.039	0.388
Batch 1	2	1	15	BCHLM213	1.3	6.45	<0.010	0.537	<0.010	<0.100	22.6	0.378	<0.010	0.065
Batch 1	2	2	1	BCHLM221	1.31	6.42	<0.010	0.519	<0.010	<0.100	22.9	0.387	<0.010	0.064
KT1-HB	2	2	2	P08LM22	0.942	10.2	0.315	0.244	0.09	<0.100	20.6	4.71	0.036	0.352
KT1-LA	2	2	3	P07LM12	0.992	11.1	0.336	0.261	0.097	<0.100	21.6	4.72	0.038	0.374
KT1-HA	2	2	4	P03LM22	1.03	11.1	0.34	0.236	0.102	<0.100	22.7	<0.010	0.037	0.382
KT1-LS	2	2	5	P11LM22	0.981	10.5	0.325	0.248	0.094	<0.100	21.3	4.74	0.035	0.364
KT1-HA	2	2	6	P03LM12	1.03	11	0.337	0.263	0.101	<0.100	22.5	<0.010	0.038	0.382
KT1-HL	2	2	7	P13LM12	0.937	10.2	0.309	0.24	0.087	<0.100	20.4	4.7	0.033	0.347
KT1-HB	2	2	8	P08LM12	0.94	10.1	0.307	0.239	0.088	<0.100	20.6	4.57	0.038	0.35
Batch 1	2	2	9	BCHLM222	1.32	6.42	<0.010	0.516	<0.010	<0.100	23.1	0.387	<0.010	0.066
KT1-LS	2	2	10	P11LM12	0.98	11	0.323	0.245	0.095	<0.100	21.3	4.71	0.034	0.362
KT1-LB	2	2	11	P12LM22	0.973	10.7	0.322	0.243	0.096	<0.100	21.3	4.59	0.036	0.362
KT1-LA	2	2	12	P07LM22	0.971	10.8	0.315	0.24	0.09	<0.100	21.5	4.63	0.038	0.355
KT1-LB	2	2	13	P12LM12	0.972	10.6	0.325	0.247	0.096	<0.100	21.4	4.61	0.037	0.366
KT1-HL	2	2	14	P13LM22	0.952	10.3	0.311	0.241	0.088	<0.100	20.6	4.73	0.033	0.345
Batch 1	2	2	15	BCHLM223	1.31	6.54	<0.010	0.524	<0.010	<0.100	23	0.376	<0.010	0.065

Table A-3. PSAL Chemical Composition Measurements of the KT01-Series of Glasses Using PF Preparation Method.

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Fe (wt%)	Li (wt%)
Batch 1	1	1	1	BCHPF111	2.52	2.58	8.97	2.06
KT1-HF	1	1	2	P09PF11	2.76	1.37	11.0	2.00
KT1-LF	1	1	3	P04PF11	3.11	1.53	5.60	2.25
KT1-LF	1	1	4	P04PF21	3.11	1.56	5.61	2.26
KT1-HS	1	1	5	P05PF21	2.79	1.39	7.70	2.02
KT1-HK	1	1	6	P01PF11	2.77	1.37	7.53	0.65
KT1-HA	1	1	7	P03PF11	4.87	1.55	8.18	2.24
KT1-HS	1	1	8	P05PF11	2.78	1.37	7.51	2.01
Batch 1	1	1	9	BCHPF112	2.51	2.43	8.93	2.07
KT1-HF	1	1	10	P09PF21	2.77	1.45	11.0	2.02
KT1-LL	1	1	11	P10PF21	2.93	1.51	7.98	2.19
KT1-HN	1	1	12	P02PF21	2.88	1.47	7.95	2.10
KT1-HN	1	1	13	P02PF11	2.89	1.48	7.88	2.09
KT1-HK	1	1	14	P01PF21	2.71	1.38	7.41	0.65
KT1-LL	1	1	15	P10PF11	2.98	1.52	8.11	2.22
KT1-HA	1	1	16	P03PF21	4.94	1.58	8.27	2.25
Batch 1	1	1	17	BCHPF113	2.51	2.44	8.90	2.06
Batch 1	1	2	1	BCHPF121	2.53	2.51	8.90	2.04
KT1-HA	1	2	2	P03PF12	4.96	1.61	8.25	2.25
KT1-LL	1	2	3	P10PF12	2.94	1.49	7.93	2.17
KT1-HS	1	2	4	P05PF22	2.79	1.39	7.62	2.00
KT1-LL	1	2	5	P10PF22	2.96	1.47	7.97	2.18
KT1-HN	1	2	6	P02PF22	2.84	1.41	7.80	2.03
KT1-HA	1	2	7	P03PF22	4.99	1.55	8.34	2.24
KT1-LF	1	2	8	P04PF22	3.14	1.55	5.72	2.25
Batch 1	1	2	9	BCHPF122	2.53	2.39	8.96	2.04
KT1-HS	1	2	10	P05PF12	2.86	1.41	7.66	2.03
KT1-HK	1	2	11	P01PF22	2.70	1.33	7.37	0.63
KT1-HF	1	2	12	P09PF12	2.76	1.37	11.0	1.99
KT1-HK	1	2	13	P01PF12	2.78	1.36	7.60	0.64
KT1-LF	1	2	14	P04PF12	3.15	1.55	5.63	2.24
KT1-HF	1	2	15	P09PF22	2.80	1.38	11.0	2.00
KT1-HN	1	2	16	P02PF12	2.93	1.44	7.91	2.08
Batch 1	1	2	17	BCHPF123	2.52	2.40	8.93	2.04
Batch 1	2	1	1	BCHPF211	2.48	2.48	8.89	2.03
KT1-LB	2	1	2	P12PF11	3.00	1.56	7.99	2.16
KT1-HB	2	1	3	P08PF21	2.82	2.20	7.55	2.02
KT1-LN	2	1	4	P06PF11	3.01	1.51	8.17	2.17
KT1-HB	2	1	5	P08PF11	2.83	2.22	7.80	2.04
KT1-LS	2	1	6	P11PF21	2.92	1.45	8.01	2.12
KT1-LN	2	1	7	P06PF21	2.98	1.46	8.02	2.15
KT1-LA	2	1	8	P07PF21	2.21	1.45	8.16	2.13
Batch 1	2	1	9	BCHPF212	2.45	2.37	8.83	2.01
KT1-HL	2	1	10	P13PF21	2.87	1.46	7.95	3.29
KT1-HL	2	1	11	P13PF11	2.85	1.43	7.79	3.25
KT1-LB	2	1	12	P12PF21	2.90	1.47	7.81	2.09
KT1-LS	2	1	13	P11PF11	2.96	1.45	7.93	2.14
KT1-LA	2	1	14	P07PF11	2.17	1.41	7.91	2.09
Batch 1	2	1	15	BCHPF213	2.45	2.36	8.84	2.01
Batch 1	2	2	1	BCHPF221	2.53	2.53	8.96	2.07
KT1-LB	2	2	2	P12PF22	2.93	1.54	7.86	2.12
KT1-LA	2	2	3	P07PF22	2.25	1.51	8.20	2.16
KT1-HB	2	2	4	P08PF12	2.89	2.28	7.85	2.09
KT1-HL	2	2	5	P13PF22	2.86	1.45	8.00	3.31
KT1-LA	2	2	6	P07PF12	2.20	1.44	7.91	2.12
KT1-HL	2	2	7	P13PF12	2.90	1.44	7.91	3.33
KT1-LB	2	2	8	P12PF12	2.97	1.50	7.99	2.16
Batch 1	2	2	9	BCHPF222	2.48	2.39	8.90	2.04
KT1-LN	2	2	10	P06PF12	3.00	1.53	8.19	2.18
KT1-LS	2	2	11	P11PF22	2.96	1.49	8.06	2.14
KT1-HB	2	2	12	P08PF22	2.83	2.22	7.69	2.05
KT1-LS	2	2	13	P11PF12	2.97	1.48	8.06	2.15
KT1-LN	2	2	14	P06PF22	2.99	1.49	8.08	2.17
Batch 1	2	2	15	BCHPF223	2.49	2.42	8.93	2.05

Table A-4. Comparison of Measured versus Targeted Composition for KT01 Glasses.

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Diff of Measured	% Diff of Measured
Batch 1	Al_2O_3	4.7238	4.8770	-0.1533	-3.1%
Batch 1	B_2O_3	7.8619	7.7770	0.0849	1.1%
Batch 1	BaO	0.1368	0.1510	-0.0142	-9.4%
Batch 1	CaO	1.1767	1.2200	-0.0433	-3.5%
Batch 1	Ce_2O_3	0.0059	0.0000	0.0059	
Batch 1	Cr_2O_3	0.1099	0.1070	0.0029	2.7%
Batch 1	CuO	0.3831	0.3990	-0.0159	-4.0%
Batch 1	Fe_2O_3	12.7410	12.8390	-0.0980	-0.8%
Batch 1	K_2O	3.5204	3.3270	0.1934	5.8%
Batch 1	La_2O_3	0.0059	0.0000	0.0059	
Batch 1	Li_2O	4.3991	4.4290	-0.0299	-0.7%
Batch 1	MgO	1.3385	1.4190	-0.0805	-5.7%
Batch 1	MnO	1.6925	1.7260	-0.0335	-1.9%
Batch 1	Na_2O	8.7013	9.0030	-0.3017	-3.4%
Batch 1	Nb_2O_5	0.0072	0.0000	0.0072	
Batch 1	NiO	0.6735	0.7510	-0.0775	-10.3%
Batch 1	PbO	0.0054	0.0000	0.0054	
Batch 1	SiO_2	49.7387	50.2200	-0.4813	-1.0%
Batch 1	SO_4	0.1498	0.0000	0.1498	
Batch 1	TiO_2	0.6628	0.6770	-0.0142	-2.1%
Batch 1	ZnO	0.0062	0.0000	0.0062	
Batch 1	ZrO_2	0.0886	0.0980	-0.0094	-9.6%
Batch 1	Sum	98.1289	99.0200	-0.8911	-0.9%
KT1-HA	Al_2O_3	9.3341	8.4200	0.9141	10.9%
KT1-HA	B_2O_3	5.0633	4.5200	0.5433	12.0%
KT1-HA	BaO	0.0748	0.0800	-0.0052	-6.5%
KT1-HA	CaO	1.0323	0.9500	0.0823	8.7%
KT1-HA	Ce_2O_3	0.2050	0.2000	0.0050	2.5%
KT1-HA	Cr_2O_3	0.1096	0.1000	0.0096	9.6%
KT1-HA	CuO	0.0460	0.0300	0.0160	53.3%
KT1-HA	Fe_2O_3	11.8093	11.3400	0.4693	4.1%
KT1-HA	K_2O	0.0726	0.0700	0.0026	3.7%
KT1-HA	La_2O_3	0.0677	0.0700	-0.0023	-3.2%
KT1-HA	Li_2O	4.8333	4.5200	0.3133	6.9%
KT1-HA	MgO	0.1530	0.1400	0.0130	9.3%
KT1-HA	MnO	1.3332	1.2200	0.1132	9.3%
KT1-HA	Na_2O	15.0976	14.1400	0.9576	6.8%
KT1-HA	Nb_2O_5	0.4803	0.4100	0.0703	17.1%
KT1-HA	NiO	0.3200	0.3400	-0.0200	-5.9%
KT1-HA	PbO	0.1118	0.1100	0.0018	1.6%
KT1-HA	SiO_2	48.0808	44.7200	3.3608	7.5%
KT1-HA	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-HA	TiO_2	0.0083	8.0000	-7.9917	-99.9%
KT1-HA	ZnO	0.0479	0.0500	-0.0021	-4.2%
KT1-HA	ZrO_2	0.5201	0.4900	0.0301	6.1%
KT1-HA	Sum	98.9507	99.9900	-1.0393	-1.0%
KT1-HB	Al_2O_3	5.3709	5.3800	-0.0091	-0.2%
KT1-HB	B_2O_3	7.1804	7.2000	-0.0196	-0.3%
KT1-HB	BaO	0.0692	0.0800	-0.0108	-13.5%
KT1-HB	CaO	0.9707	0.9600	0.0107	1.1%
KT1-HB	Ce_2O_3	0.1889	0.2000	-0.0111	-5.6%
KT1-HB	Cr_2O_3	0.1005	0.1000	0.0005	0.5%
KT1-HB	CuO	0.0444	0.0300	0.0144	48.1%
KT1-HB	Fe_2O_3	11.0409	11.3900	-0.3491	-3.1%
KT1-HB	K_2O	0.0702	0.0700	0.0002	0.2%
KT1-HB	La_2O_3	0.0622	0.0700	-0.0078	-11.2%
KT1-HB	Li_2O	4.4134	4.5400	-0.1266	-2.8%
KT1-HB	MgO	0.1389	0.1400	-0.0011	-0.8%
KT1-HB	MnO	1.2105	1.2300	-0.0195	-1.6%
KT1-HB	Na_2O	13.7833	14.2000	-0.4167	-2.9%
KT1-HB	Nb_2O_5	0.4417	0.4100	0.0317	7.7%

Table A-4. Comparison of Measured versus Targeted Composition for KT01 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Diff of Measured	% Diff of Measured
KT1-HB	NiO	0.3083	0.3400	-0.0317	-9.3%
KT1-HB	PbO	0.0969	0.1100	-0.0131	-11.9%
KT1-HB	SiO_2	44.1765	44.9200	-0.7435	-1.7%
KT1-HB	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-HB	TiO_2	7.6353	8.0000	-0.3647	-4.6%
KT1-HB	ZnO	0.0470	0.0500	-0.0030	-6.0%
KT1-HB	ZrO_2	0.4758	0.4900	-0.0142	-2.9%
KT1-HB	Sum	97.9756	99.9800	-2.0044	-2.0%
KT1-HF	Al_2O_3	5.2386	5.2400	-0.0014	0.0%
KT1-HF	B_2O_3	4.4837	4.4200	0.0637	1.4%
KT1-HF	BaO	0.0684	0.0800	-0.0116	-14.5%
KT1-HF	CaO	0.9448	0.9300	0.0148	1.6%
KT1-HF	Ce_2O_3	0.1766	0.1900	-0.0134	-7.1%
KT1-HF	Cr_2O_3	0.1019	0.1000	0.0019	1.9%
KT1-HF	CuO	0.0344	0.0300	0.0044	14.7%
KT1-HF	Fe_2O_3	15.7267	16.0800	-0.3533	-2.2%
KT1-HF	K_2O	0.0690	0.0700	-0.0010	-1.5%
KT1-HF	La_2O_3	0.0592	0.0700	-0.0108	-15.4%
KT1-HF	Li_2O	4.3112	4.4200	-0.1088	-2.5%
KT1-HF	MgO	0.1343	0.1400	-0.0057	-4.1%
KT1-HF	MnO	1.1789	1.2000	-0.0211	-1.8%
KT1-HF	Na_2O	13.3317	13.8400	-0.5083	-3.7%
KT1-HF	Nb_2O_5	0.4163	0.4000	0.0163	4.1%
KT1-HF	NiO	0.2895	0.3400	-0.0505	-14.9%
KT1-HF	PbO	0.0953	0.1100	-0.0147	-13.3%
KT1-HF	SiO_2	43.5348	43.7500	-0.2152	-0.5%
KT1-HF	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-HF	TiO_2	7.8271	8.0000	-0.1729	-2.2%
KT1-HF	ZnO	0.0429	0.0500	-0.0071	-14.1%
KT1-HF	ZrO_2	0.4542	0.4800	-0.0258	-5.4%
KT1-HF	Sum	98.6694	100.0100	-1.3406	-1.3%
KT1-HK	Al_2O_3	5.1772	4.9700	0.2072	4.2%
KT1-HK	B_2O_3	4.3791	4.2000	0.1791	4.3%
KT1-HK	BaO	0.0681	0.0700	-0.0019	-2.7%
KT1-HK	CaO	0.8679	0.8900	-0.0221	-2.5%
KT1-HK	Ce_2O_3	0.1713	0.1900	-0.0187	-9.8%
KT1-HK	Cr_2O_3	0.1151	0.1000	0.0151	15.1%
KT1-HK	CuO	0.0441	0.0300	0.0141	47.1%
KT1-HK	Fe_2O_3	10.6906	10.5400	0.1506	1.4%
KT1-HK	K_2O	16.3826	18.3800	-1.9974	-10.9%
KT1-HK	La_2O_3	0.0566	0.0700	-0.0134	-19.2%
KT1-HK	Li_2O	1.3832	1.2800	0.1032	8.1%
KT1-HK	MgO	0.1256	0.1300	-0.0044	-3.4%
KT1-HK	MnO	1.1179	1.1400	-0.0221	-1.9%
KT1-HK	Na_2O	7.1444	7.0900	0.0544	0.8%
KT1-HK	Nb_2O_5	0.4030	0.3800	0.0230	6.1%
KT1-HK	NiO	0.2990	0.3200	-0.0210	-6.6%
KT1-HK	PbO	0.0932	0.1000	-0.0068	-6.8%
KT1-HK	SiO_2	41.3420	41.5600	-0.2180	-0.5%
KT1-HK	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-HK	TiO_2	7.7896	8.0000	-0.2104	-2.6%
KT1-HK	ZnO	0.0405	0.0500	-0.0095	-19.1%
KT1-HK	ZrO_2	0.4258	0.4600	-0.0342	-7.4%
KT1-HK	Sum	98.2665	100.0200	-1.7535	-1.8%
KT1-HL	Al_2O_3	5.4229	5.3800	0.0429	0.8%
KT1-HL	B_2O_3	4.6528	4.5400	0.1128	2.5%
KT1-HL	BaO	0.0692	0.0800	-0.0108	-13.5%
KT1-HL	CaO	0.9805	0.9600	0.0205	2.1%
KT1-HL	Ce_2O_3	0.1862	0.2000	-0.0138	-6.9%
KT1-HL	Cr_2O_3	0.0994	0.1000	-0.0006	-0.6%

Table A-4. Comparison of Measured versus Targeted Composition for KT01 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Diff of Measured	% Diff of Measured
KT1-HL	CuO	0.0369	0.0300	0.0069	23.1%
KT1-HL	Fe_2O_3	11.3125	11.3900	-0.0775	-0.7%
KT1-HL	K_2O	0.0714	0.0700	0.0014	2.0%
KT1-HL	La_2O_3	0.0622	0.0700	-0.0078	-11.2%
KT1-HL	Li_2O	7.0938	7.2000	-0.1062	-1.5%
KT1-HL	MgO	0.1385	0.1400	-0.0015	-1.1%
KT1-HL	MnO	1.2215	1.2300	-0.0085	-0.7%
KT1-HL	Na_2O	13.8170	14.2000	-0.3830	-2.7%
KT1-HL	Nb_2O_5	0.4435	0.4100	0.0335	8.2%
KT1-HL	NiO	0.3083	0.3400	-0.0317	-9.3%
KT1-HL	PbO	0.0959	0.1100	-0.0141	-12.8%
KT1-HL	SiO_2	44.1765	44.9200	-0.7435	-1.7%
KT1-HL	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-HL	TiO_2	7.8104	8.0000	-0.1896	-2.4%
KT1-HL	ZnO	0.0423	0.0500	-0.0077	-15.4%
KT1-HL	ZrO_2	0.4691	0.4900	-0.0209	-4.3%
KT1-HL	Sum	98.6604	99.9800	-1.3196	-1.3%
KT1-HN	Al_2O_3	5.4512	5.4100	0.0412	0.8%
KT1-HN	B_2O_3	4.6689	4.5700	0.0989	2.2%
KT1-HN	BaO	0.0715	0.0800	-0.0085	-10.7%
KT1-HN	CaO	0.9396	0.9600	-0.0204	-2.1%
KT1-HN	Ce_2O_3	0.1862	0.2000	-0.0138	-6.9%
KT1-HN	Cr_2O_3	0.1173	0.1000	0.0173	17.3%
KT1-HN	CuO	0.0419	0.0300	0.0119	39.8%
KT1-HN	Fe_2O_3	11.2732	11.4600	-0.1868	-1.6%
KT1-HN	K_2O	0.0912	0.0700	0.0212	30.4%
KT1-HN	La_2O_3	0.0613	0.0700	-0.0087	-12.5%
KT1-HN	Li_2O	4.4673	4.5700	-0.1027	-2.2%
KT1-HN	MgO	0.1410	0.1500	-0.0090	-6.0%
KT1-HN	MnO	1.2076	1.2400	-0.0324	-2.6%
KT1-HN	Na_2O	15.8727	16.4100	-0.5373	-3.3%
KT1-HN	Nb_2O_5	0.4313	0.4100	0.0213	5.2%
KT1-HN	NiO	0.3248	0.3500	-0.0252	-7.2%
KT1-HN	PbO	0.1023	0.1100	-0.0077	-7.0%
KT1-HN	SiO_2	44.6579	45.1900	-0.5321	-1.2%
KT1-HN	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-HN	TiO_2	7.7937	8.0000	-0.2063	-2.6%
KT1-HN	ZnO	0.0464	0.0500	-0.0036	-7.3%
KT1-HN	ZrO_2	0.4674	0.5000	-0.0326	-6.5%
KT1-HN	Sum	98.5644	100.0000	-1.4356	-1.4%
KT1-HS	Al_2O_3	5.3000	5.1800	0.1200	2.3%
KT1-HS	B_2O_3	4.4757	4.3700	0.1057	2.4%
KT1-HS	BaO	0.0684	0.0800	-0.0116	-14.5%
KT1-HS	CaO	0.9336	0.9200	0.0136	1.5%
KT1-HS	Ce_2O_3	0.1734	0.1900	-0.0166	-8.8%
KT1-HS	Cr_2O_3	0.0946	0.1000	-0.0054	-5.4%
KT1-HS	CuO	0.0360	0.0300	0.0060	20.0%
KT1-HS	Fe_2O_3	10.8979	10.9700	-0.0721	-0.7%
KT1-HS	K_2O	0.0750	0.0700	0.0050	7.1%
KT1-HS	La_2O_3	0.0586	0.0700	-0.0114	-16.2%
KT1-HS	Li_2O	4.3381	4.3700	-0.0319	-0.7%
KT1-HS	MgO	0.1327	0.1400	-0.0073	-5.2%
KT1-HS	MnO	1.1637	1.1800	-0.0163	-1.4%
KT1-HS	Na_2O	13.3081	13.6700	-0.3619	-2.6%
KT1-HS	Nb_2O_5	0.4177	0.3900	0.0277	7.1%
KT1-HS	NiO	0.2882	0.3300	-0.0418	-12.7%
KT1-HS	PbO	0.0921	0.1100	-0.0179	-16.3%
KT1-HS	SiO_2	48.6691	49.2400	-0.5709	-1.2%
KT1-HS	SO_4	0.1498	0.0700	0.0798	114.0%

Table A-4. Comparison of Measured versus Targeted Composition for KT01 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Diff of Measured	% Diff of Measured
KT1-HS	TiO_2	7.8229	8.0000	-0.1771	-2.2%
KT1-HS	ZnO	0.0457	0.0500	-0.0043	-8.5%
KT1-HS	ZrO_2	0.4451	0.4800	-0.0349	-7.3%
KT1-HS	Sum	98.9864	100.0100	-1.0236	-1.0%
KT1-LA	Al_2O_3	4.1711	4.1900	-0.0189	-0.5%
KT1-LA	B_2O_3	4.6769	4.7500	-0.0731	-1.5%
KT1-LA	BaO	0.0726	0.0800	-0.0074	-9.3%
KT1-LA	CaO	1.0253	1.0000	0.0253	2.5%
KT1-LA	Ce_2O_3	0.1950	0.2100	-0.0150	-7.1%
KT1-LA	Cr_2O_3	0.1023	0.1100	-0.0077	-7.0%
KT1-LA	CuO	0.0438	0.0300	0.0138	46.0%
KT1-LA	Fe_2O_3	11.5019	11.9200	-0.4181	-3.5%
KT1-LA	K_2O	0.0925	0.0700	0.0225	32.1%
KT1-LA	La_2O_3	0.0625	0.0800	-0.0175	-21.9%
KT1-LA	Li_2O	4.5749	4.7500	-0.1751	-3.7%
KT1-LA	MgO	0.1430	0.1500	-0.0070	-4.6%
KT1-LA	MnO	1.2612	1.2800	-0.0188	-1.5%
KT1-LA	Na_2O	14.8280	14.8600	-0.0320	-0.2%
KT1-LA	Nb_2O_5	0.4656	0.4300	0.0356	8.3%
KT1-LA	NiO	0.3204	0.3600	-0.0396	-11.0%
KT1-LA	PbO	0.1021	0.1200	-0.0179	-14.9%
KT1-LA	SiO_2	46.1554	46.9800	-0.8246	-1.8%
KT1-LA	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-LA	TiO_2	7.7312	8.0000	-0.2688	-3.4%
KT1-LA	ZnO	0.0482	0.0500	-0.0018	-3.5%
KT1-LA	ZrO_2	0.4944	0.5200	-0.0256	-4.9%
KT1-LA	Sum	98.2180	100.0100	-1.7920	-1.8%
KT1-LB	Al_2O_3	5.5740	5.5300	0.0440	0.8%
KT1-LB	B_2O_3	4.8862	4.8000	0.0862	1.8%
KT1-LB	BaO	0.0715	0.0800	-0.0085	-10.7%
KT1-LB	CaO	1.0001	0.9800	0.0201	2.0%
KT1-LB	Ce_2O_3	0.1968	0.2100	-0.0132	-6.3%
KT1-LB	Cr_2O_3	0.1034	0.1100	-0.0066	-6.0%
KT1-LB	CuO	0.0441	0.0300	0.0141	47.1%
KT1-LB	Fe_2O_3	11.3125	11.7200	-0.4075	-3.5%
KT1-LB	K_2O	0.0759	0.0700	0.0059	8.4%
KT1-LB	La_2O_3	0.0645	0.0800	-0.0155	-19.4%
KT1-LB	Li_2O	4.5911	4.6700	-0.0789	-1.7%
KT1-LB	MgO	0.1410	0.1500	-0.0090	-6.0%
KT1-LB	MnO	1.2538	1.2600	-0.0062	-0.5%
KT1-LB	Na_2O	14.3225	14.6100	-0.2875	-2.0%
KT1-LB	Nb_2O_5	0.4628	0.4200	0.0428	10.2%
KT1-LB	NiO	0.3146	0.3500	-0.0354	-10.1%
KT1-LB	PbO	0.1048	0.1100	-0.0052	-4.8%
KT1-LB	SiO_2	45.8880	46.1900	-0.3020	-0.7%
KT1-LB	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-LB	TiO_2	7.6144	8.0000	-0.3856	-4.8%
KT1-LB	ZnO	0.0467	0.0500	-0.0033	-6.6%
KT1-LB	ZrO_2	0.4951	0.5100	-0.0149	-2.9%
KT1-LB	Sum	98.7133	100.0000	-1.2867	-1.3%
KT1-LF	Al_2O_3	5.9094	5.7800	0.1294	2.2%
KT1-LF	B_2O_3	4.9828	4.8800	0.1028	2.1%
KT1-LF	BaO	0.0762	0.0800	-0.0038	-4.7%
KT1-LF	CaO	1.0225	1.0300	-0.0075	-0.7%
KT1-LF	Ce_2O_3	0.1959	0.2200	-0.0241	-11.0%
KT1-LF	Cr_2O_3	0.1111	0.1100	0.0011	1.0%
KT1-LF	CuO	0.0372	0.0300	0.0072	24.1%
KT1-LF	Fe_2O_3	8.0635	8.2400	-0.1765	-2.1%
KT1-LF	K_2O	0.0783	0.0800	-0.0017	-2.1%

Table A-4. Comparison of Measured versus Targeted Composition for KT01 Glasses. (continued)

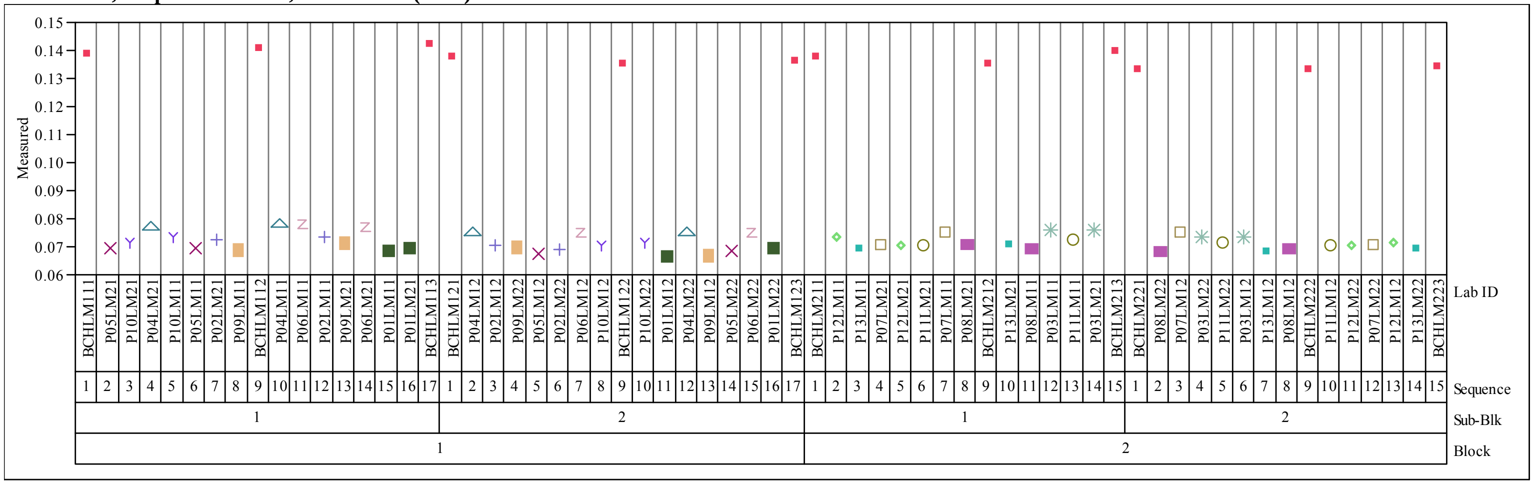
Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Diff of Measured	% Diff of Measured
KT1-LF	La_2O_3	0.0651	0.0800	-0.0149	-18.6%
KT1-LF	Li_2O	4.8440	4.8800	-0.0360	-0.7%
KT1-LF	MgO	0.1497	0.1500	-0.0003	-0.2%
KT1-LF	MnO	1.3073	1.3200	-0.0127	-1.0%
KT1-LF	Na_2O	14.8280	15.2600	-0.4320	-2.8%
KT1-LF	Nb_2O_5	0.4646	0.4400	0.0246	5.6%
KT1-LF	NiO	0.3328	0.3700	-0.0372	-10.1%
KT1-LF	PbO	0.1023	0.1200	-0.0177	-14.7%
KT1-LF	SiO_2	48.1343	48.2700	-0.1358	-0.3%
KT1-LF	SO_4	0.1498	0.0800	0.0698	87.2%
KT1-LF	TiO_2	7.6353	8.0000	-0.3647	-4.6%
KT1-LF	ZnO	0.0507	0.0500	0.0007	1.5%
KT1-LF	ZrO_2	0.5035	0.5300	-0.0265	-5.0%
KT1-LF	Sum	99.0442	100.0000	-0.9558	-1.0%
KT1-LL	Al_2O_3	5.5787	5.5300	0.0487	0.9%
KT1-LL	B_2O_3	4.8218	4.6700	0.1518	3.3%
KT1-LL	BaO	0.0717	0.0800	-0.0083	-10.3%
KT1-LL	CaO	0.9945	0.9800	0.0145	1.5%
KT1-LL	Ce_2O_3	0.1874	0.2100	-0.0226	-10.8%
KT1-LL	Cr_2O_3	0.1071	0.1100	-0.0029	-2.7%
KT1-LL	CuO	0.0404	0.0300	0.0104	34.6%
KT1-LL	Fe_2O_3	11.4340	11.7200	-0.2860	-2.4%
KT1-LL	K_2O	0.0672	0.0700	-0.0028	-4.1%
KT1-LL	La_2O_3	0.0639	0.0800	-0.0161	-20.1%
KT1-LL	Li_2O	4.7149	4.8000	-0.0851	-1.8%
KT1-LL	MgO	0.1447	0.1500	-0.0053	-3.5%
KT1-LL	MnO	1.2389	1.2600	-0.0211	-1.7%
KT1-LL	Na_2O	14.1540	14.6100	-0.4560	-3.1%
KT1-LL	Nb_2O_5	0.4442	0.4200	0.0242	5.8%
KT1-LL	NiO	0.3181	0.3500	-0.0319	-9.1%
KT1-LL	PbO	0.1018	0.1100	-0.0082	-7.5%
KT1-LL	SiO_2	45.3532	46.1900	-0.8368	-1.8%
KT1-LL	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-LL	TiO_2	7.8229	8.0000	-0.1771	-2.2%
KT1-LL	ZnO	0.0538	0.0500	0.0038	7.7%
KT1-LL	ZrO_2	0.4819	0.5100	-0.0281	-5.5%
KT1-LL	Sum	98.3449	100.0000	-1.6551	-1.7%
KT1-LN	Al_2O_3	5.6591	5.6500	0.0091	0.2%
KT1-LN	B_2O_3	4.8218	4.7700	0.0518	1.1%
KT1-LN	BaO	0.0762	0.0800	-0.0038	-4.7%
KT1-LN	CaO	1.0018	1.0000	0.0018	0.2%
KT1-LN	Ce_2O_3	0.1971	0.2100	-0.0129	-6.2%
KT1-LN	Cr_2O_3	0.1140	0.1100	0.0040	3.6%
KT1-LN	CuO	0.0388	0.0300	0.0088	29.4%
KT1-LN	Fe_2O_3	11.6020	11.9700	-0.3680	-3.1%
KT1-LN	K_2O	0.0684	0.0700	-0.0016	-2.3%
KT1-LN	La_2O_3	0.0663	0.0800	-0.0137	-17.2%
KT1-LN	Li_2O	4.6664	4.7700	-0.1036	-2.2%
KT1-LN	MgO	0.1513	0.1500	0.0013	0.9%
KT1-LN	MnO	1.2741	1.2900	-0.0159	-1.2%
KT1-LN	Na_2O	12.6207	13.0700	-0.4494	-3.4%
KT1-LN	Nb_2O_5	0.4688	0.4300	0.0388	9.0%
KT1-LN	NiO	0.3350	0.3600	-0.0250	-6.9%
KT1-LN	PbO	0.1061	0.1200	-0.0139	-11.6%
KT1-LN	SiO_2	46.8507	47.1900	-0.3393	-0.7%
KT1-LN	SO_4	0.1498	0.0800	0.0698	87.2%
KT1-LN	TiO_2	7.8021	8.0000	-0.1979	-2.5%
KT1-LN	ZnO	0.0585	0.0500	0.0085	17.0%
KT1-LN	ZrO_2	0.5035	0.5200	-0.0165	-3.2%

Table A-4. Comparison of Measured versus Targeted Composition for KT01 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Diff of Measured	% Diff of Measured
KT1-LN	Sum	98.6324	100.0000	-1.3676	-1.4%
KT1-LS	Al_2O_3	5.5787	5.5700	0.0087	0.2%
KT1-LS	B_2O_3	4.7252	4.7000	0.0252	0.5%
KT1-LS	BaO	0.0712	0.0800	-0.0088	-11.0%
KT1-LS	CaO	1.0120	0.9900	0.0220	2.2%
KT1-LS	Ce_2O_3	0.1971	0.2100	-0.0129	-6.2%
KT1-LS	Cr_2O_3	0.0979	0.1100	-0.0121	-11.0%
KT1-LS	CuO	0.0376	0.0300	0.0076	25.2%
KT1-LS	Fe_2O_3	11.4590	11.8100	-0.3510	-3.0%
KT1-LS	K_2O	0.0774	0.0700	0.0074	10.6%
KT1-LS	La_2O_3	0.0610	0.0800	-0.0190	-23.8%
KT1-LS	Li_2O	4.6018	4.7000	-0.0982	-2.1%
KT1-LS	MgO	0.1410	0.1500	-0.0090	-6.0%
KT1-LS	MnO	1.2657	1.2700	-0.0043	-0.3%
KT1-LS	Na_2O	14.4910	14.7300	-0.2390	-1.6%
KT1-LS	Nb_2O_5	0.4628	0.4200	0.0428	10.2%
KT1-LS	NiO	0.3153	0.3600	-0.0447	-12.4%
KT1-LS	PbO	0.1029	0.1100	-0.0071	-6.5%
KT1-LS	SiO_2	45.4601	45.9600	-0.4999	-1.1%
KT1-LS	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-LS	TiO_2	7.7645	8.0000	-0.2355	-2.9%
KT1-LS	ZnO	0.0442	0.0500	-0.0058	-11.6%
KT1-LS	ZrO_2	0.4941	0.5100	-0.0159	-3.1%
KT1-LS	Sum	98.6102	99.9800	-1.3698	-1.4%

Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide.

Series=KT1, Prep Method=LM, Oxide=BaO (wt%)



Series=KT1, Prep Method=LM, Oxide=CaO (wt%)

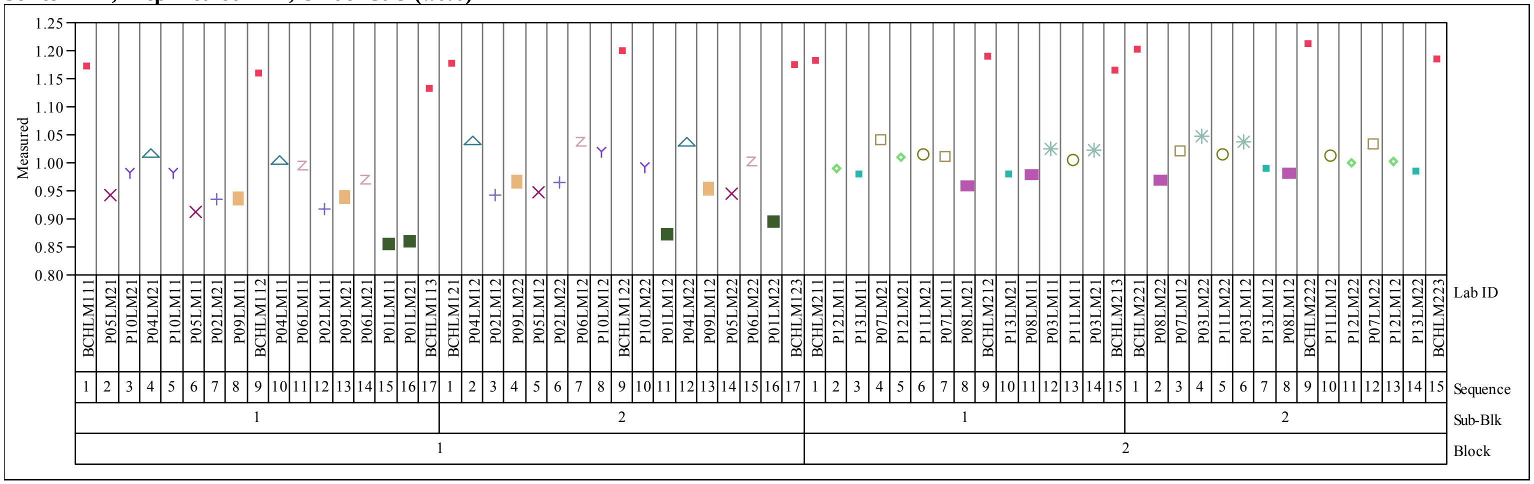
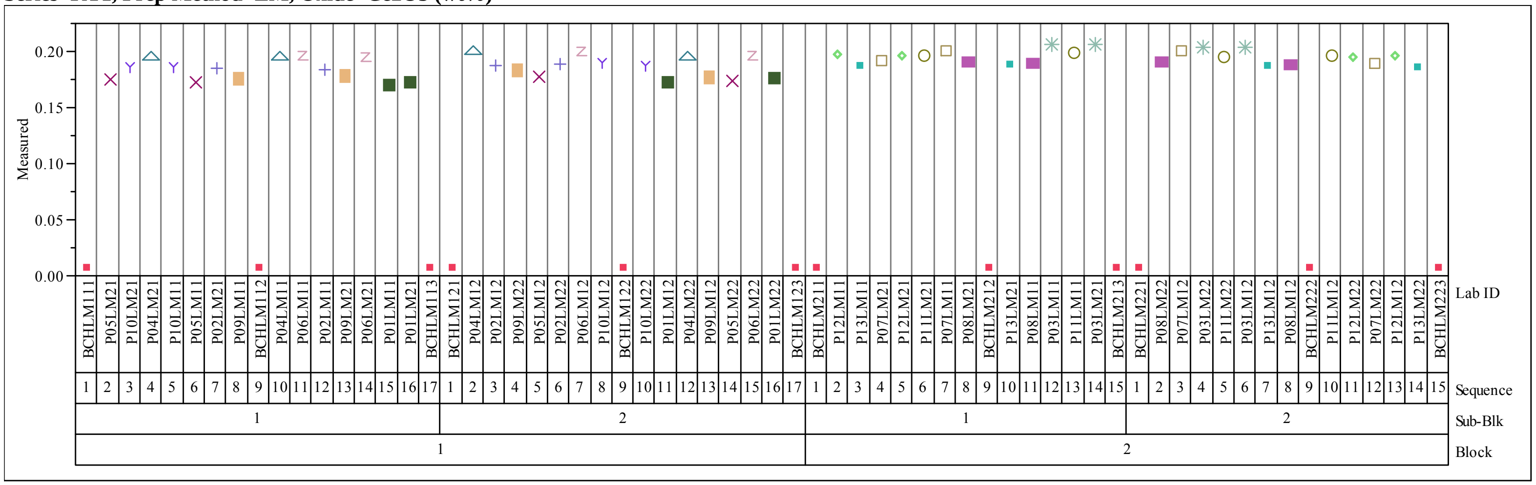


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=Ce2O3 (wt%)



Series=KT1, Prep Method=LM, Oxide=Cr2O3 (wt%)

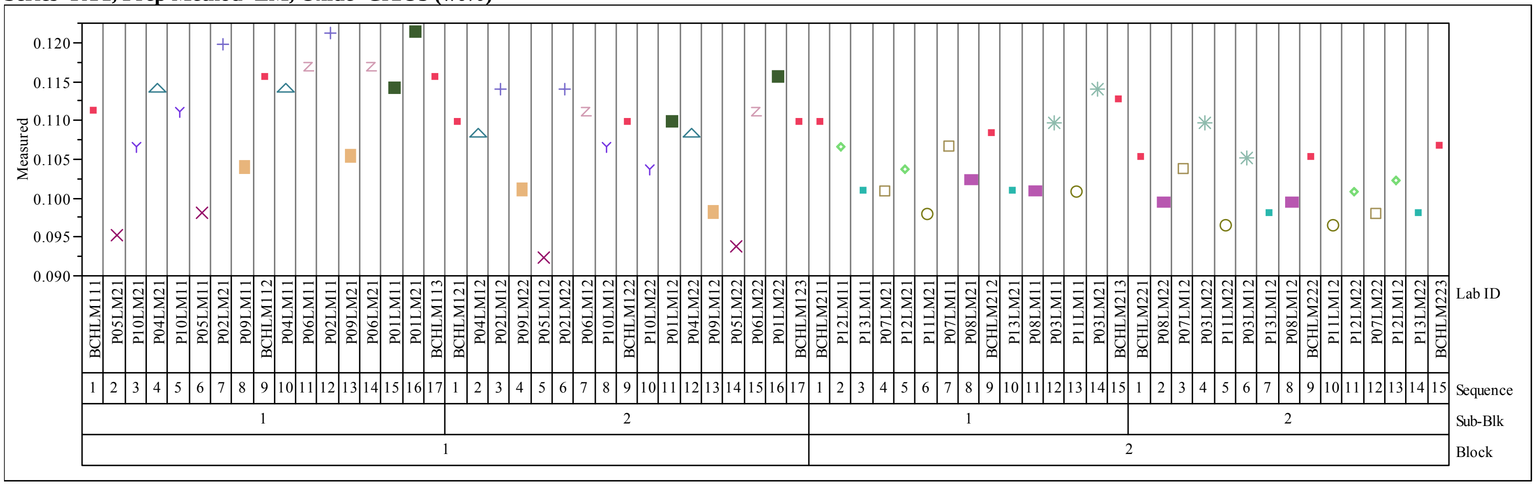
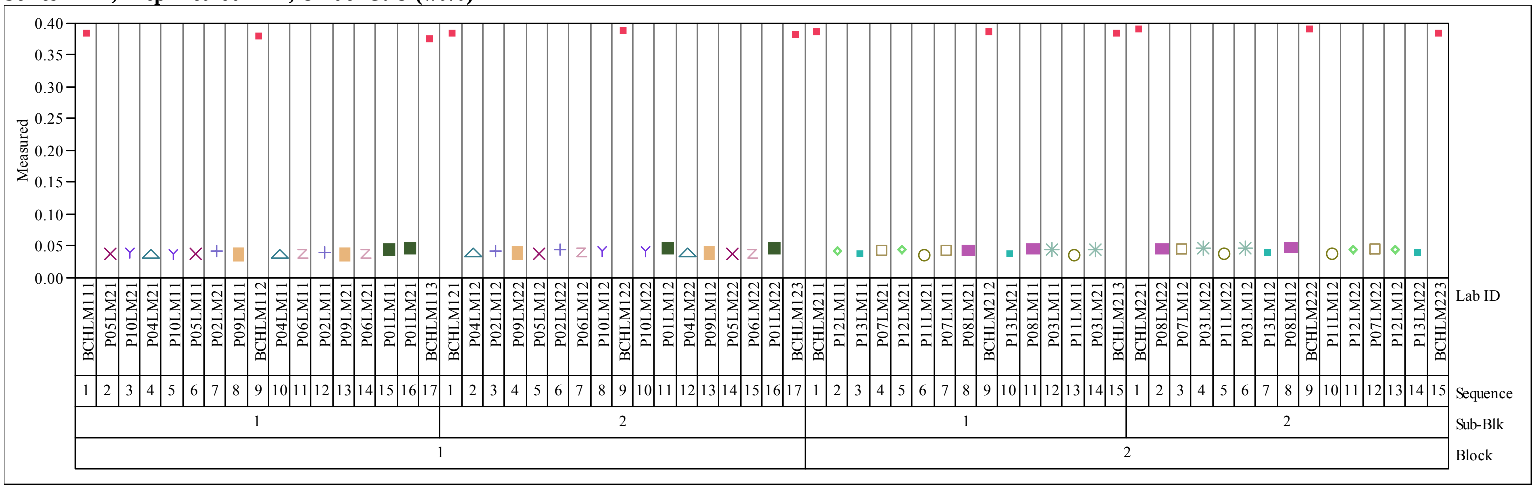


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=CuO (wt%)



Series=KT1, Prep Method=LM, Oxide=K2O (wt%)

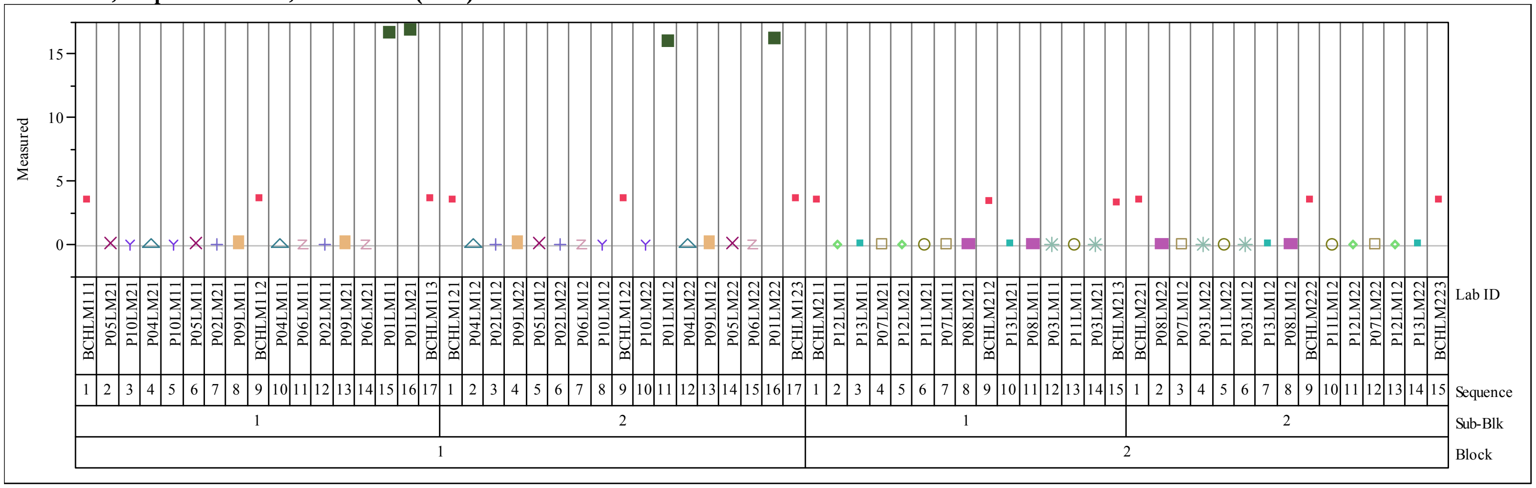
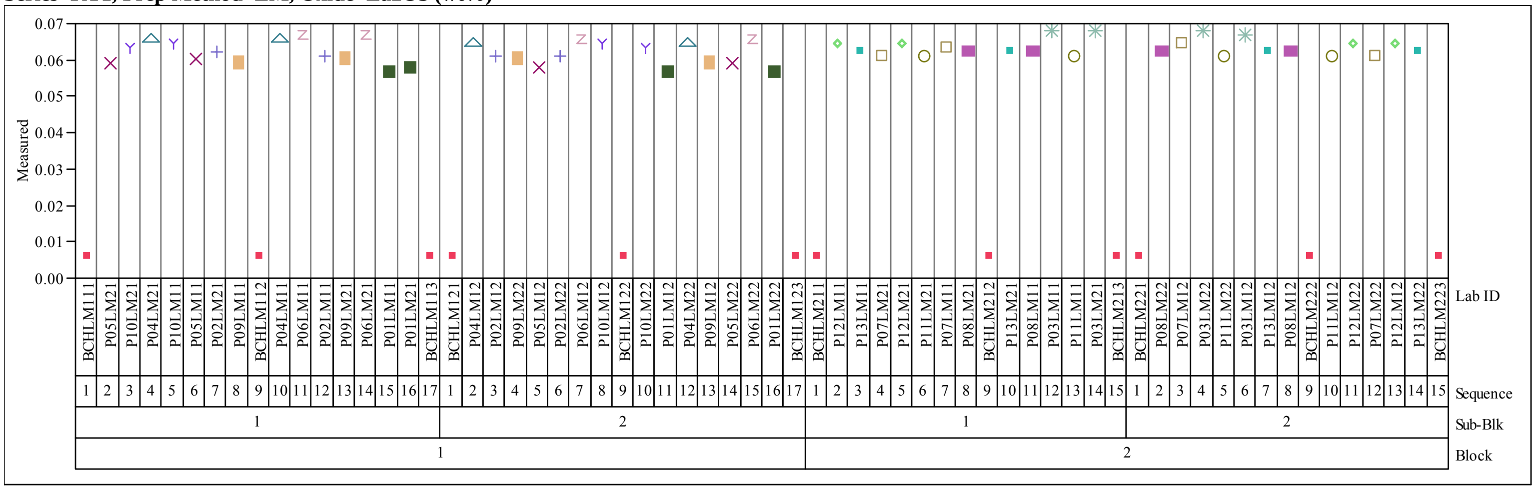


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=La2O3 (wt%)



Series=KT1, Prep Method=LM, Oxide=MgO (wt%)

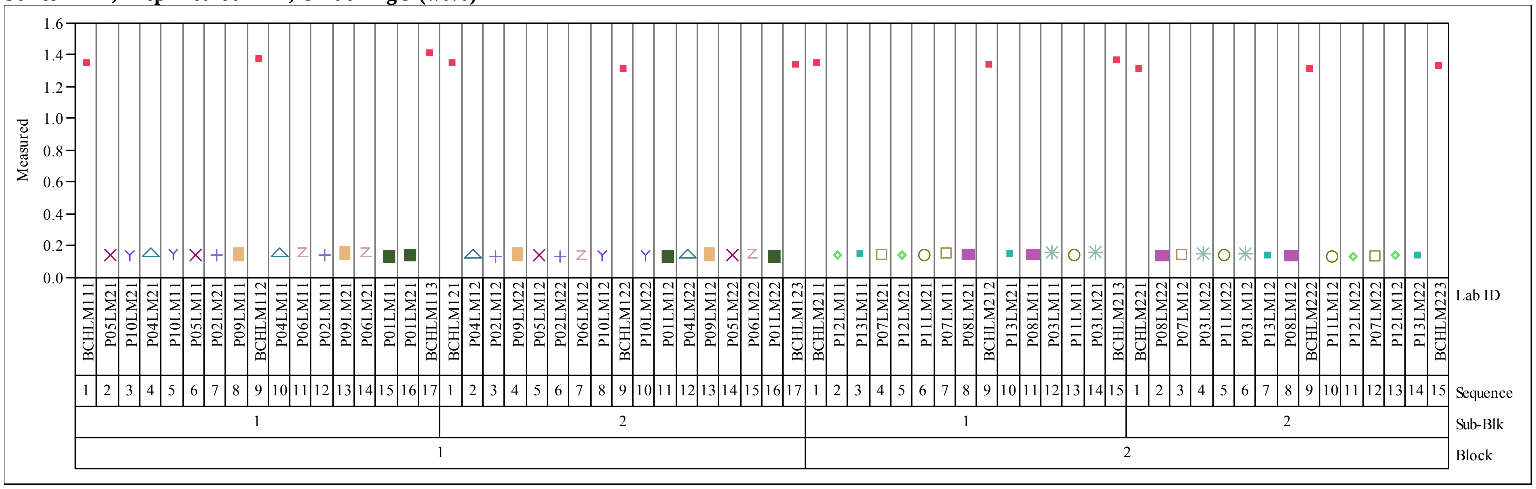
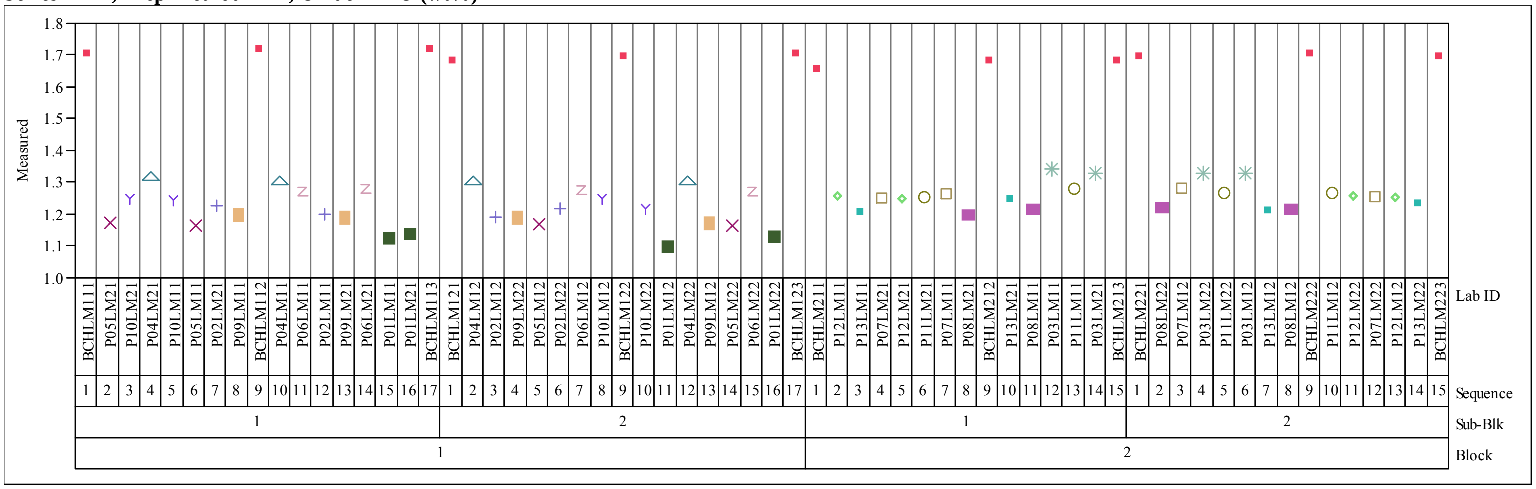


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=MnO (wt%)



Series=KT1, Prep Method=LM, Oxide=Na2O (wt%)

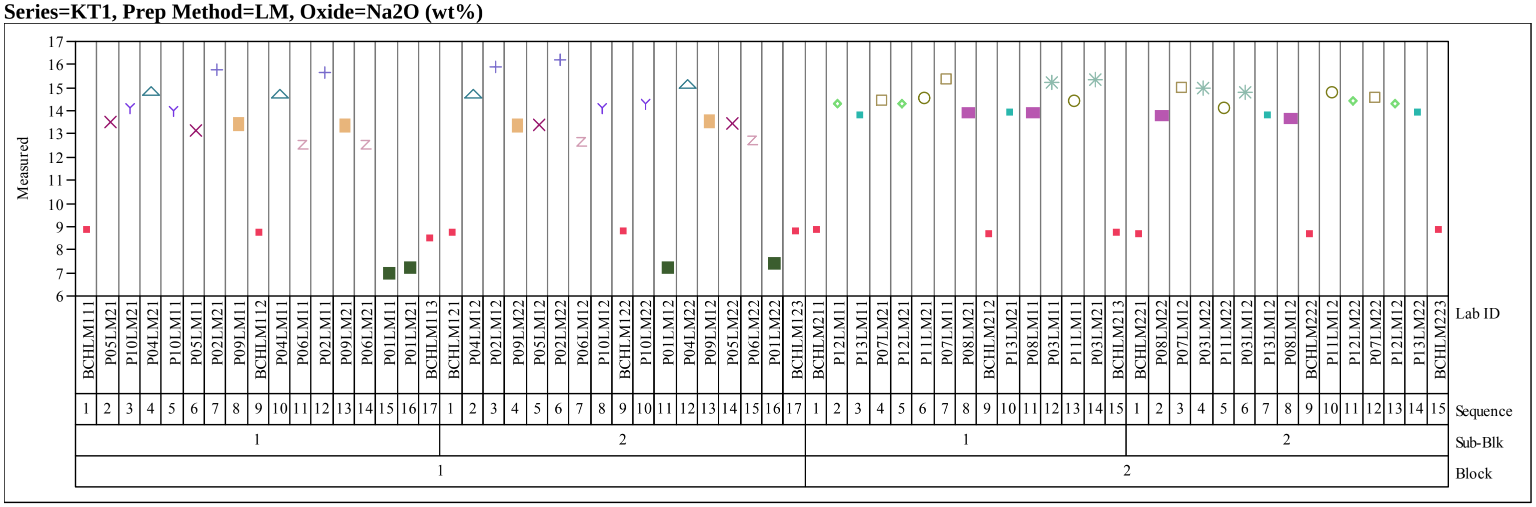
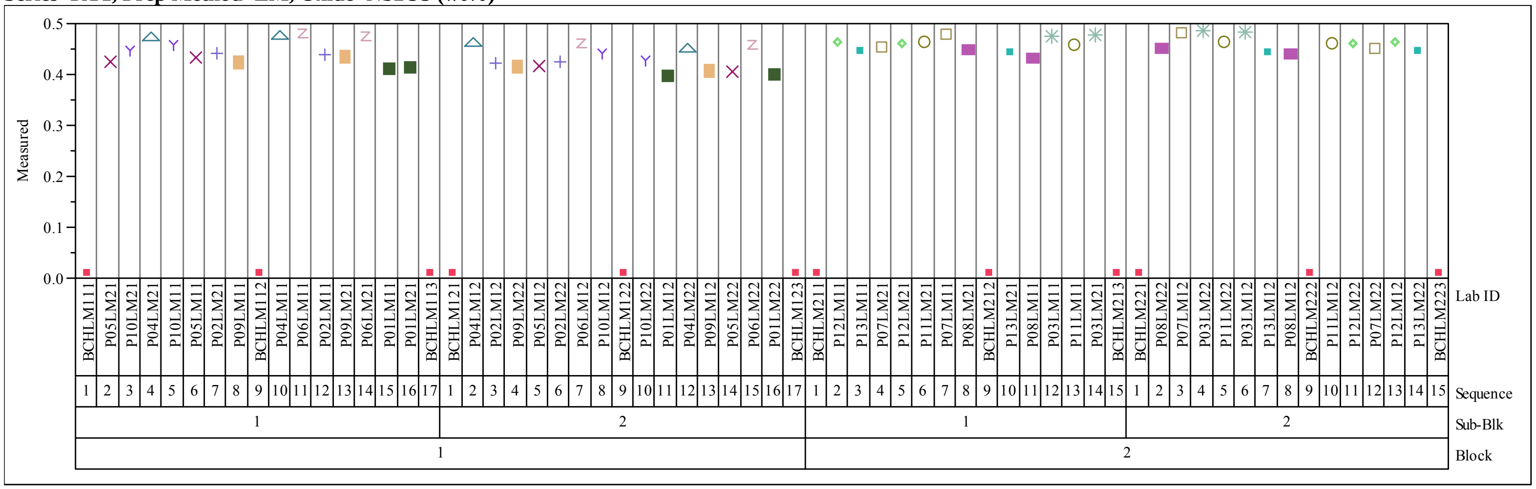


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=Nb2O5 (wt%)



Series=KT1, Prep Method=LM, Oxide=NiO (wt%)

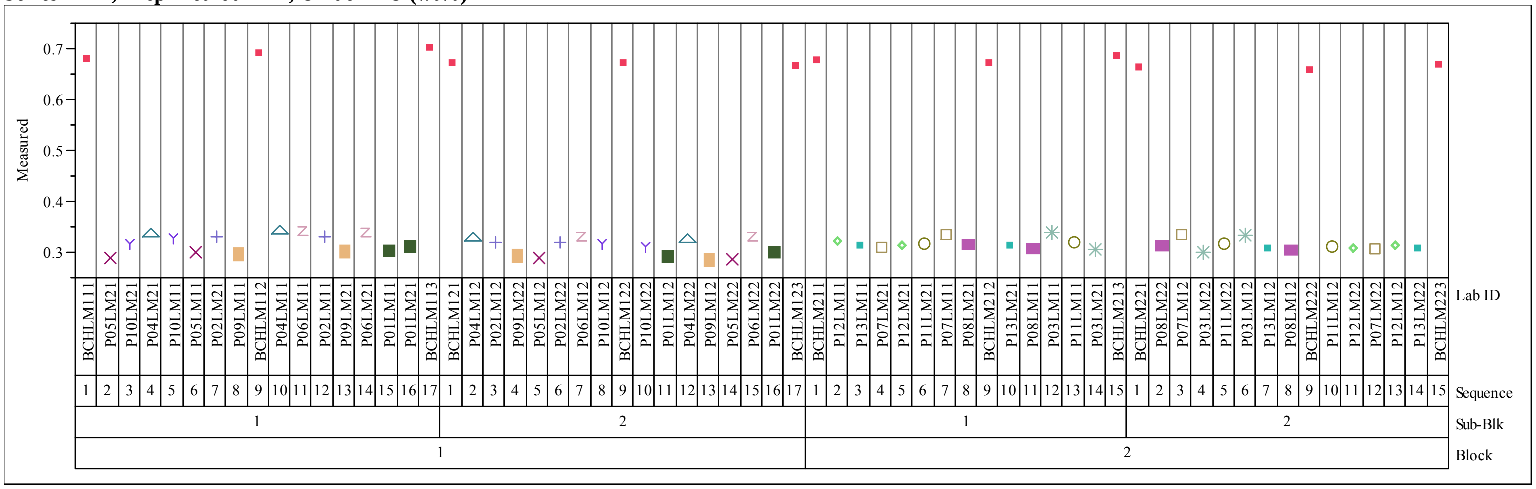
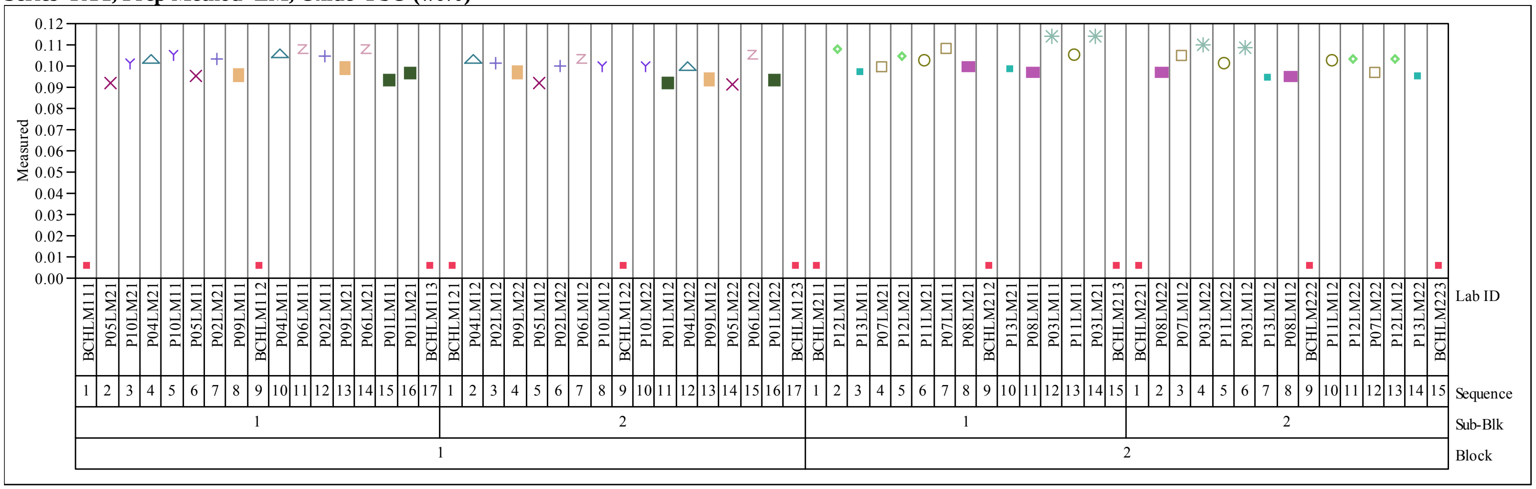


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=PbO (wt%)



Series=KT1, Prep Method=LM, Oxide=SiO2 (wt%)

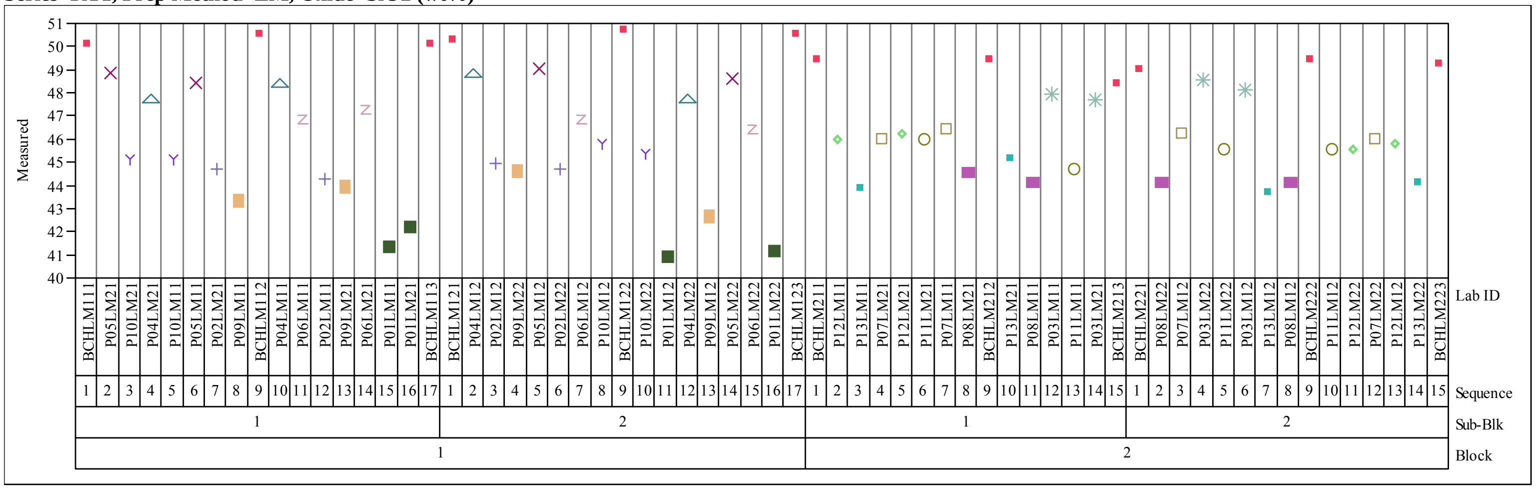
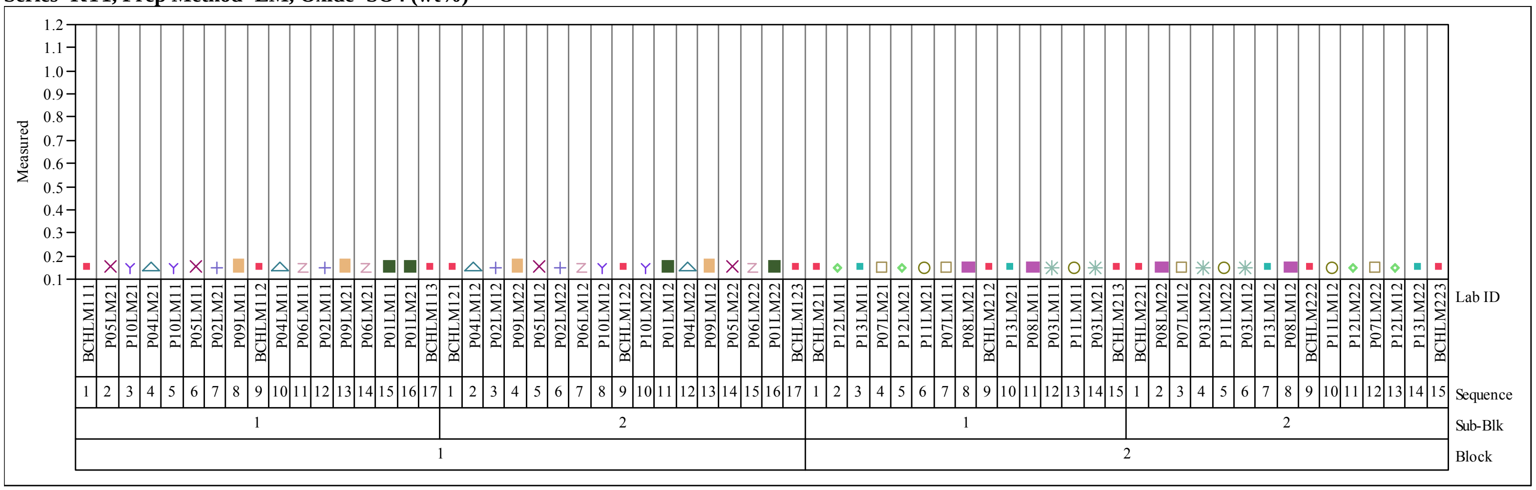


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=SO4 (wt%)



Series=KT1, Prep Method=LM, Oxide=TiO2 (wt%)

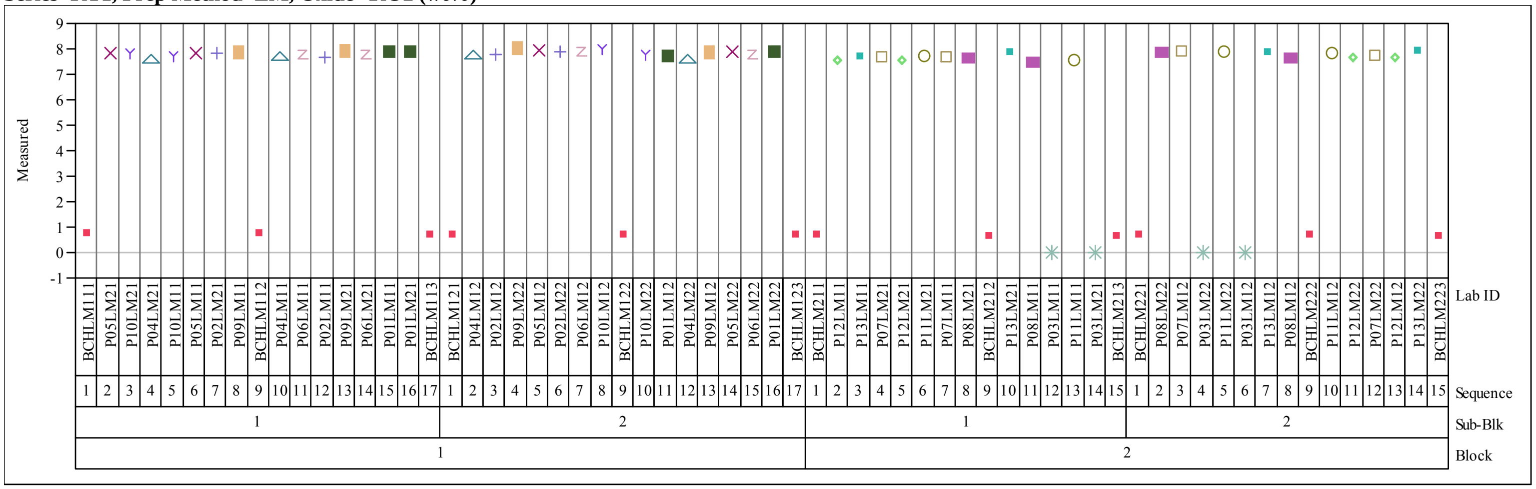
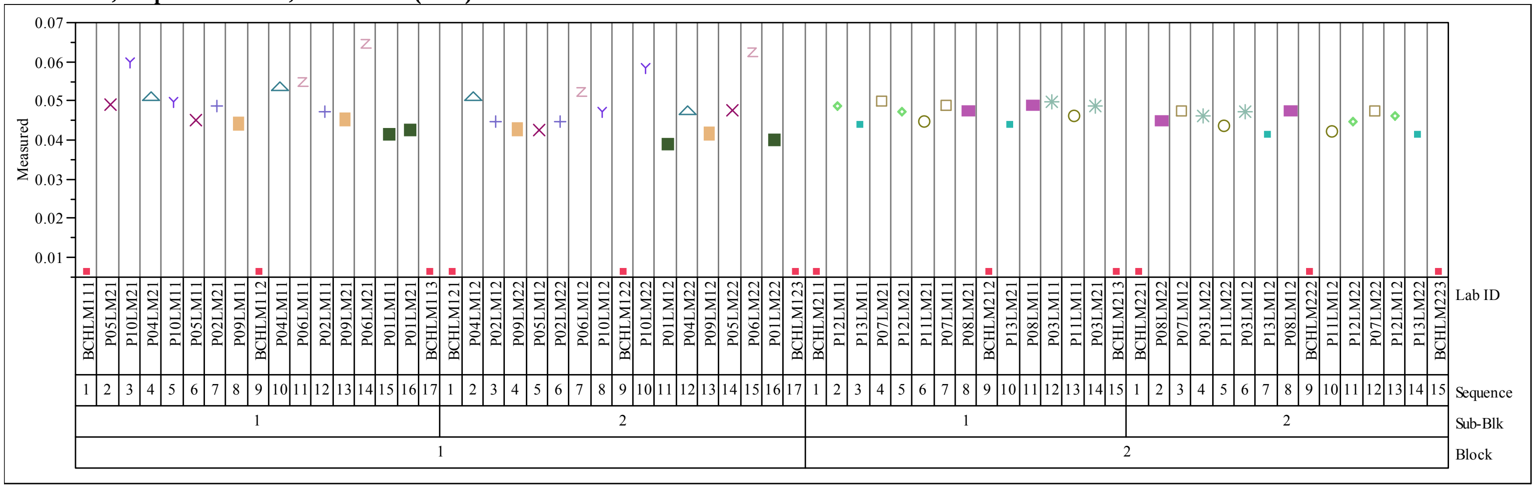


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=ZnO (wt%)



Series=KT1, Prep Method=LM, Oxide=ZrO2 (wt%)

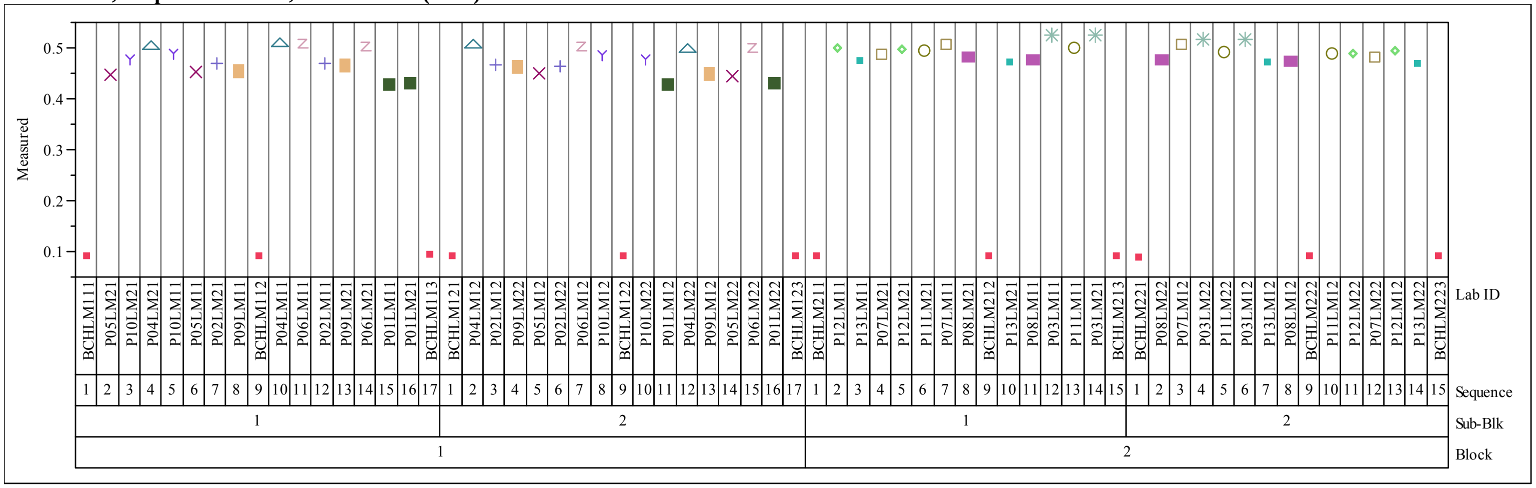
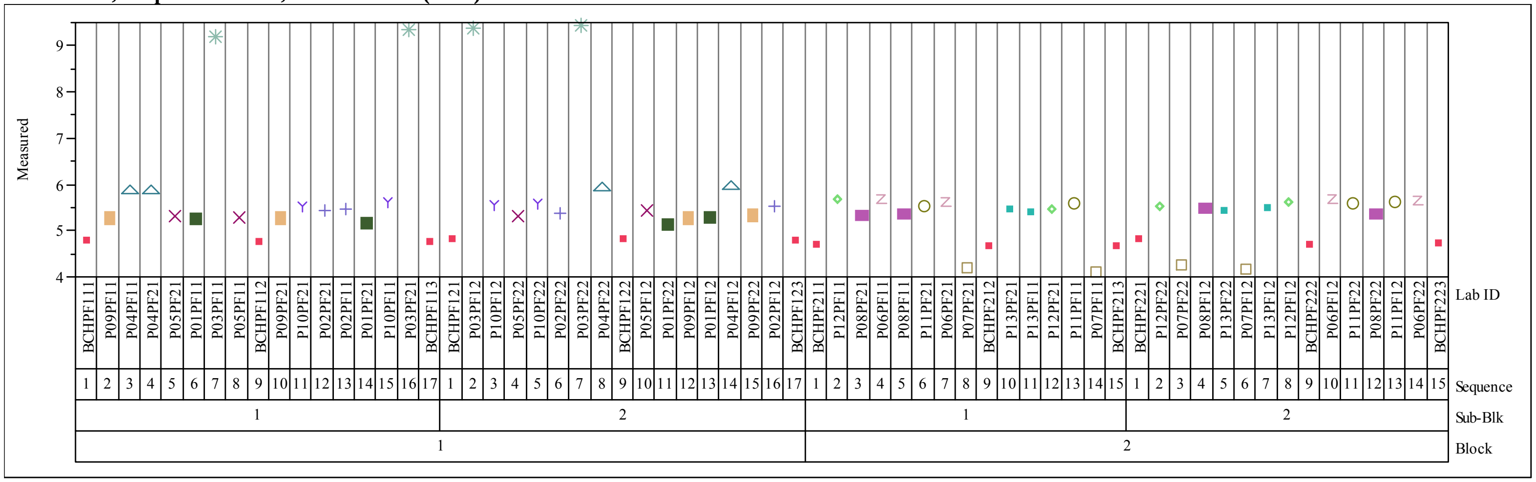


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=PF, Oxide=Al2O3 (wt%)



Series=KT1, Prep Method=PF, Oxide=B2O3 (wt%)

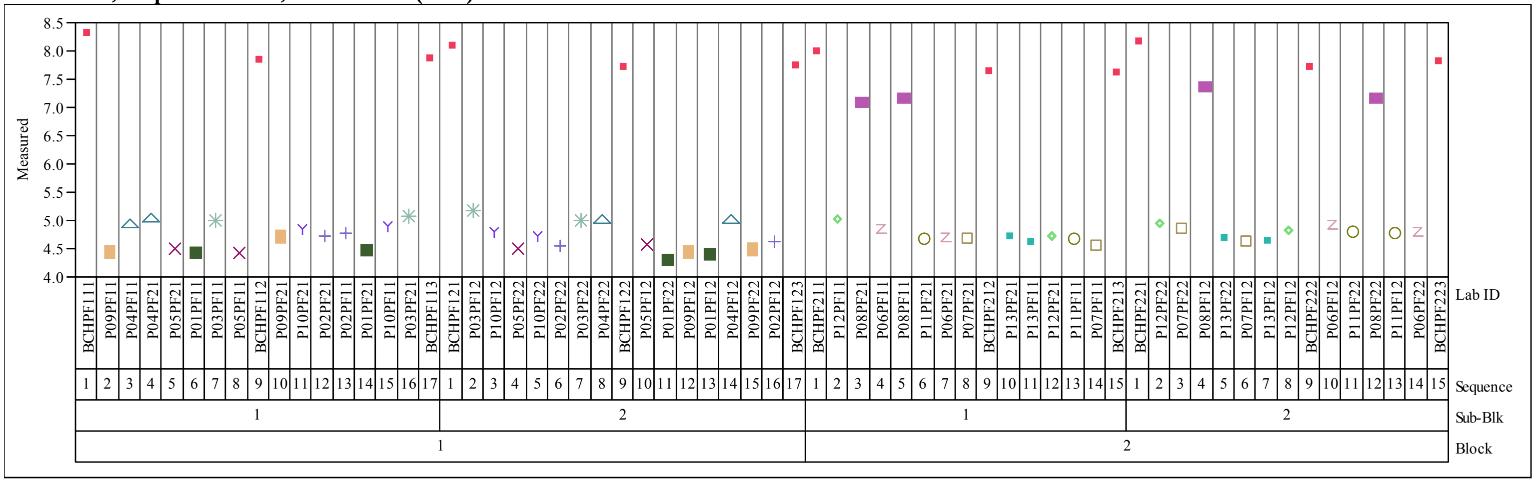
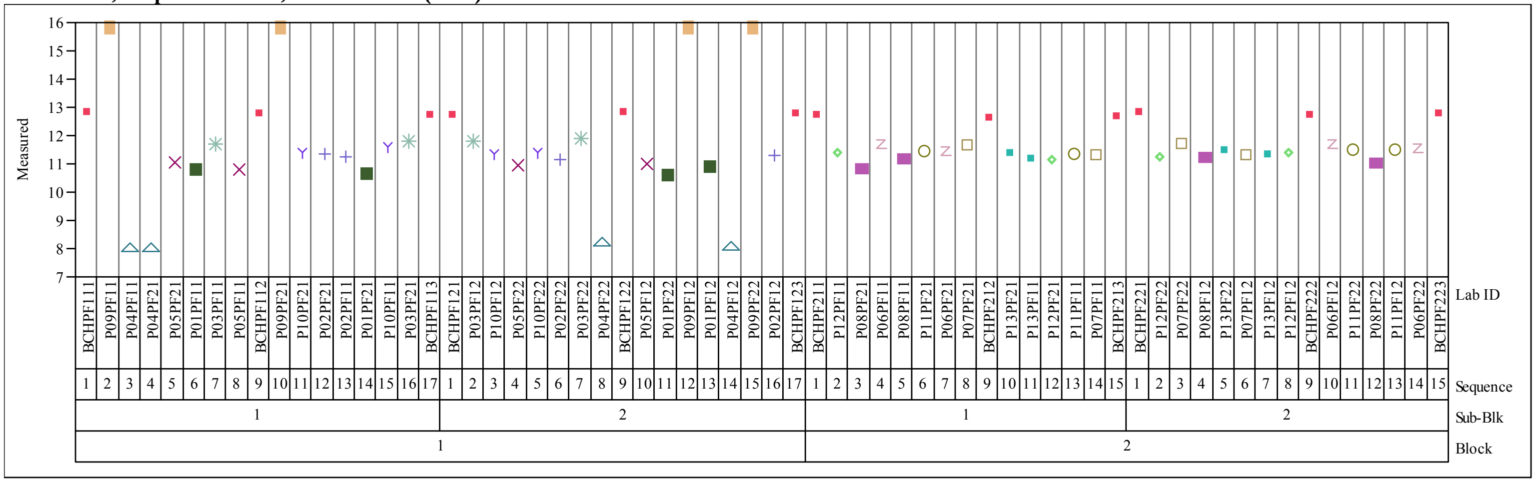


Exhibit A-1. Measurements in Analytical Sequence for KT01-Series by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=PF, Oxide=Fe2O3 (wt%)



Series=KT1, Prep Method=PF, Oxide=Li2O (wt%)

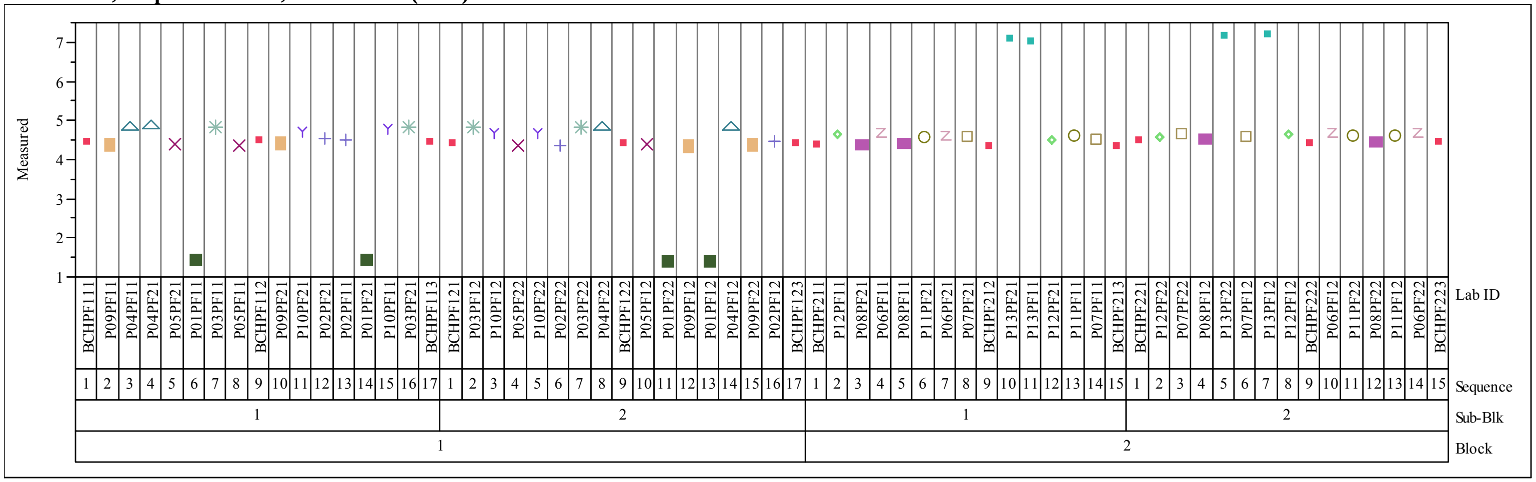
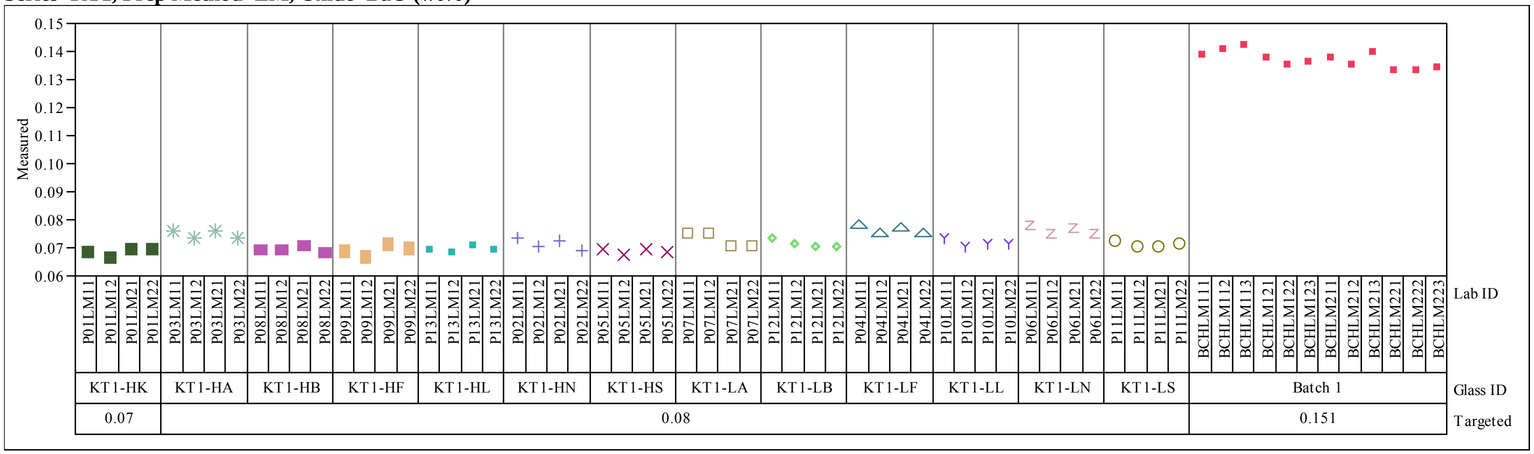


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide.

Series=KT1, Prep Method=LM, Oxide=BaO (wt%)



Series=KT1, Prep Method=LM, Oxide=CaO (wt%)

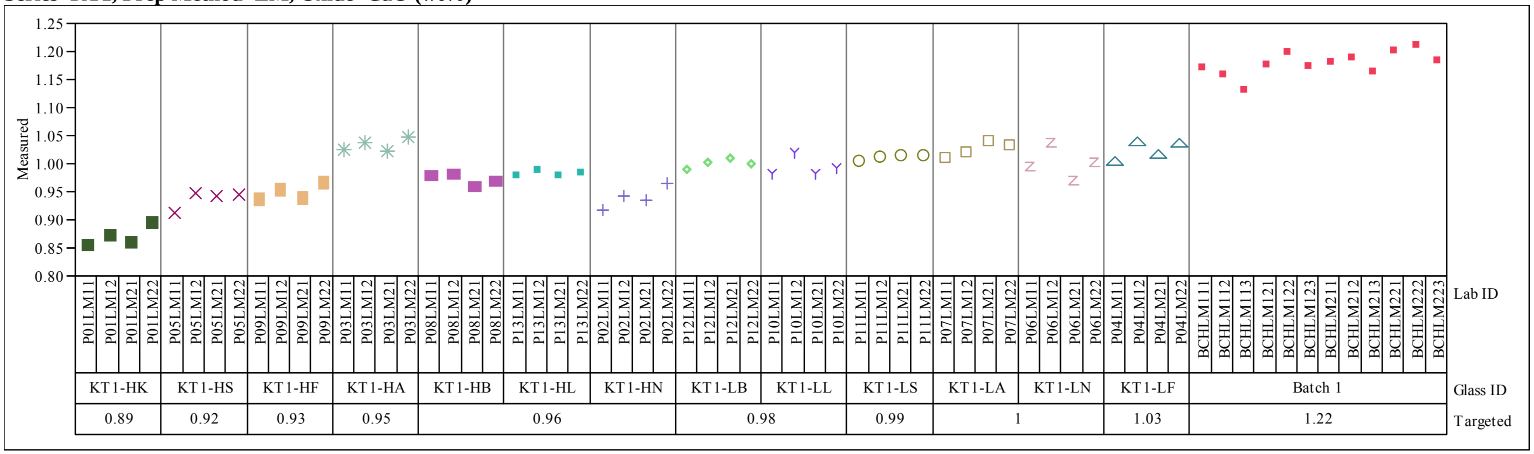
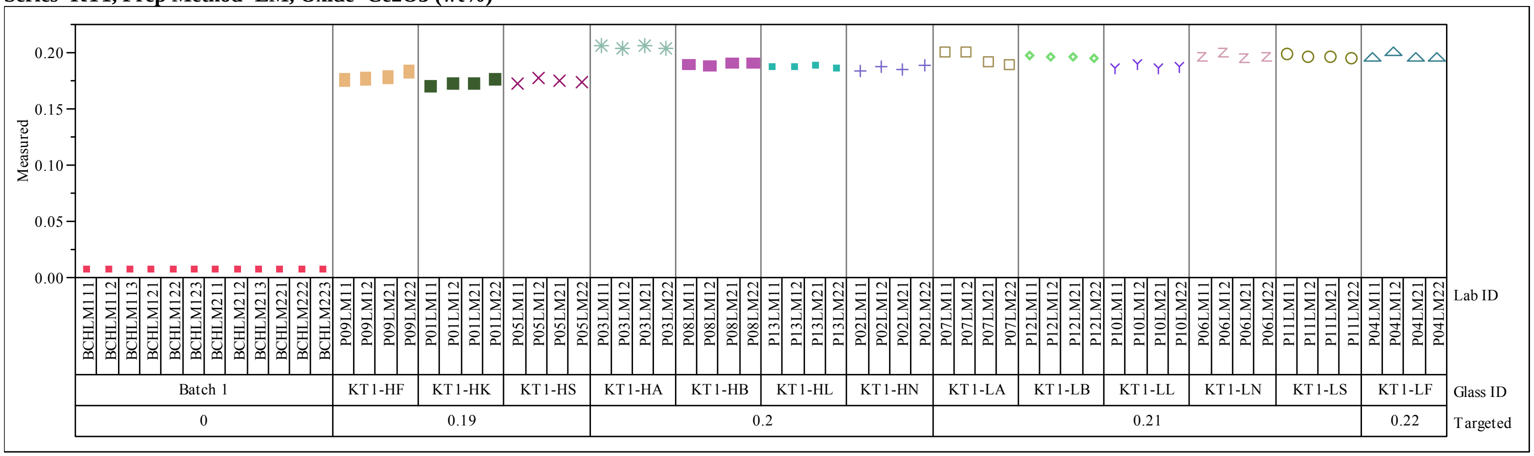


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=Ce2O3 (wt%)



Series=KT1, Prep Method=LM, Oxide=Cr2O3 (wt%)

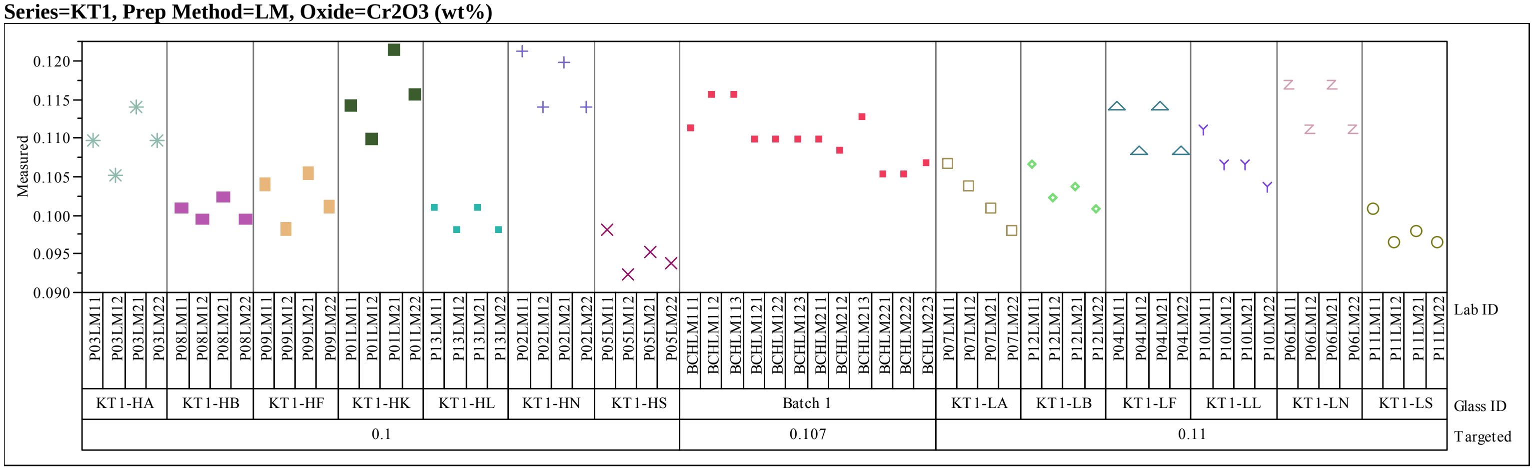
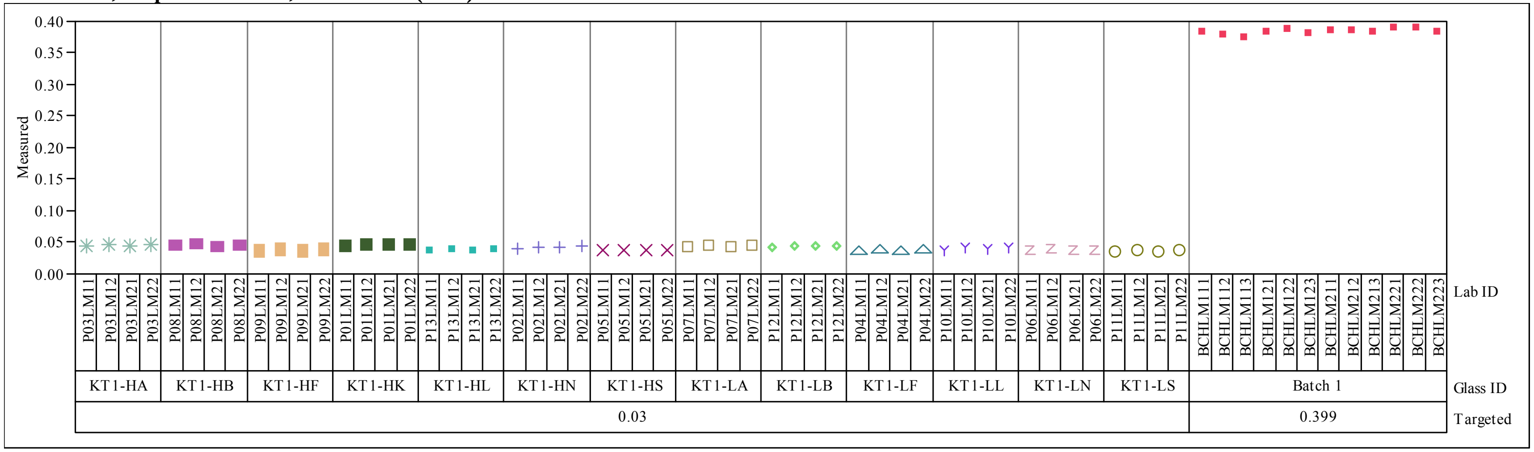


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=CuO (wt%)



Series=KT1, Prep Method=LM, Oxide=K2O (wt%)

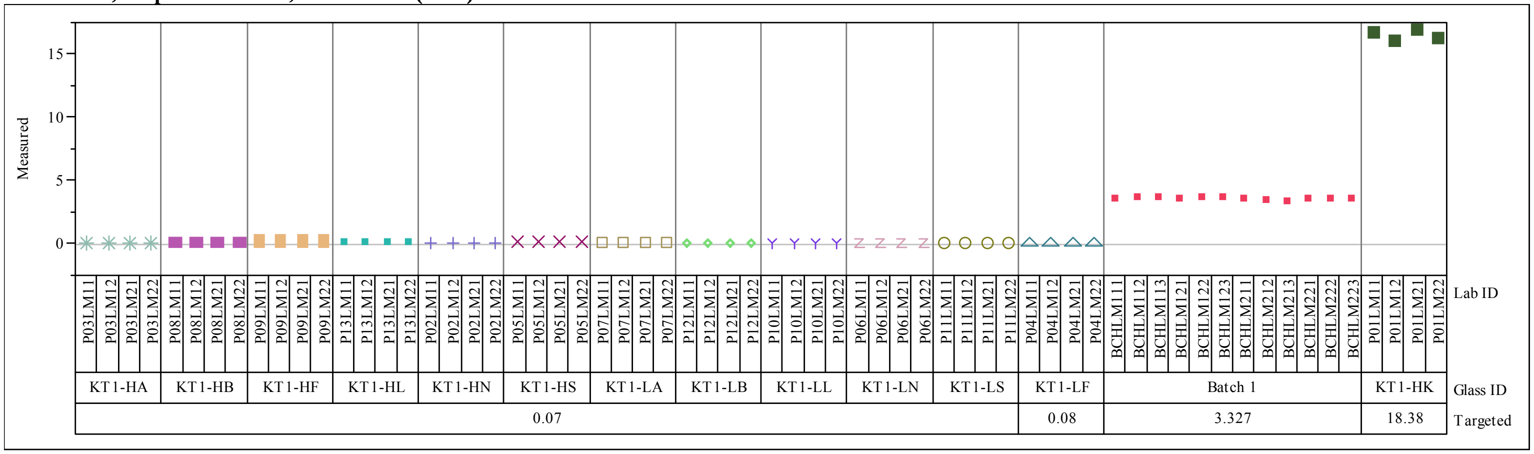
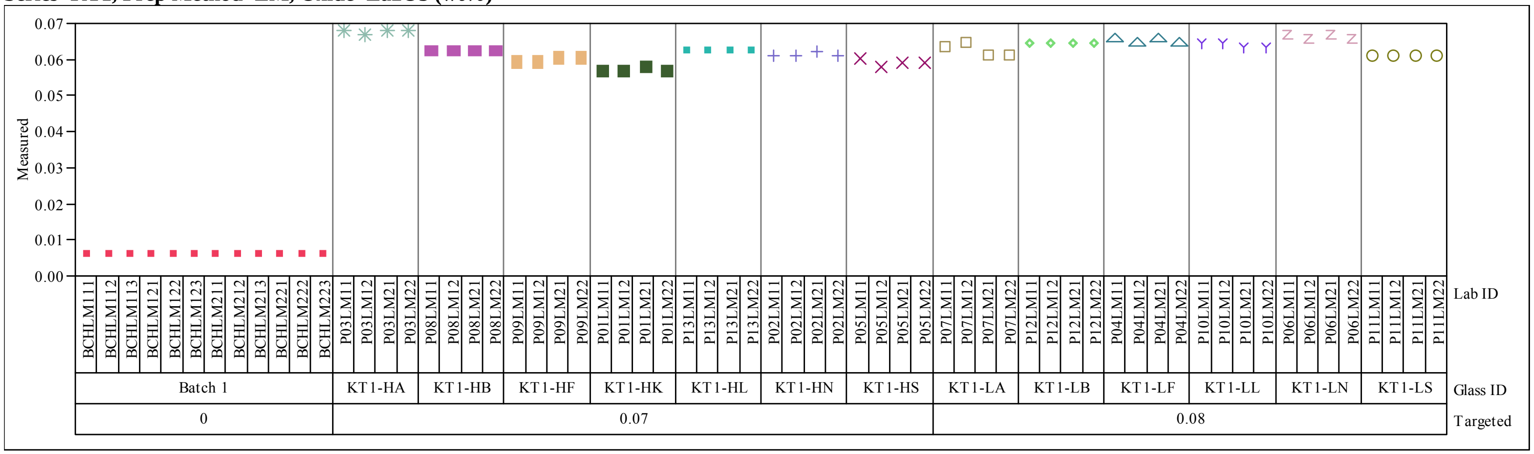


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=La2O3 (wt%)



Series=KT1, Prep Method=LM, Oxide=MgO (wt%)

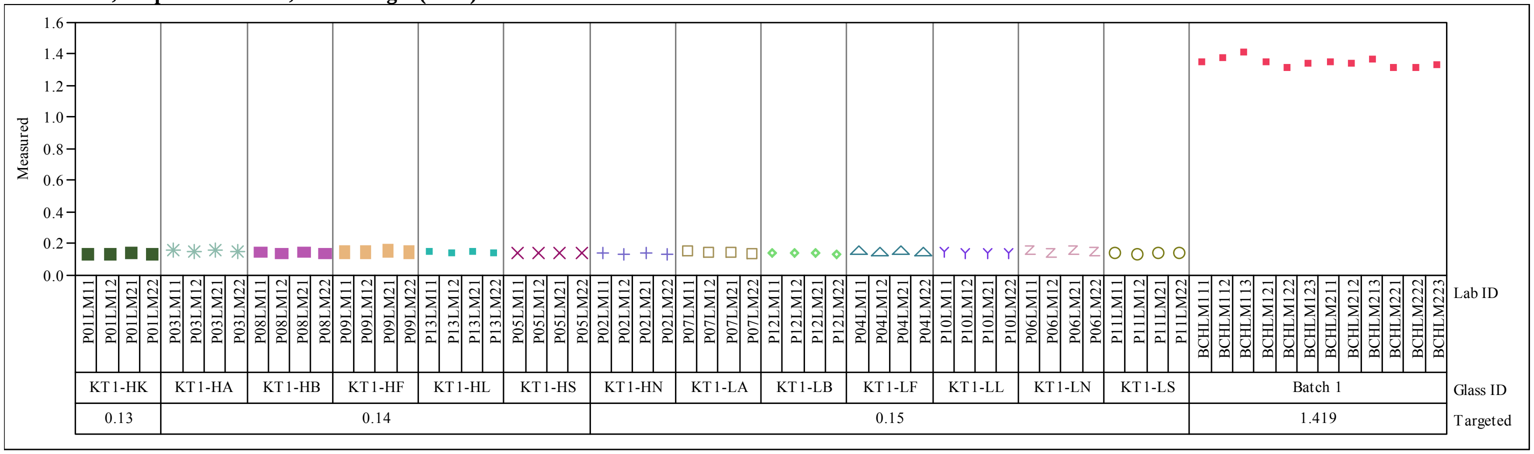
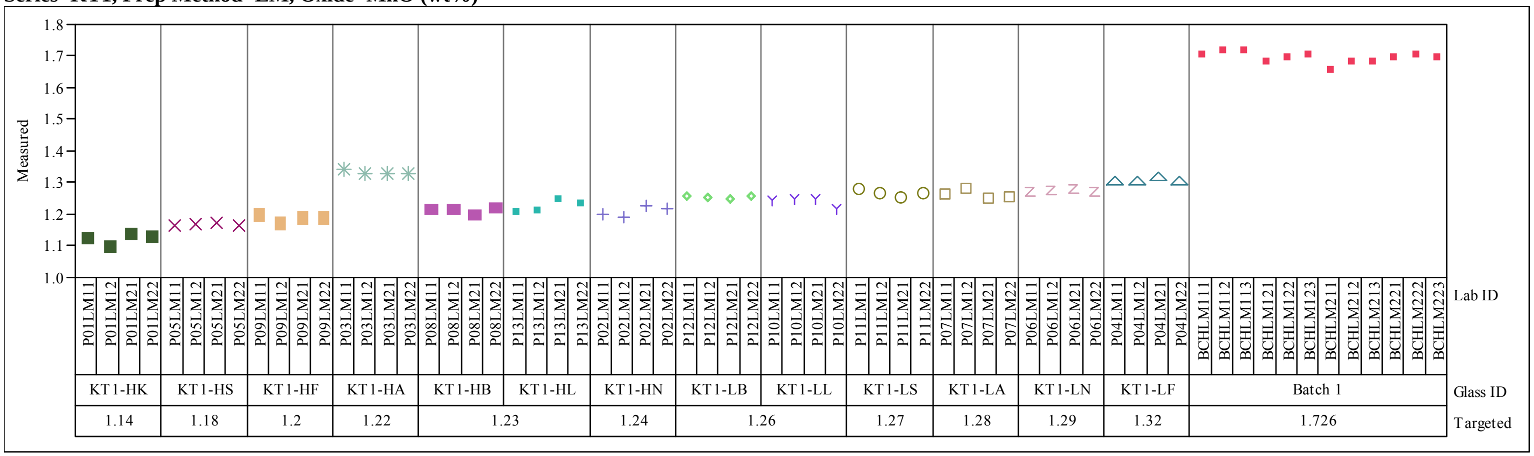


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=MnO (wt%)



Series=KT1, Prep Method=LM, Oxide=Na2O (wt%)

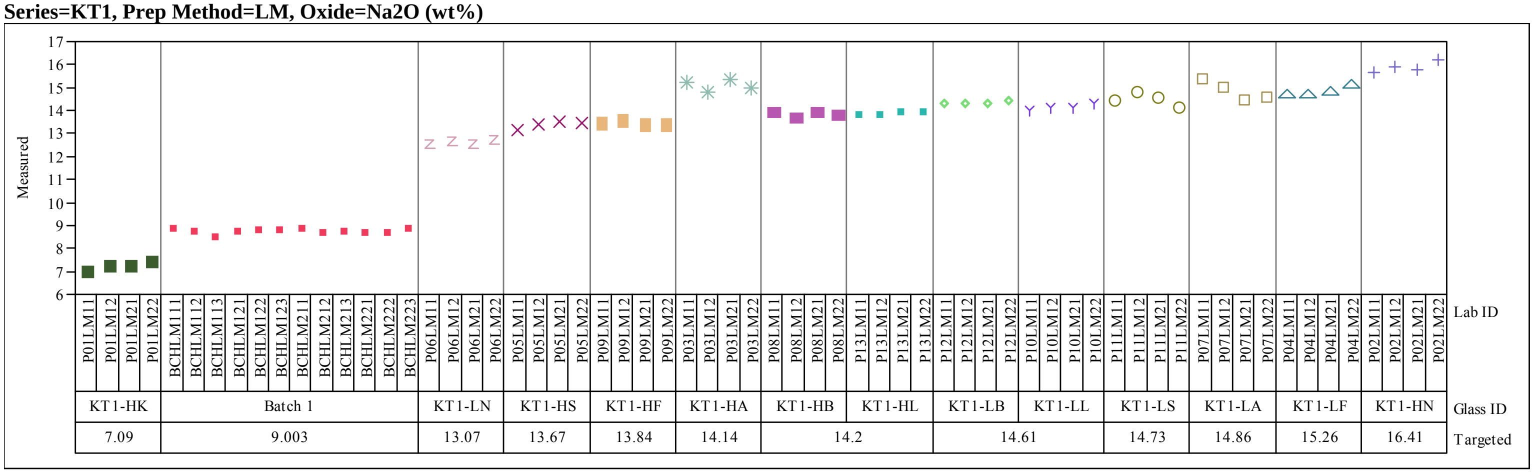
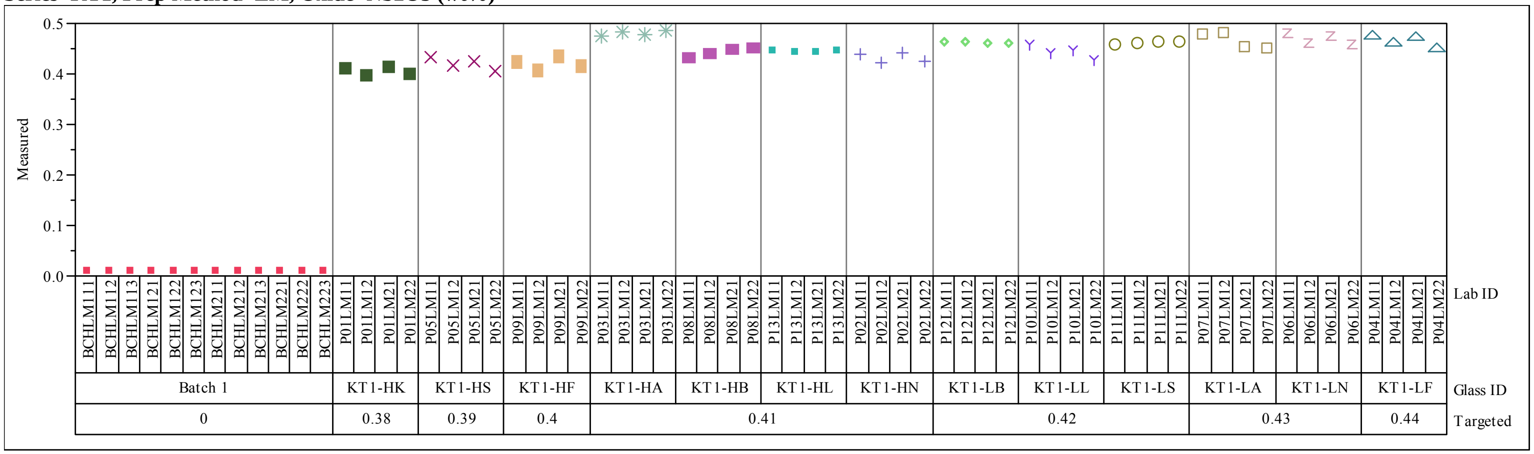


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=Nb2O5 (wt%)



Series=KT1, Prep Method=LM, Oxide=NiO (wt%)

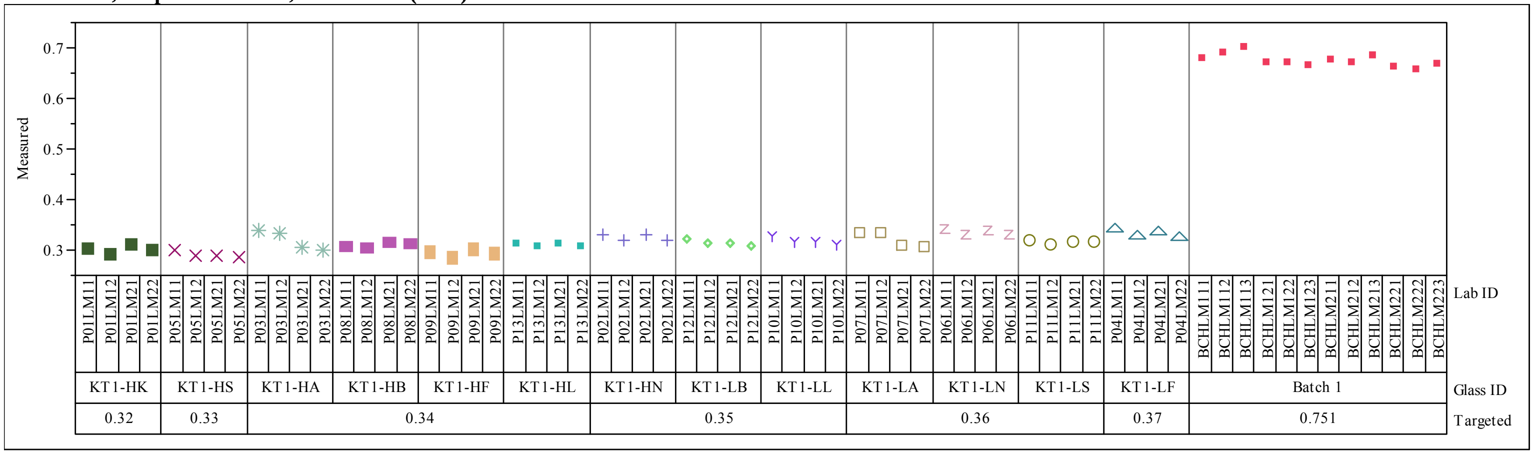
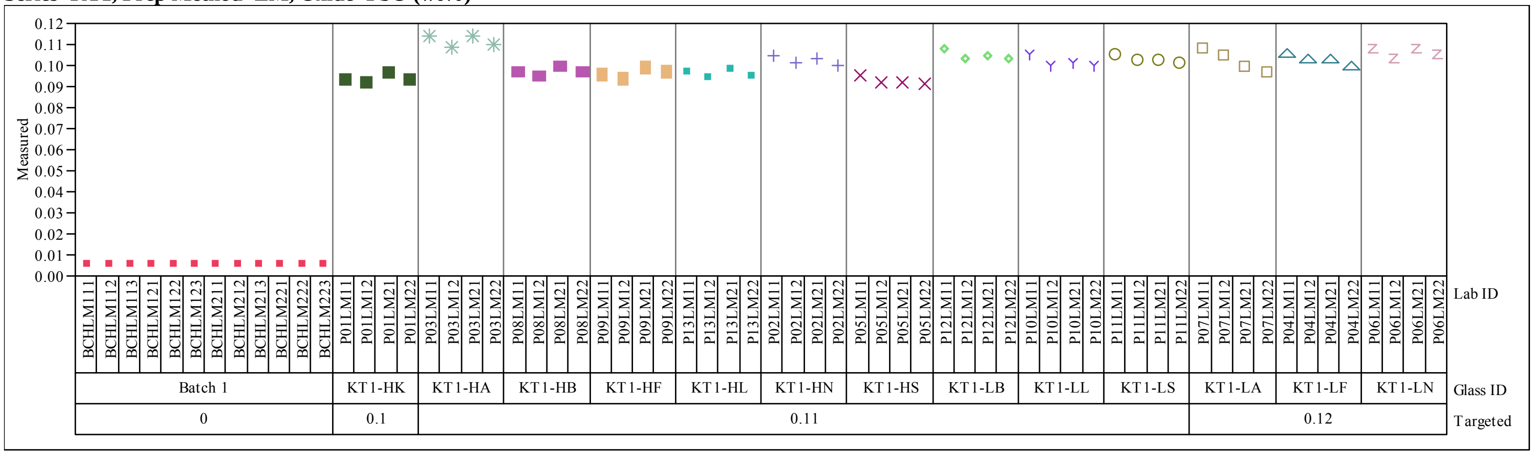


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=PbO (wt%)



Series=KT1, Prep Method=LM, Oxide=SiO2 (wt%)

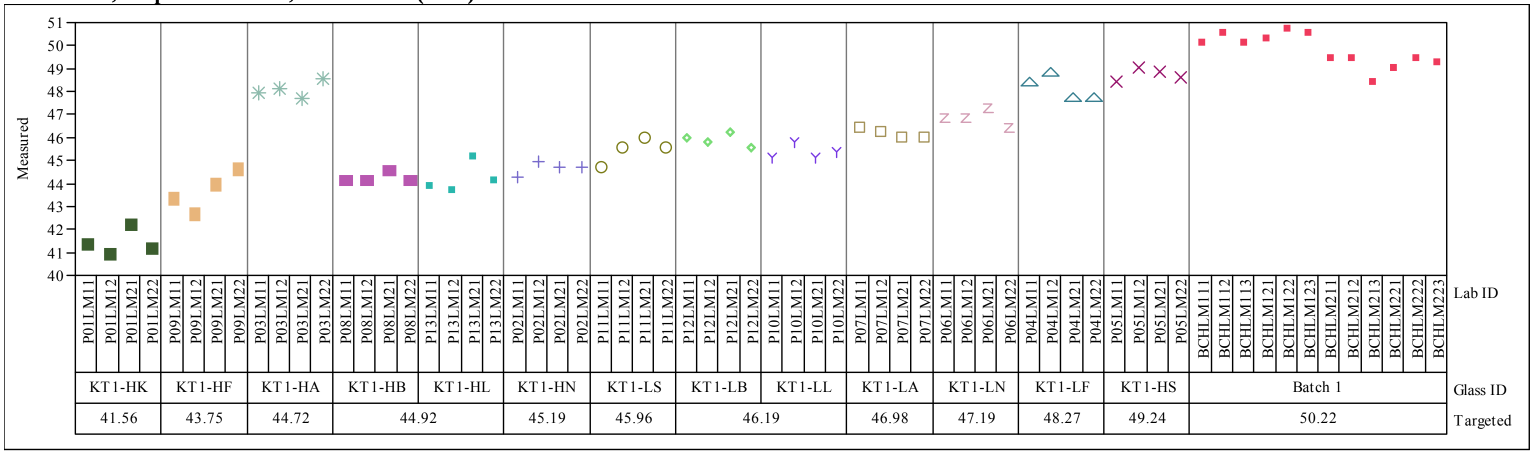
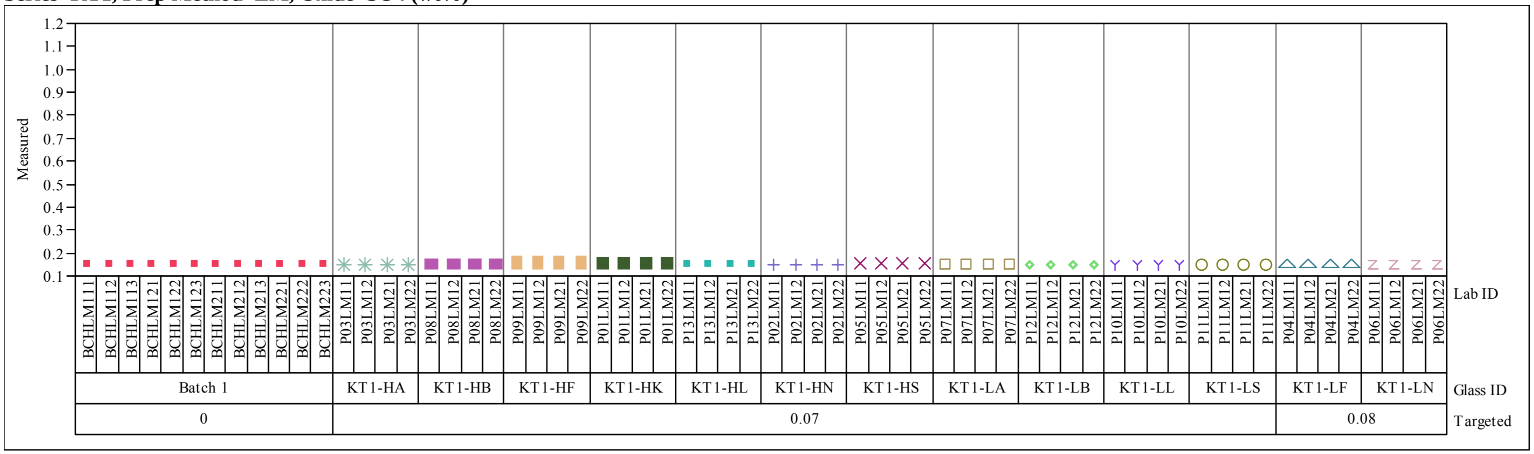


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=SO4 (wt%)



Series=KT1, Prep Method=LM, Oxide=TiO2 (wt%)

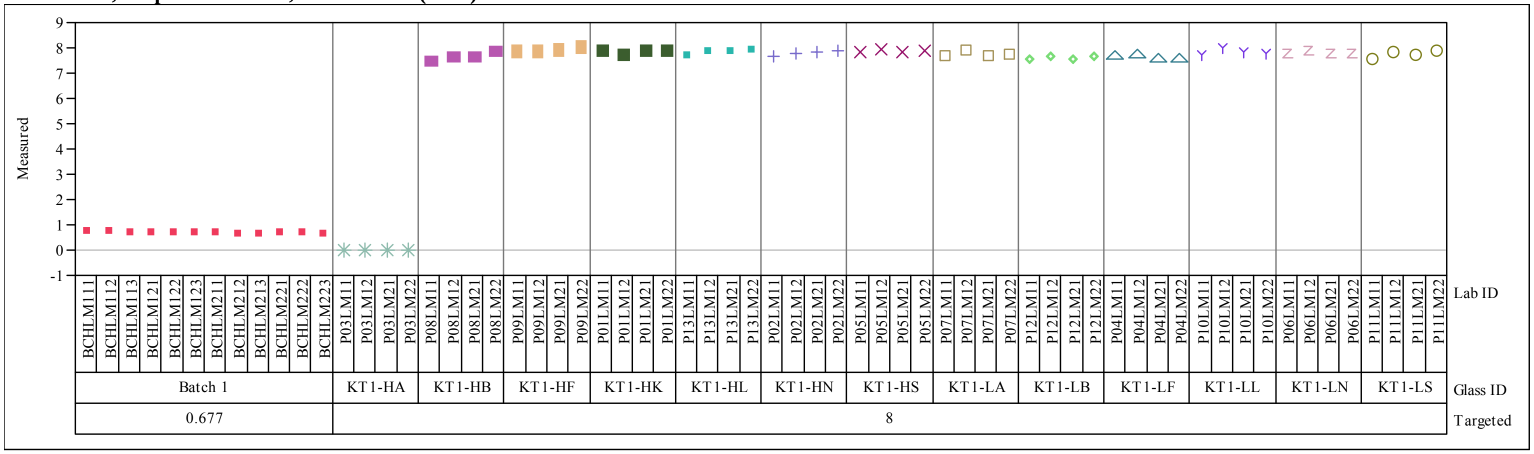
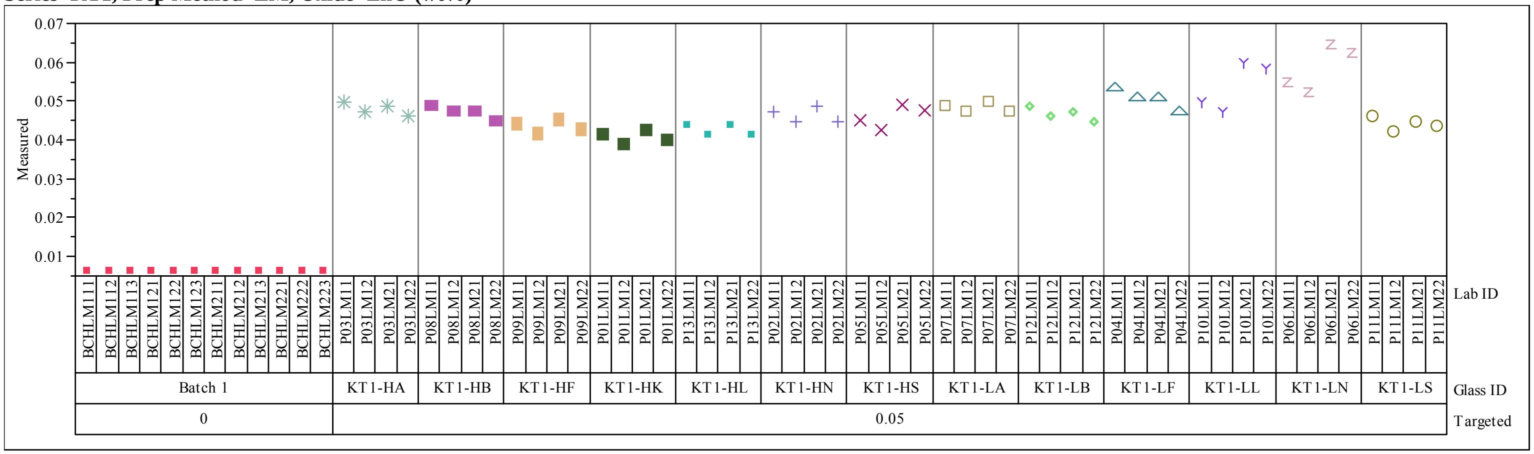


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=LM, Oxide=ZnO (wt%)



Series=KT1, Prep Method=LM, Oxide=ZrO2 (wt%)

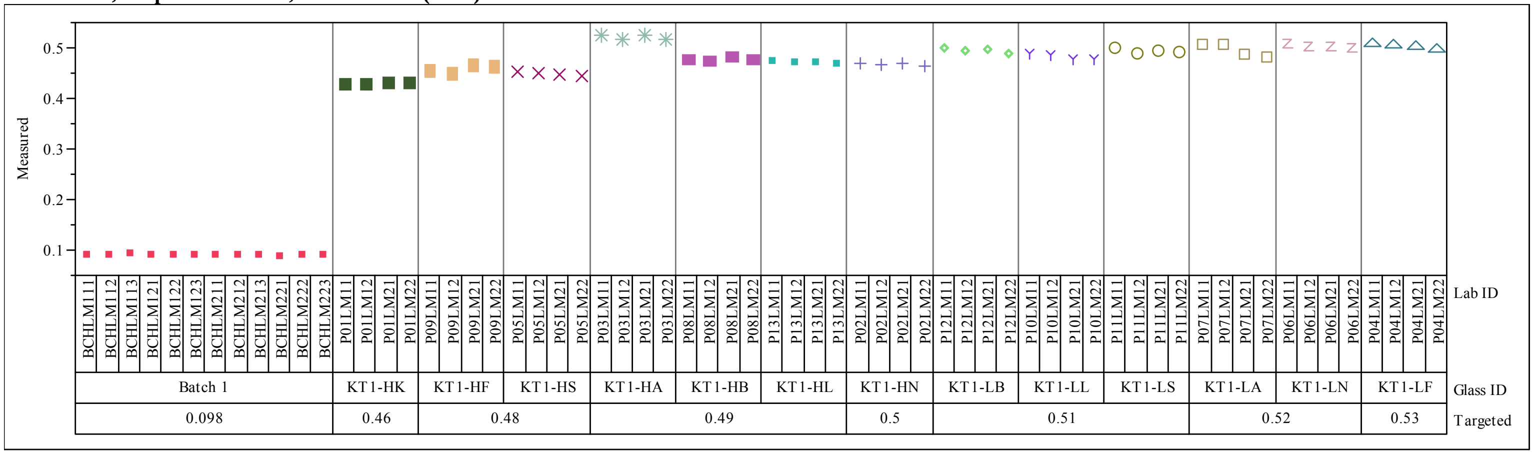
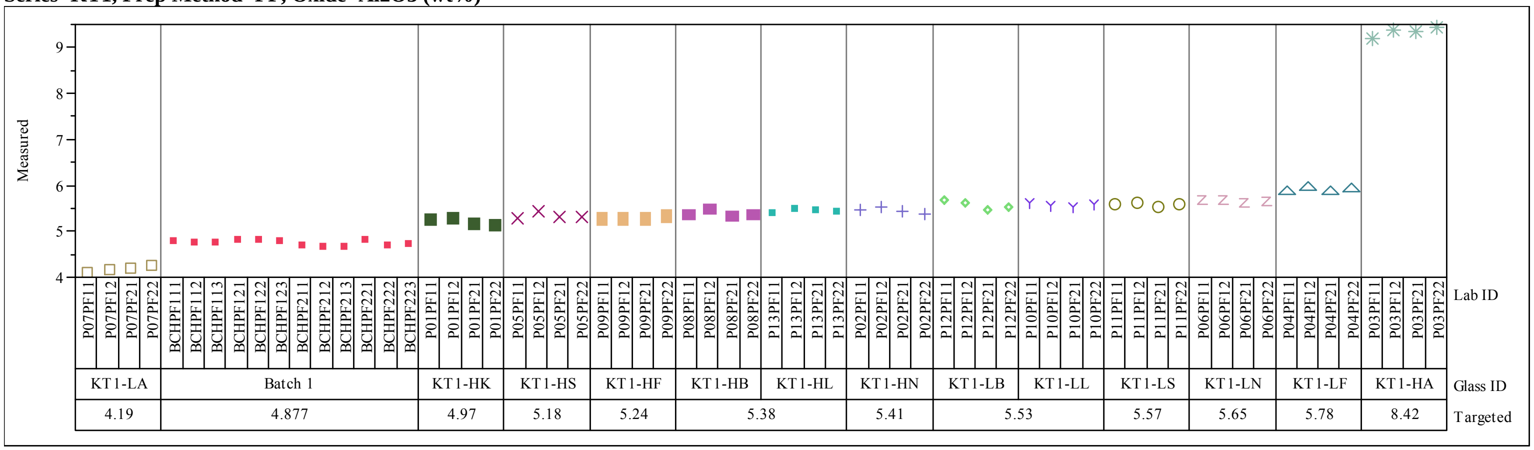


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=PF, Oxide=Al2O3 (wt%)



Series=KT1, Prep Method=PF, Oxide=B2O3 (wt%)

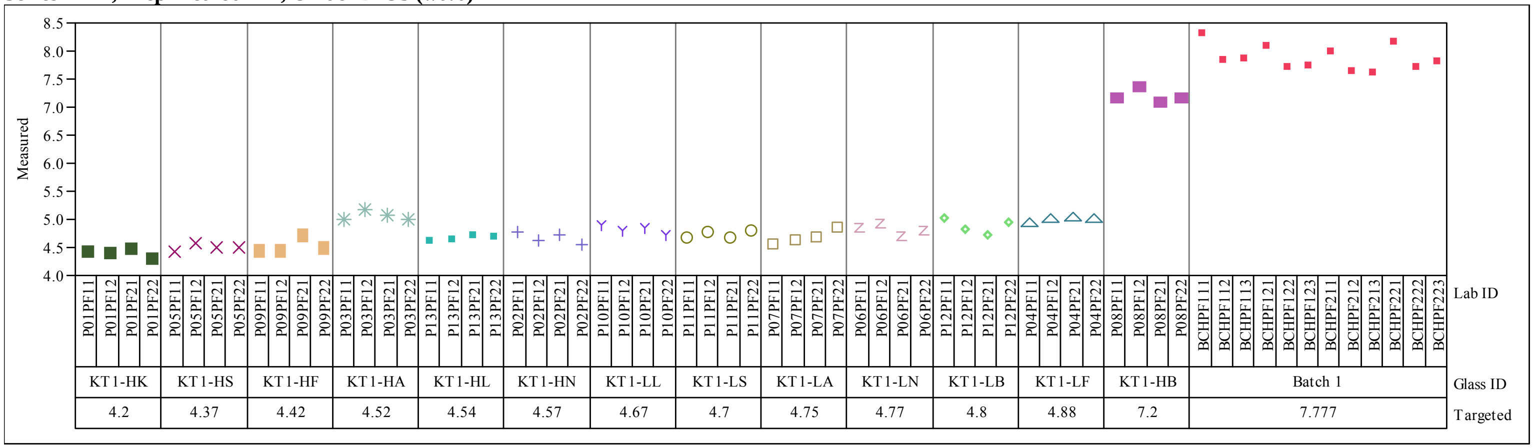
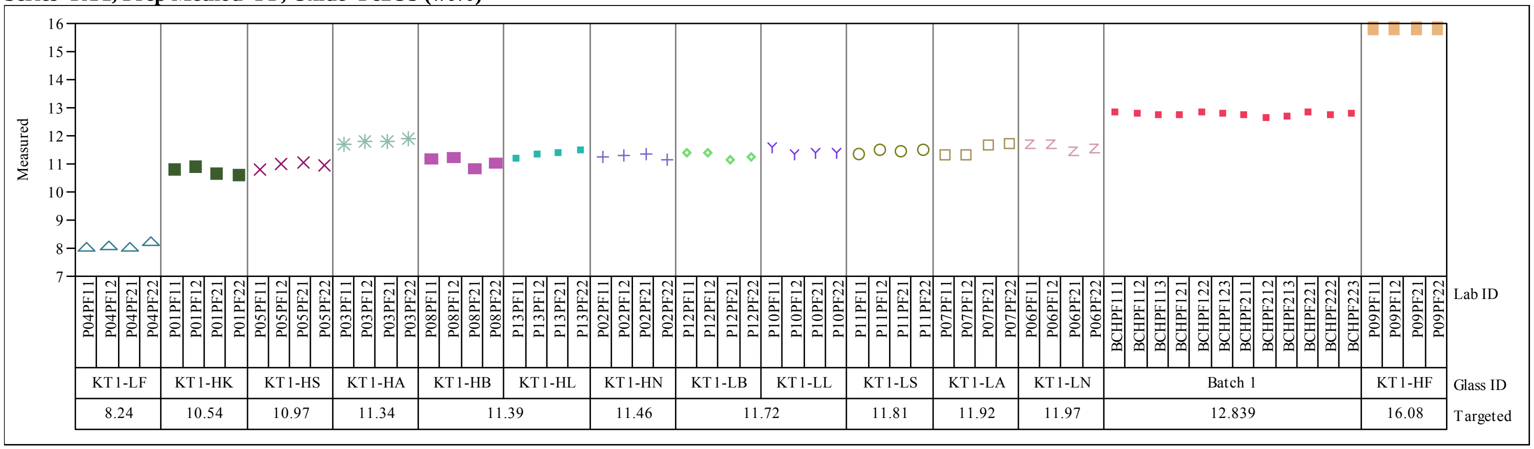


Exhibit A-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT1, Prep Method=PF, Oxide=Fe2O3 (wt%)



Series=KT1, Prep Method=PF, Oxide=Li2O (wt%)

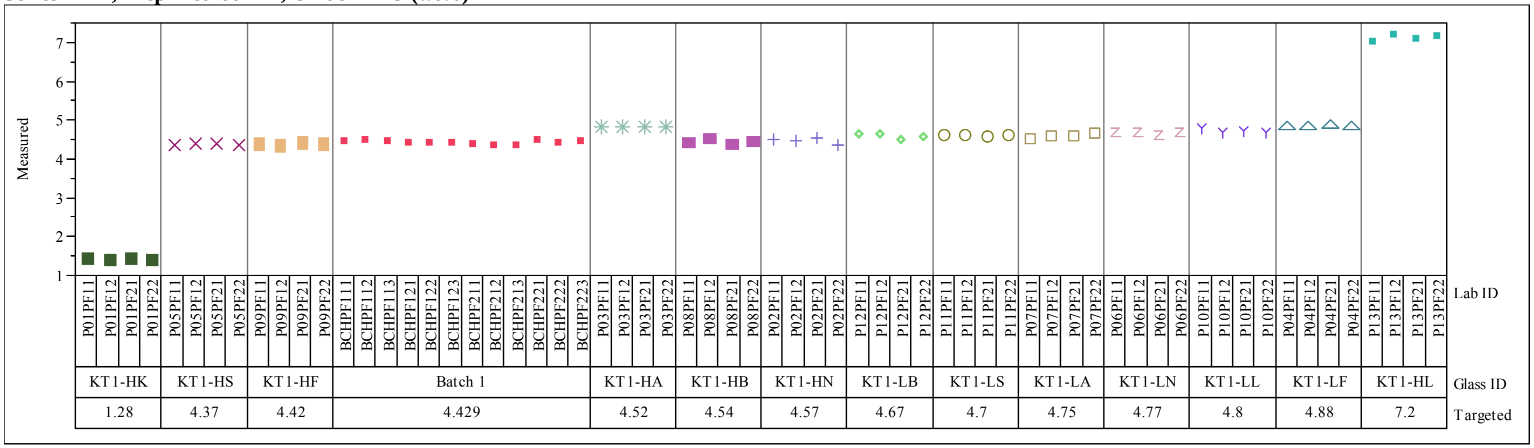
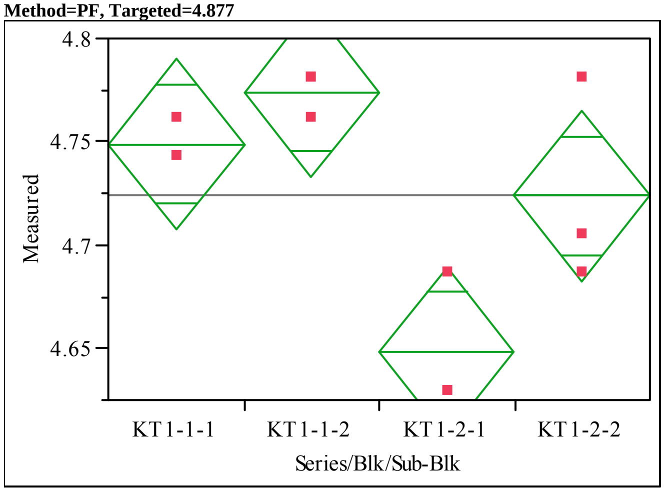


Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide.

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=Al2O3 (wt%), Prep Method=PF, Targeted=4.877



Oneway Anova
Summary of Fit

Rsquare	0.777778
Adj Rsquare	0.694444
Root Mean Square Error	0.030855
Mean of Response	4.72375
Observations (or Sum Wgts)	12

Analysis of Variance

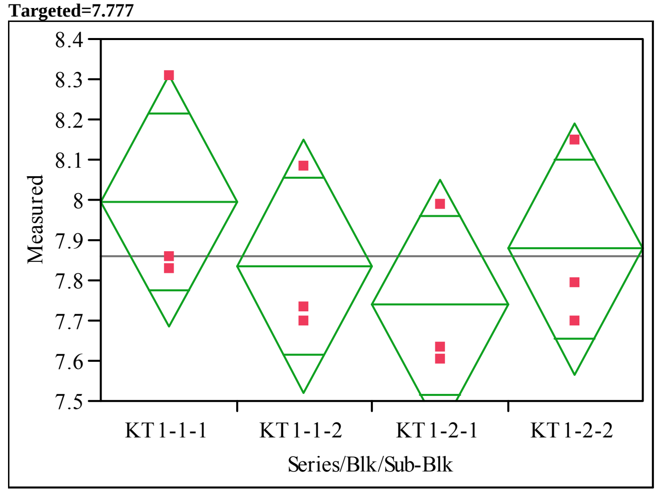
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.02665757	0.008886	9.3333	0.0054
Error	8	0.00761645	0.000952		
C. Total	11	0.03427402			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	4.74894	0.01781	4.7079	4.7900
KT1-1-2	3	4.77414	0.01781	4.7331	4.8152
KT1-2-1	3	4.64817	0.01781	4.6071	4.6893
KT1-2-2	3	4.72375	0.01781	4.6827	4.7648

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=B2O3 (wt%), Prep Method=PF, Targeted=7.777



Oneway Anova
Summary of Fit

Rsquare	0.188332
Adj Rsquare	-0.11604
Root Mean Square Error	0.235148
Mean of Response	7.861923
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.10264078	0.034214	0.6188	0.6222
Error	8	0.44235759	0.055295		
C. Total	11	0.54499837			

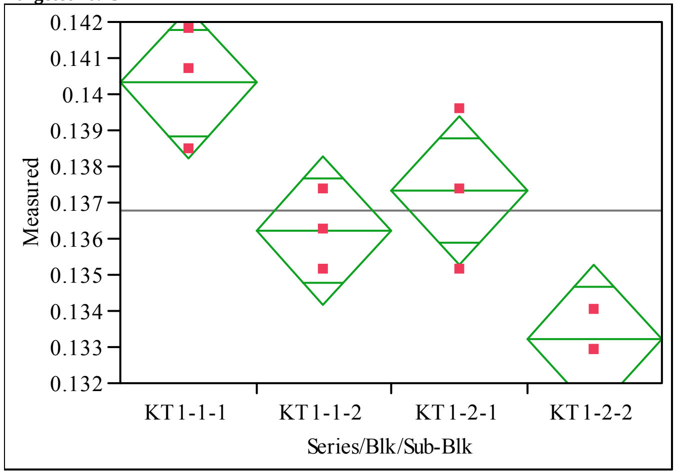
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	7.99609	0.13576	7.6830	8.3092
KT1-1-2	3	7.83509	0.13576	7.5220	8.1482
KT1-2-1	3	7.73849	0.13576	7.4254	8.0516
KT1-2-2	3	7.87802	0.13576	7.5650	8.1911

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=BaO (wt%), Prep Method=LM, Targeted=0.151



Oneway Anova
Summary of Fit

Rsquare	0.800866
Adj Rsquare	0.72619
Root Mean Square Error	0.001546
Mean of Response	0.136771
Observations (or Sum Wgts)	12

Analysis of Variance

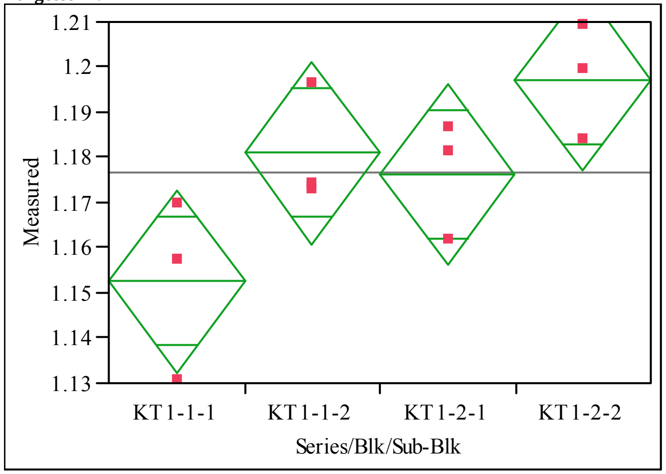
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00007687	0.000026	10.7246	0.0035
Error	8	0.00001911	2.389e-6		
C. Total	11	0.00009599			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.140307	0.00089	0.13825	0.14236
KT1-1-2	3	0.136213	0.00089	0.13416	0.13827
KT1-2-1	3	0.137330	0.00089	0.13527	0.13939
KT1-2-2	3	0.133236	0.00089	0.13118	0.13529

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=CaO (wt%), Prep Method=LM, Targeted=1.22



Oneway Anova
Summary of Fit

Rsquare	0.627592
Adj Rsquare	0.487939
Root Mean Square Error	0.015118
Mean of Response	1.176727
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00308152	0.001027	4.4939	0.0396
Error	8	0.00182855	0.000229		
C. Total	11	0.00491006			

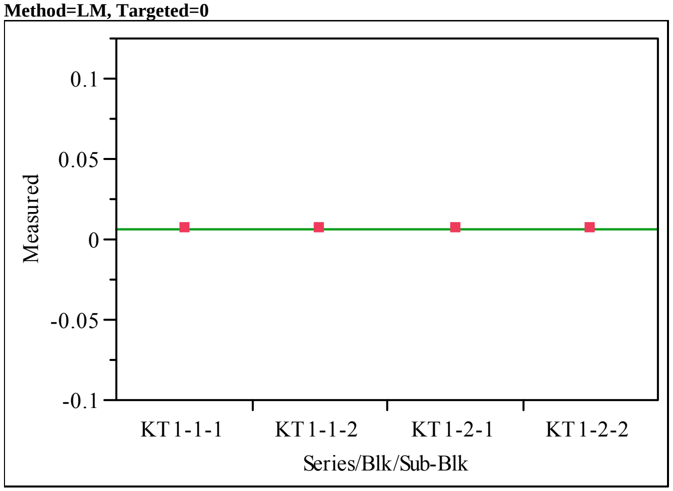
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	1.15247	0.00873	1.1323	1.1726
KT1-1-2	3	1.18092	0.00873	1.1608	1.2011
KT1-2-1	3	1.17626	0.00873	1.1561	1.1964
KT1-2-2	3	1.19725	0.00873	1.1771	1.2174

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=Ce2O3 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005857
Observations (or Sum Wgts)	12

Analysis of Variance

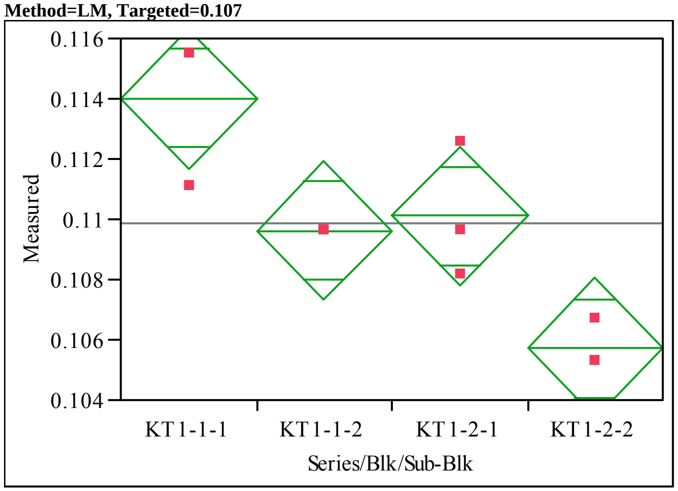
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.005857	0	0.00586	0.00586
KT1-1-2	3	0.005857	0	0.00586	0.00586
KT1-2-1	3	0.005857	0	0.00586	0.00586
KT1-2-2	3	0.005857	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=Cr2O3 (wt%), Prep Method=LM, Targeted=0.107



Oneway Anova
Summary of Fit

Rsquare	0.810056
Adj Rsquare	0.738827
Root Mean Square Error	0.00174
Mean of Response	0.109864
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00010325	0.000034	11.3725	0.0029
Error	8	0.00002421	3.026e-6		
C. Total	11	0.00012746			

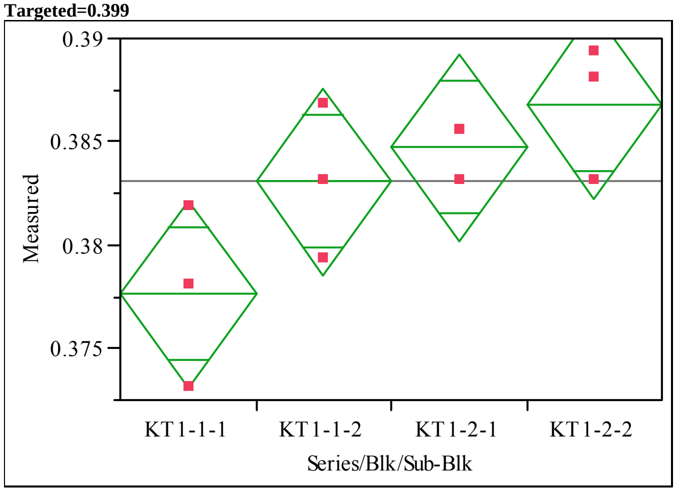
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.114005	0.00100	0.11169	0.11632
KT1-1-2	3	0.109620	0.00100	0.10730	0.11194
KT1-2-1	3	0.110107	0.00100	0.10779	0.11242
KT1-2-2	3	0.105722	0.00100	0.10341	0.10804

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=CuO (wt%), Prep Method=LM, Targeted=0.399



Oneway Anova
Summary of Fit

Rsquare	0.599099
Adj Rsquare	0.448761
Root Mean Square Error	0.003409
Mean of Response	0.383051
Observations (or Sum Wgts)	12

Analysis of Variance

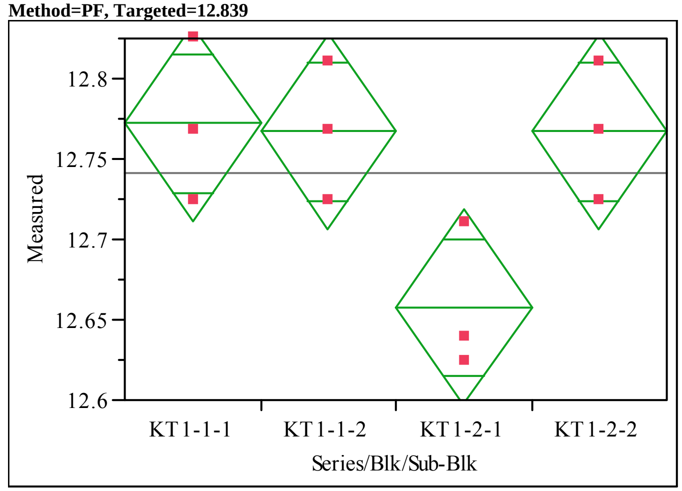
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00013894	0.000046	3.9850	0.0523
Error	8	0.00009298	0.000012		
C. Total	11	0.00023192			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.377626	0.00197	0.37309	0.38217
KT1-1-2	3	0.383051	0.00197	0.37851	0.38759
KT1-2-1	3	0.384720	0.00197	0.38018	0.38926
KT1-2-2	3	0.386806	0.00197	0.38227	0.39134

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=Fe2O3 (wt%), Prep Method=PF, Targeted=12.839



Oneway Anova
Summary of Fit

Rsquare	0.62634
Adj Rsquare	0.486217
Root Mean Square Error	0.045586
Mean of Response	12.74101
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.02786711	0.009289	4.4699	0.0401
Error	8	0.01662488	0.002078		
C. Total	11	0.04449198			

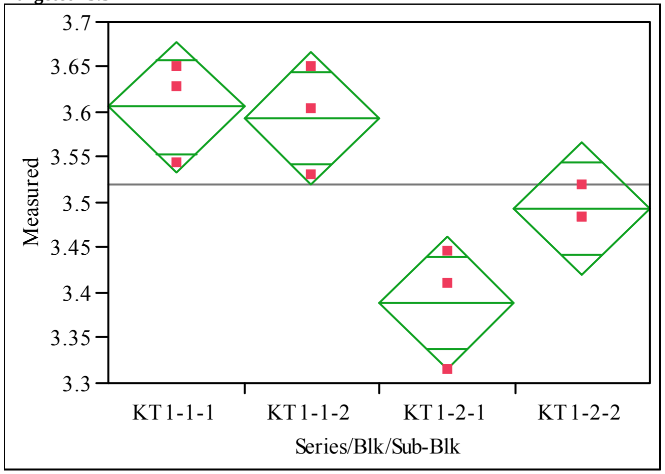
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	12.7720	0.02632	12.711	12.833
KT1-1-2	3	12.7672	0.02632	12.707	12.828
KT1-2-1	3	12.6576	0.02632	12.597	12.718
KT1-2-2	3	12.7672	0.02632	12.707	12.828

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=K2O (wt%), Prep Method=LM, Targeted=3.327



Oneway Anova
Summary of Fit

Rsquare	0.792565
Adj Rsquare	0.714777
Root Mean Square Error	0.054872
Mean of Response	3.520444
Observations (or Sum Wgts)	12

Analysis of Variance

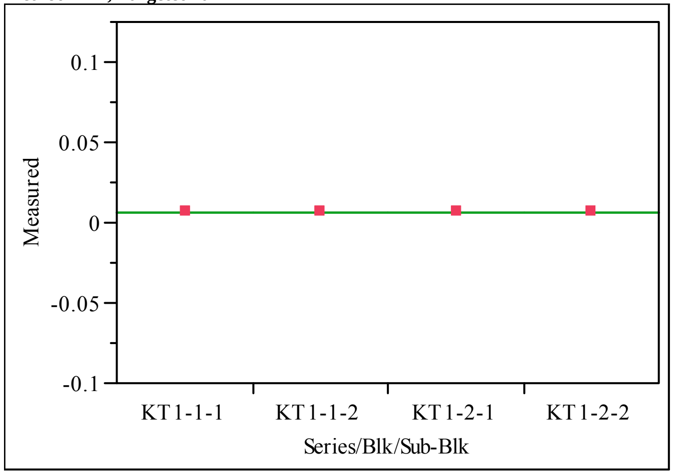
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.09203355	0.030678	10.1888	0.0042
Error	8	0.02408762	0.003011		
C. Total	11	0.11612117			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	3.60577	0.03168	3.5327	3.6788
KT1-1-2	3	3.59372	0.03168	3.5207	3.6668
KT1-2-1	3	3.38894	0.03168	3.3159	3.4620
KT1-2-2	3	3.49334	0.03168	3.4203	3.5664

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=La2O3 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005864
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

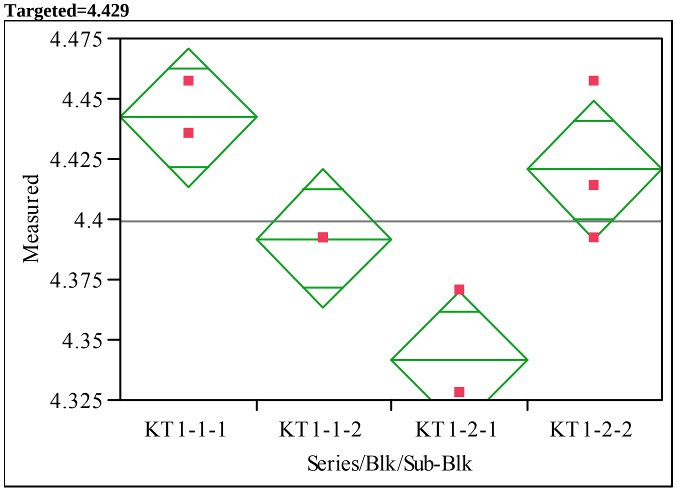
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.005864	0	0.00586	0.00586
KT1-1-2	3	0.005864	0	0.00586	0.00586
KT1-2-1	3	0.005864	0	0.00586	0.00586
KT1-2-2	3	0.005864	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=Li2O (wt%), Prep Method=PF, Targeted=4.429



Oneway Anova
Summary of Fit

Rsquare	0.820896
Adj Rsquare	0.753731
Root Mean Square Error	0.021529
Mean of Response	4.399092
Observations (or Sum Wgts)	12

Analysis of Variance

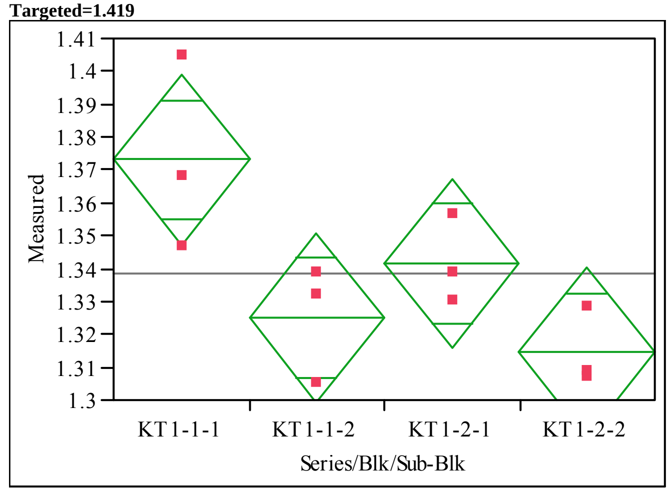
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01699492	0.005665	12.2222	0.0023
Error	8	0.00370798	0.000463		
C. Total	11	0.02070290			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	4.44215	0.01243	4.4135	4.4708
KT1-1-2	3	4.39192	0.01243	4.3633	4.4206
KT1-2-1	3	4.34168	0.01243	4.3130	4.3703
KT1-2-2	3	4.42062	0.01243	4.3920	4.4493

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=MgO (wt%), Prep Method=LM, Targeted=1.419



Oneway Anova
Summary of Fit

Rsquare	0.663125
Adj Rsquare	0.536797
Root Mean Square Error	0.019345
Mean of Response	1.338524
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00589316	0.001964	5.2492	0.0271
Error	8	0.00299379	0.000374		
C. Total	11	0.00888695			

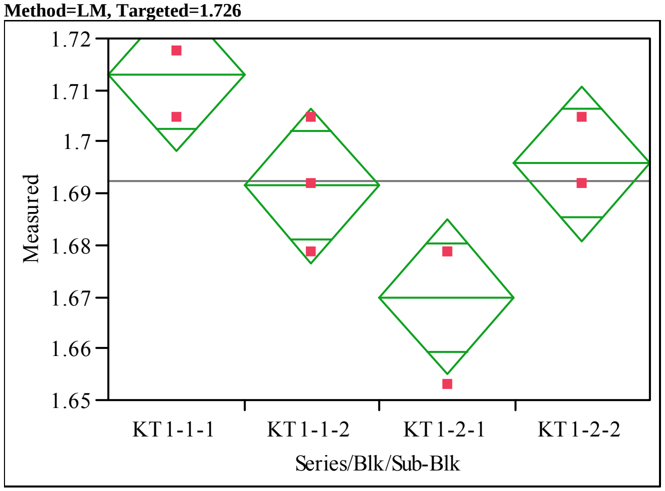
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	1.37307	0.01117	1.3473	1.3988
KT1-1-2	3	1.32498	0.01117	1.2992	1.3507
KT1-2-1	3	1.34156	0.01117	1.3158	1.3673
KT1-2-2	3	1.31448	0.01117	1.2887	1.3402

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=MnO (wt%), Prep Method=LM, Targeted=1.726



Oneway Anova
Summary of Fit

Rsquare	0.738182
Adj Rsquare	0.64
Root Mean Square Error	0.011182
Mean of Response	1.692548
Observations (or Sum Wgts)	12

Analysis of Variance

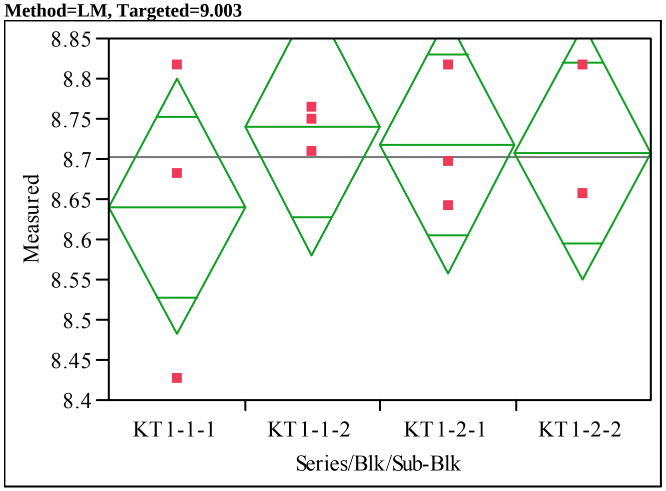
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00282034	0.000940	7.5185	0.0103
Error	8	0.00100032	0.000125		
C. Total	11	0.00382066			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	1.71299	0.00646	1.6981	1.7279
KT1-1-2	3	1.69147	0.00646	1.6766	1.7064
KT1-2-1	3	1.66995	0.00646	1.6551	1.6848
KT1-2-2	3	1.69578	0.00646	1.6809	1.7107

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=Na2O (wt%), Prep Method=LM, Targeted=9.003



Oneway Anova
Summary of Fit

Rsquare	0.125058
Adj Rsquare	-0.20305
Root Mean Square Error	0.11937
Mean of Response	8.70134
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01629337	0.005431	0.3812	0.7695
Error	8	0.11399299	0.014249		
C. Total	11	0.13028636			

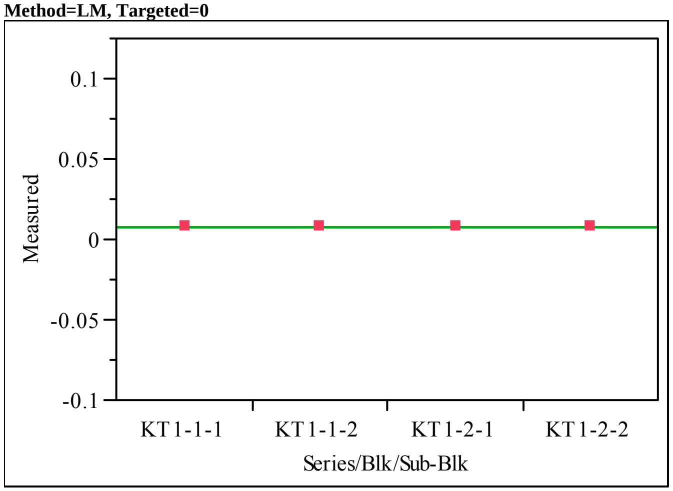
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	8.64068	0.06892	8.4818	8.7996
KT1-1-2	3	8.73953	0.06892	8.5806	8.8985
KT1-2-1	3	8.71707	0.06892	8.5581	8.8760
KT1-2-2	3	8.70808	0.06892	8.5492	8.8670

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=Nb2O5 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.375
Root Mean Square Error	1.06e-18
Mean of Response	0.007153
Observations (or Sum Wgts)	12

Analysis of Variance

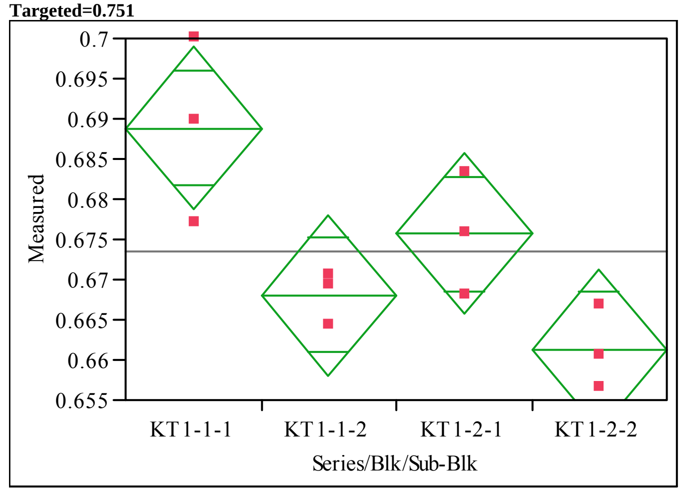
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	9.0278e-36	1.128e-36		
C. Total	11	9.0278e-36			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.007153	6.133e-19	0.00715	0.00715
KT1-1-2	3	0.007153	6.133e-19	0.00715	0.00715
KT1-2-1	3	0.007153	6.133e-19	0.00715	0.00715
KT1-2-2	3	0.007153	6.133e-19	0.00715	0.00715

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=NiO (wt%), Prep Method=LM, Targeted=0.751



Oneway Anova
Summary of Fit

Rsquare	0.734152
Adj Rsquare	0.634459
Root Mean Square Error	0.007546
Mean of Response	0.673471
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00125803	0.000419	7.3641	0.0109
Error	8	0.00045555	0.000057		
C. Total	11	0.00171358			

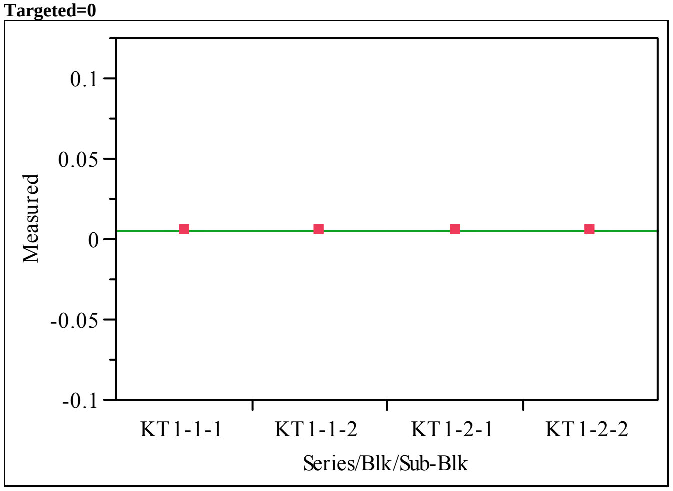
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.688847	0.00436	0.67880	0.69889
KT1-1-2	3	0.668063	0.00436	0.65802	0.67811
KT1-2-1	3	0.675698	0.00436	0.66565	0.68574
KT1-2-2	3	0.661276	0.00436	0.65123	0.67132

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=PbO (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.375
Root Mean Square Error	1.06e-18
Mean of Response	0.005386
Observations (or Sum Wgts)	12

Analysis of Variance

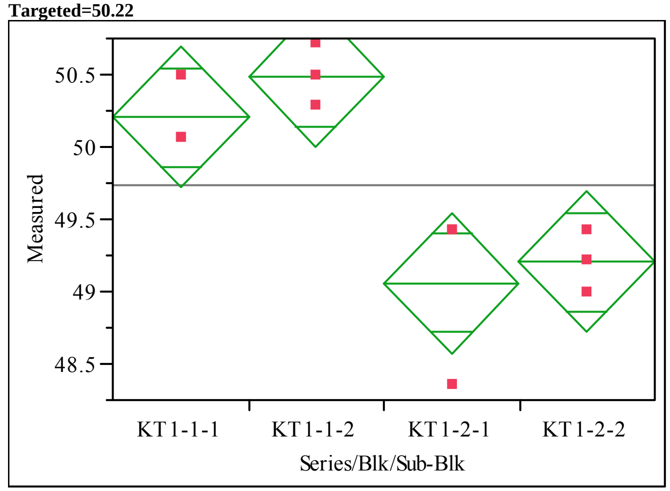
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	9.0278e-36	1.128e-36		
C. Total	11	9.0278e-36			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.005386	6.133e-19	0.00539	0.00539
KT1-1-2	3	0.005386	6.133e-19	0.00539	0.00539
KT1-2-1	3	0.005386	6.133e-19	0.00539	0.00539
KT1-2-2	3	0.005386	6.133e-19	0.00539	0.00539

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=SiO2 (wt%), Prep Method=LM, Targeted=50.22



Oneway Anova
Summary of Fit

Rsquare	0.810298
Adj Rsquare	0.73916
Root Mean Square Error	0.365355
Mean of Response	49.73873
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	4.5613491	1.52045	11.3905	0.0029
Error	8	1.0678744	0.13348		
C. Total	11	5.6292235			

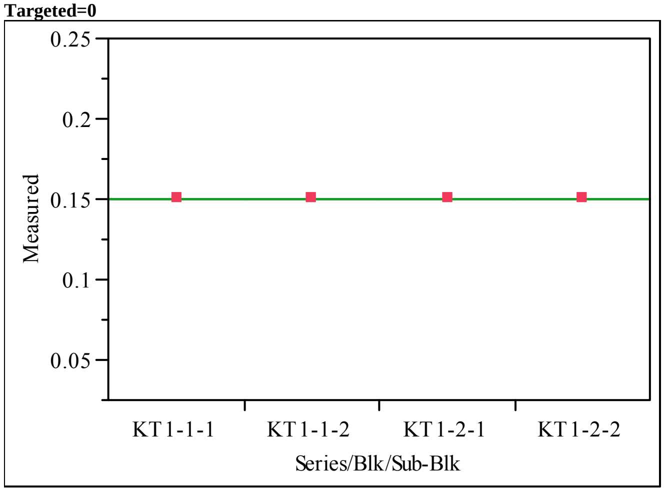
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	50.2022	0.21094	49.716	50.689
KT1-1-2	3	50.4875	0.21094	50.001	50.974
KT1-2-1	3	49.0613	0.21094	48.575	49.548
KT1-2-2	3	49.2039	0.21094	48.717	49.690

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=SO4 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.149795
Observations (or Sum Wgts)	12

Analysis of Variance

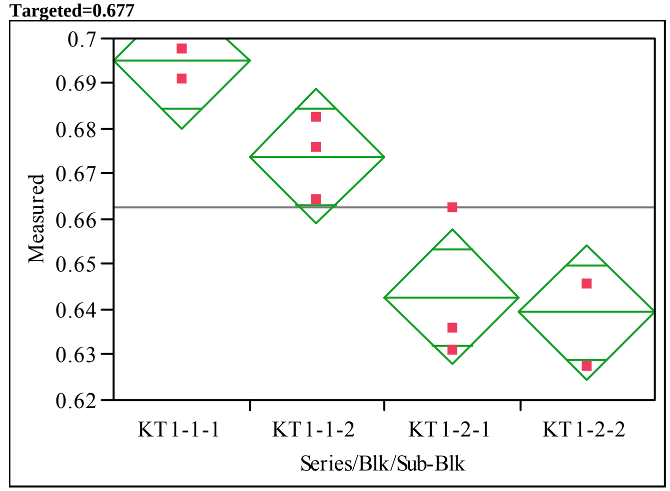
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.149795	0	0.14980	0.14980
KT1-1-2	3	0.149795	0	0.14980	0.14980
KT1-2-1	3	0.149795	0	0.14980	0.14980
KT1-2-2	3	0.149795	0	0.14980	0.14980

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=TiO2 (wt%), Prep Method=LM, Targeted=0.677



Oneway Anova
Summary of Fit

Rsquare	0.862705
Adj Rsquare	0.81122
Root Mean Square Error	0.01122
Mean of Response	0.662752
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00632863	0.002110	16.7563	0.0008
Error	8	0.00100717	0.000126		
C. Total	11	0.00733580			

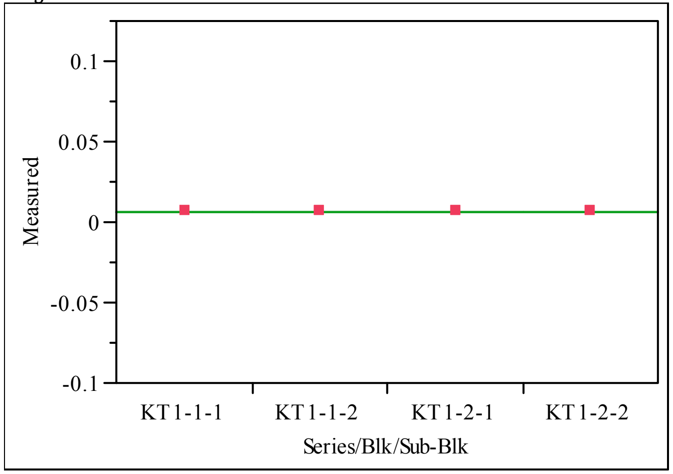
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.695000	0.00648	0.68006	0.70994
KT1-1-2	3	0.673872	0.00648	0.65893	0.68881
KT1-2-1	3	0.642736	0.00648	0.62780	0.65767
KT1-2-2	3	0.639400	0.00648	0.62446	0.65434

Std Error uses a pooled estimate of error variance

Exhibit A-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=ZnO (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006224
Observations (or Sum Wgts)	12

Analysis of Variance

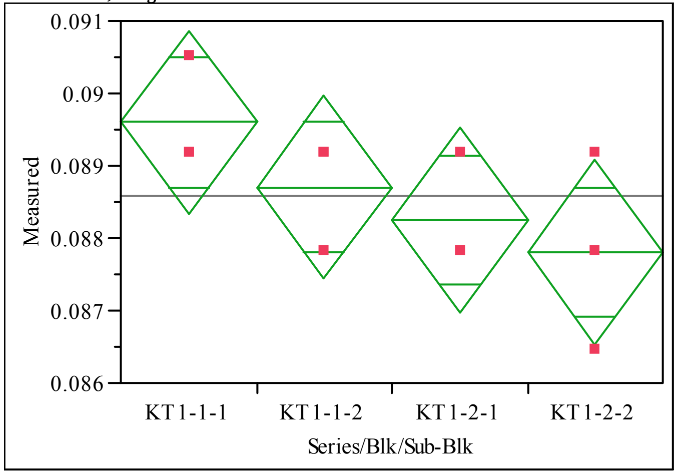
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.006224	0	0.00622	0.00622
KT1-1-2	3	0.006224	0	0.00622	0.00622
KT1-2-1	3	0.006224	0	0.00622	0.00622
KT1-2-2	3	0.006224	0	0.00622	0.00622

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT1, Oxide=ZrO2 (wt%), Prep Method=LM, Targeted=0.098



Oneway Anova
Summary of Fit

Rsquare	0.421687
Adj Rsquare	0.204819
Root Mean Square Error	0.000955
Mean of Response	0.08859
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000532	1.774e-6	1.9444	0.2011
Error	8	0.00000730	9.1233e-7		
C. Total	11	0.00001262			

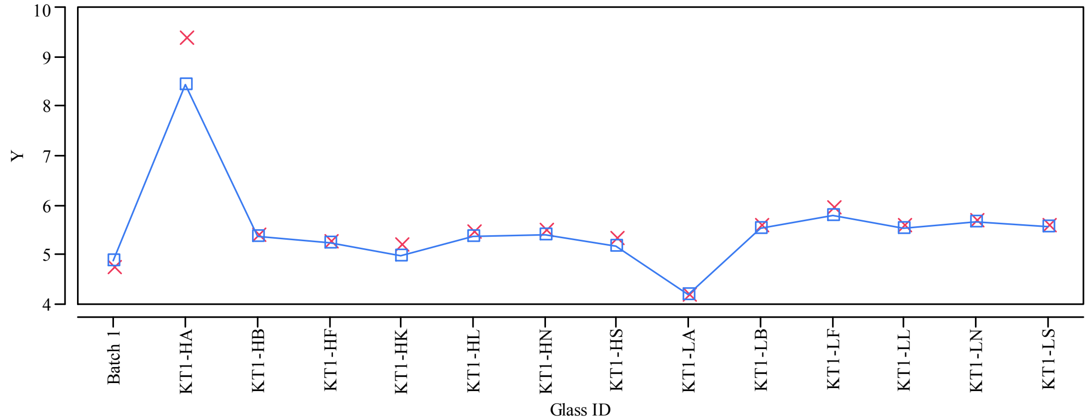
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT1-1-1	3	0.089603	0.00055	0.08833	0.09087
KT1-1-2	3	0.088703	0.00055	0.08743	0.08997
KT1-2-1	3	0.088252	0.00055	0.08698	0.08952
KT1-2-2	3	0.087802	0.00055	0.08653	0.08907

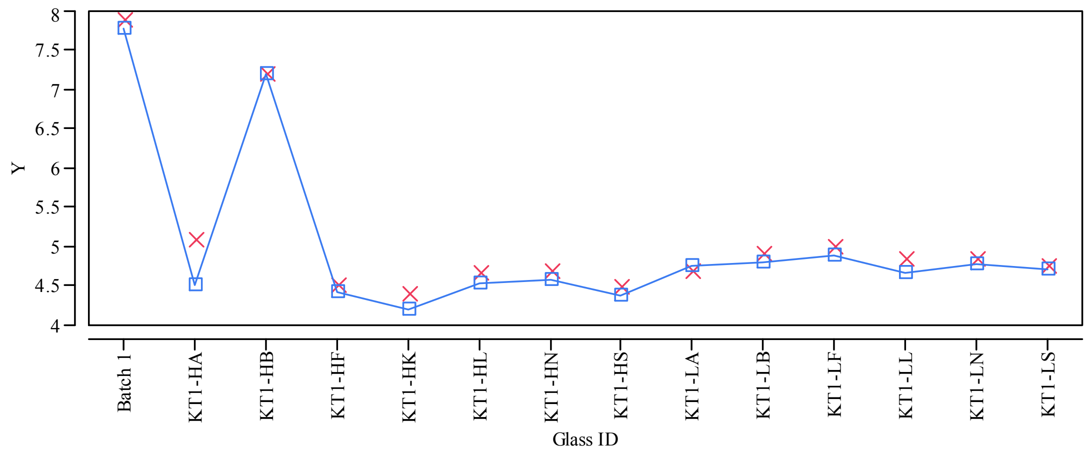
Std Error uses a pooled estimate of error variance

Exhibit A-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide.

Overlay Plot Series=KT1, Oxide=Al2O3 (wt%)



Overlay Plot Series=KT1, Oxide=B2O3 (wt%)



Overlay Plot Series=KT1, Oxide=BaO (wt%)

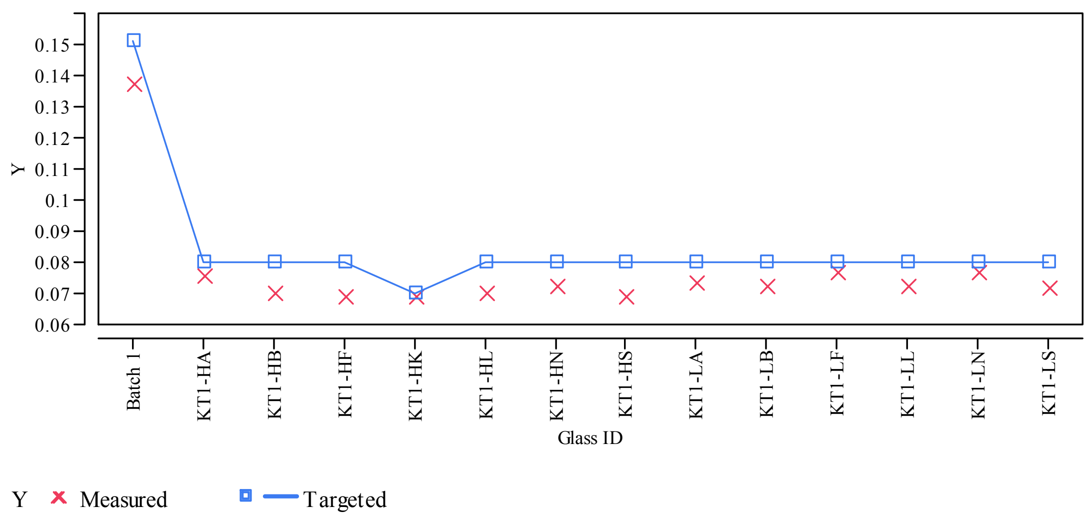
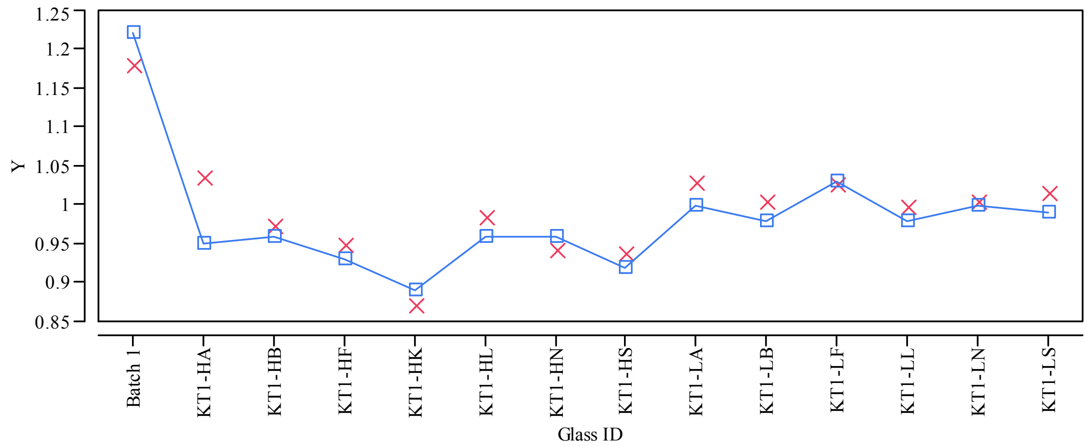
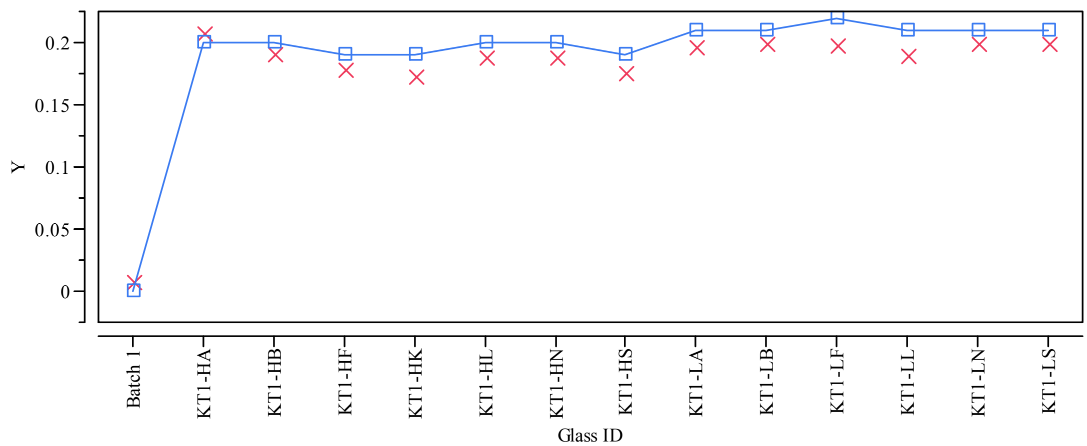


Exhibit A-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

Overlay Plot Series=KT1, Oxide=CaO (wt%)



Overlay Plot Series=KT1, Oxide=Ce2O3 (wt%)



Overlay Plot Series=KT1, Oxide=Cr2O3 (wt%)

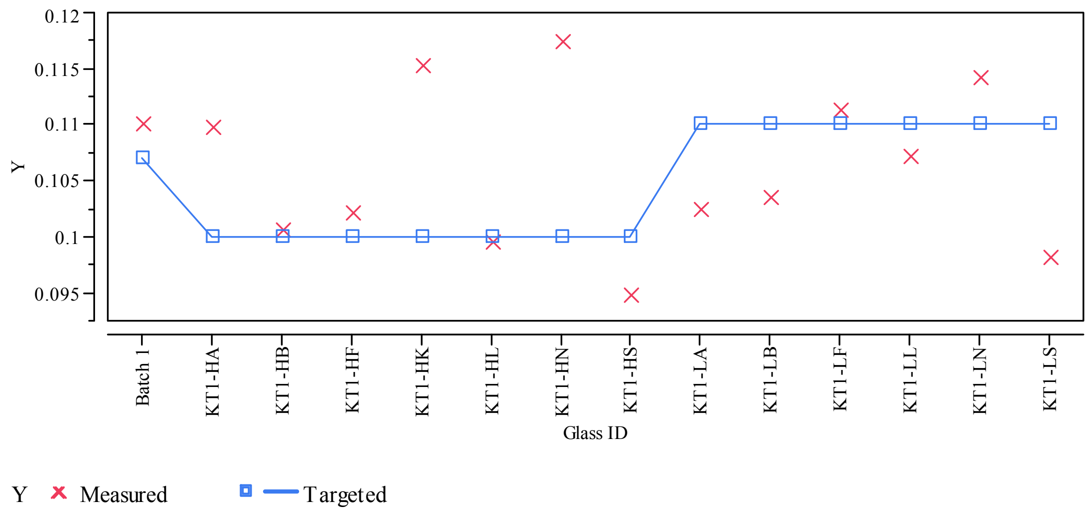
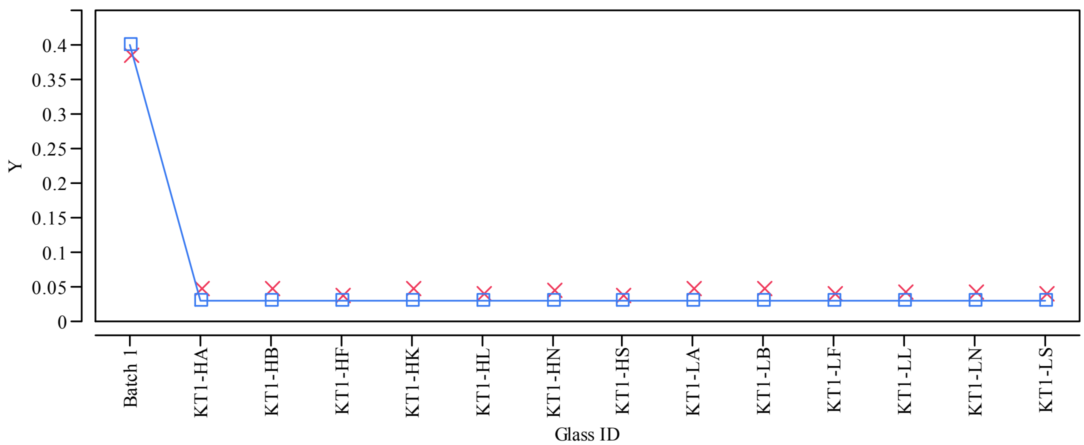
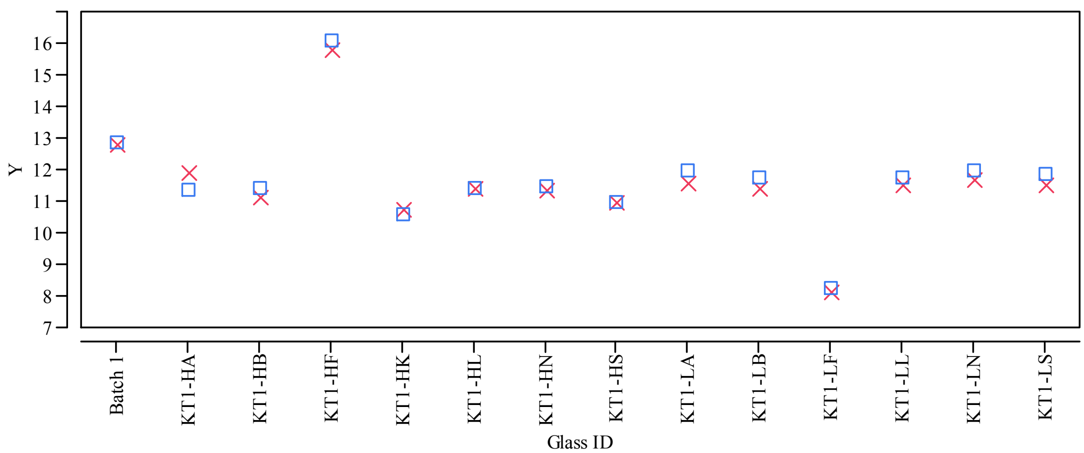


Exhibit A-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

Overlay Plot Series=KT1, Oxide=CuO (wt%)



Overlay Plot Series=KT1, Oxide=Fe2O3 (wt%)



Overlay Plot Series=KT1, Oxide=K2O (wt%)

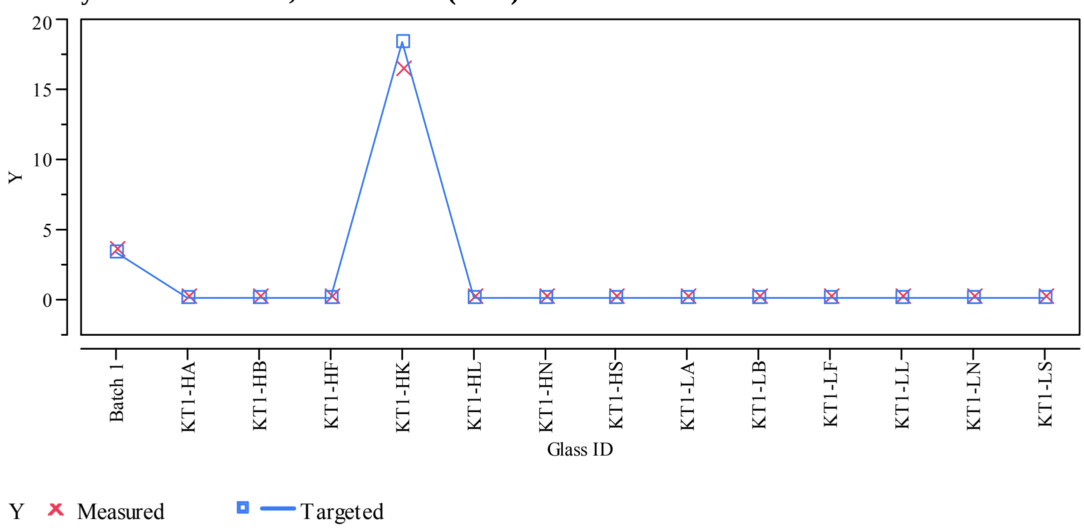
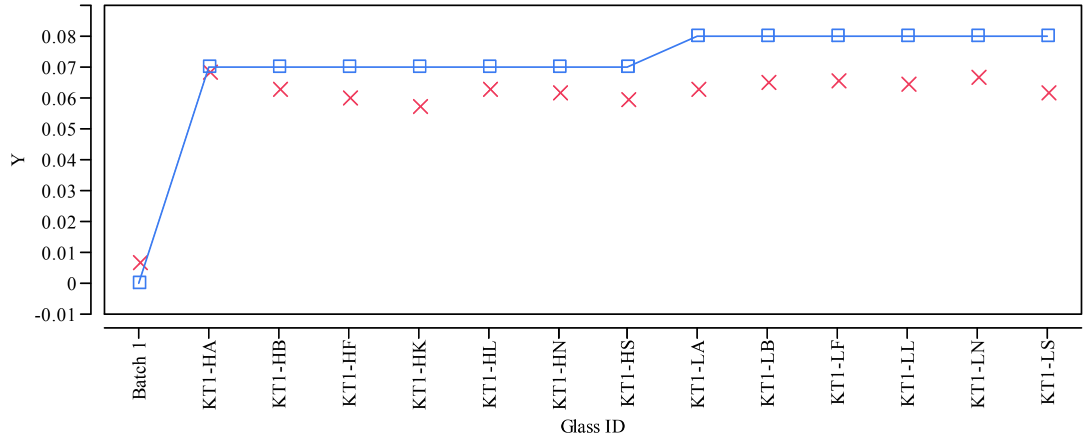
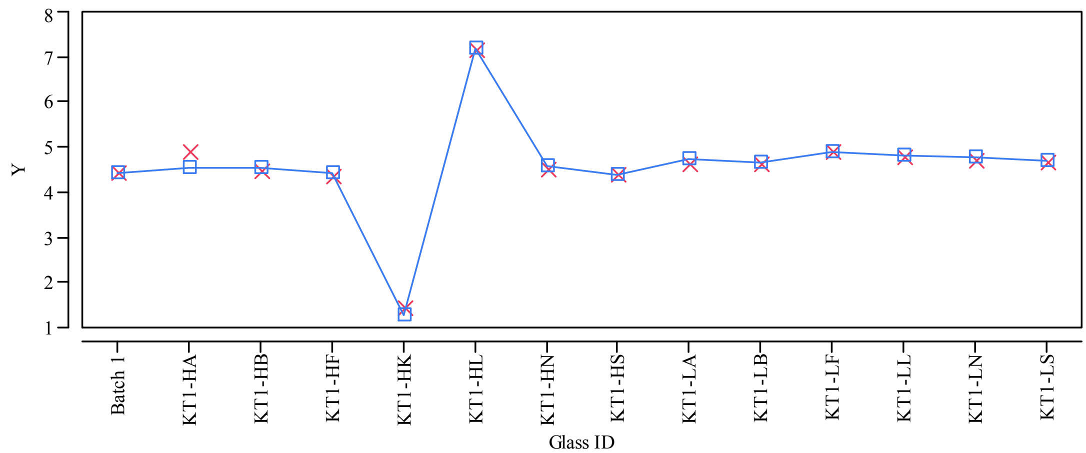


Exhibit A-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

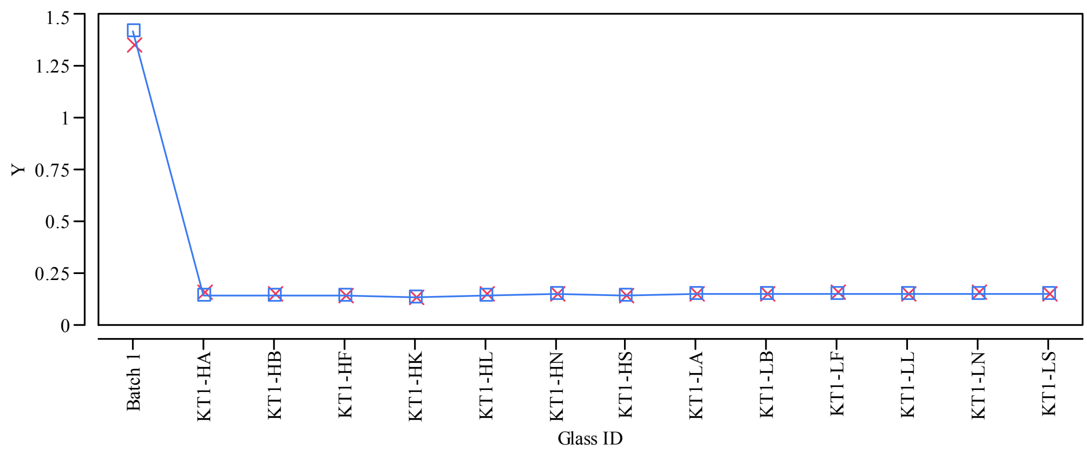
Overlay Plot Series=KT1, Oxide=La2O3 (wt%)



Overlay Plot Series=KT1, Oxide=Li2O (wt%)



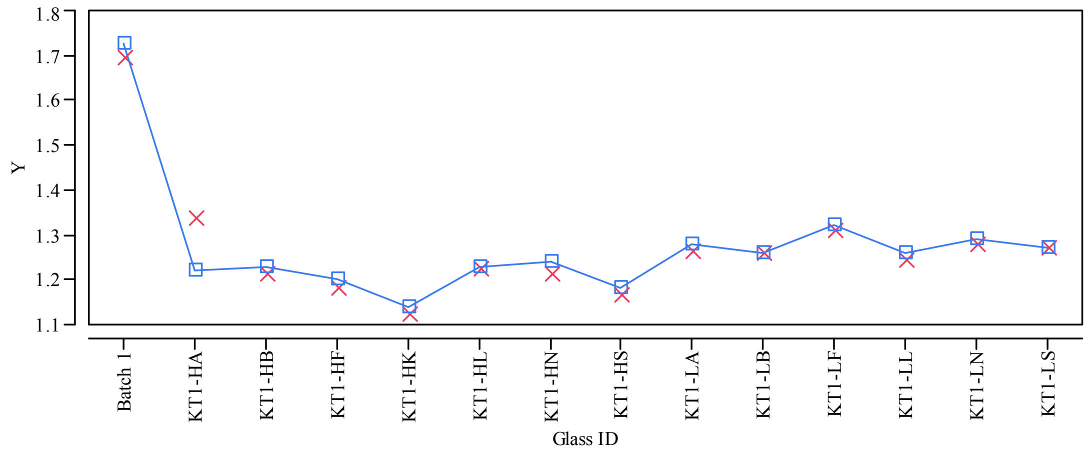
Overlay Plot Series=KT1, Oxide=MgO (wt%)



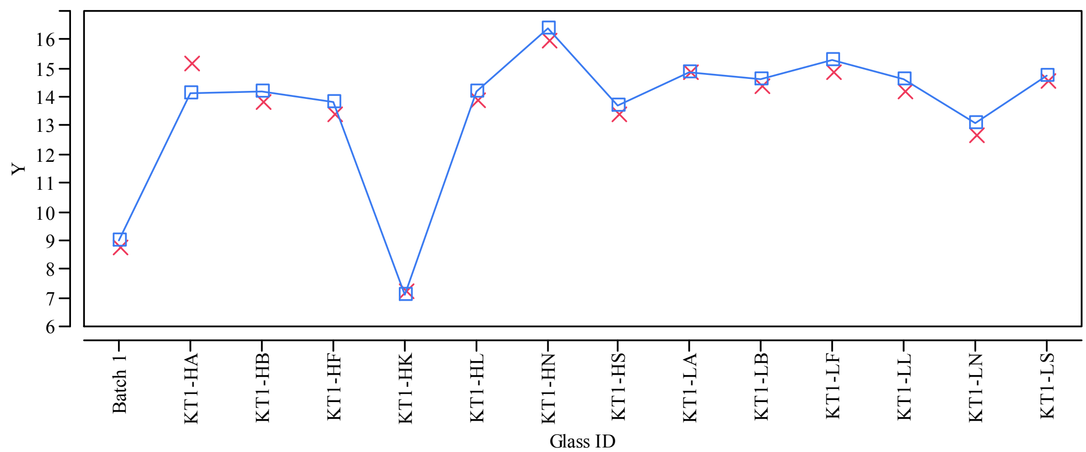
Y × Measured ▫ — Targeted

Exhibit A-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

Overlay Plot Series=KT1, Oxide=MnO (wt%)



Overlay Plot Series=KT1, Oxide=Na2O (wt%)



Overlay Plot Series=KT1, Oxide=Nb2O5 (wt%)

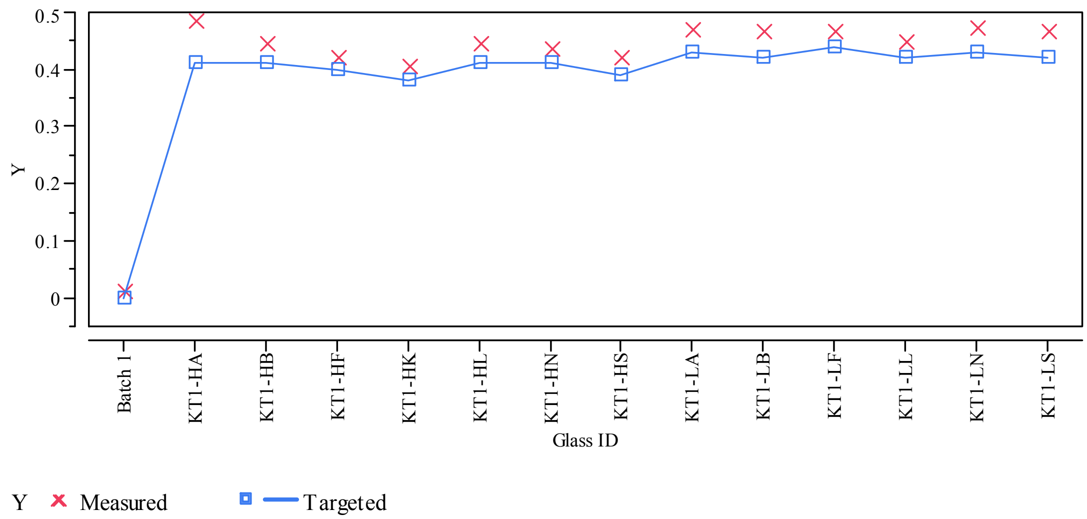


Exhibit A-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

Overlay Plot Series=KT1, Oxide=NiO (wt%)

Overlay Plot Series=KT1, Oxide=PbO (wt%)

Overlay Plot Series=KT1, Oxide=SiO2 (wt%)

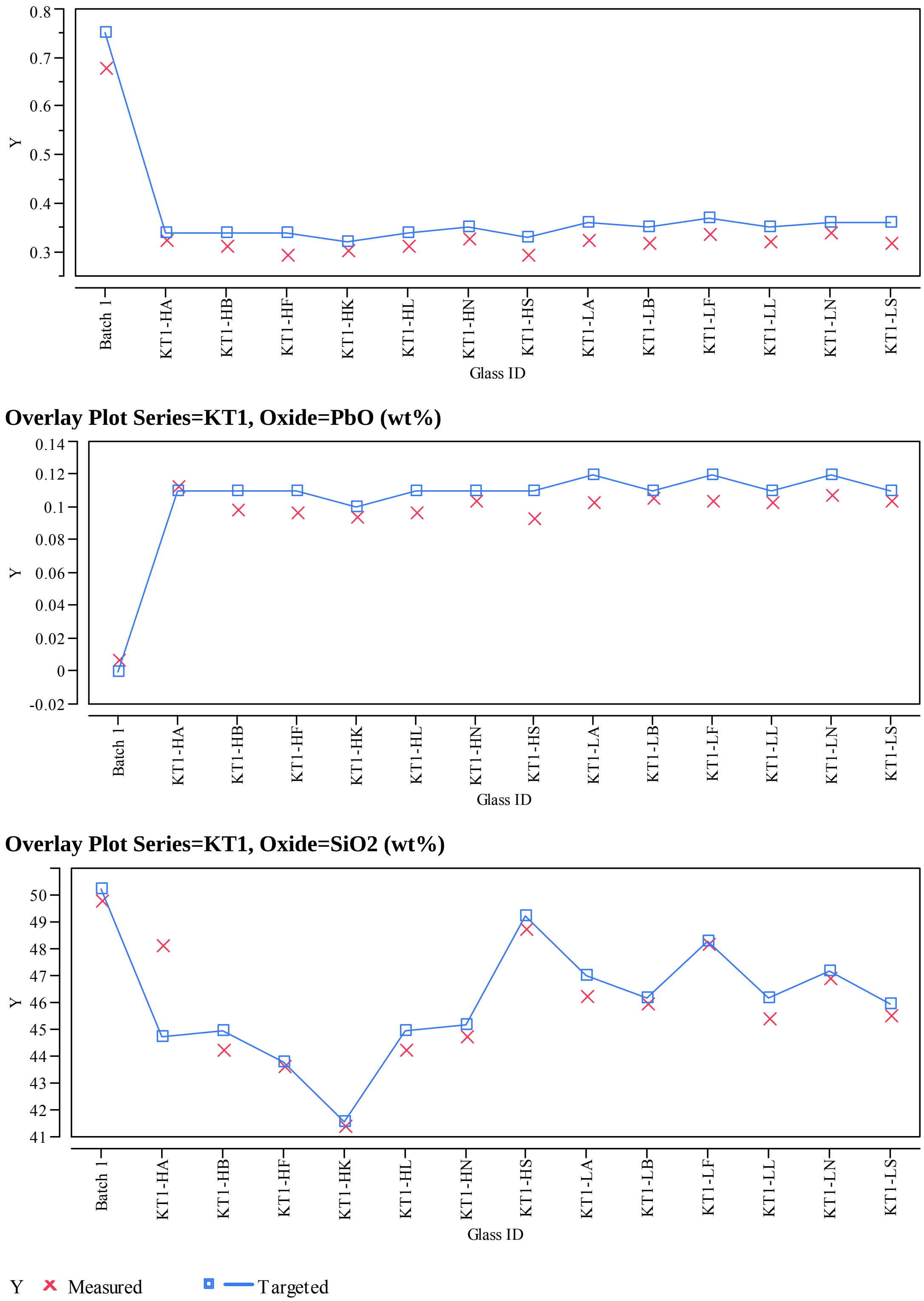
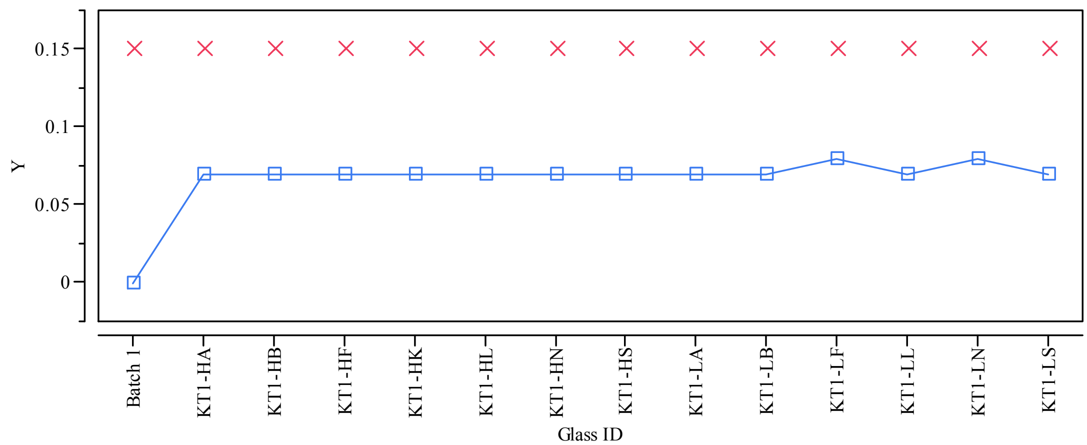
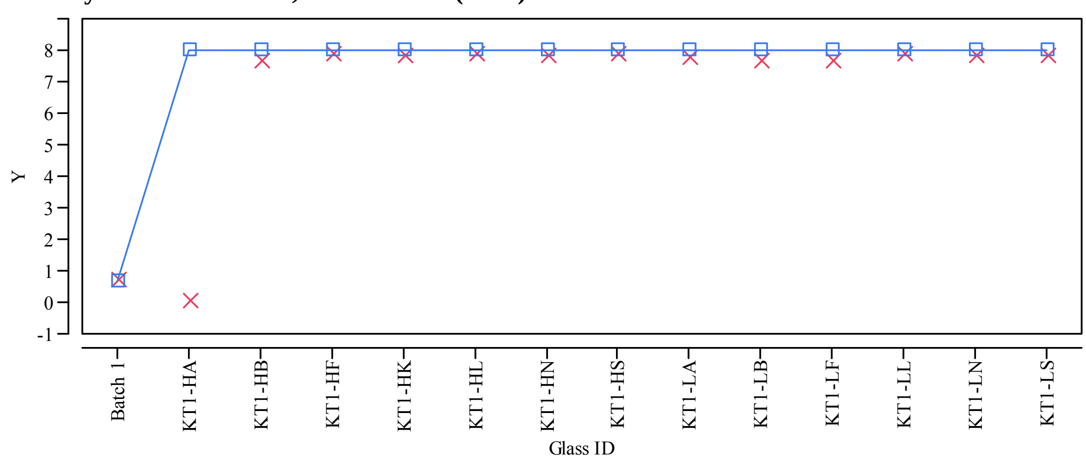


Exhibit A-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

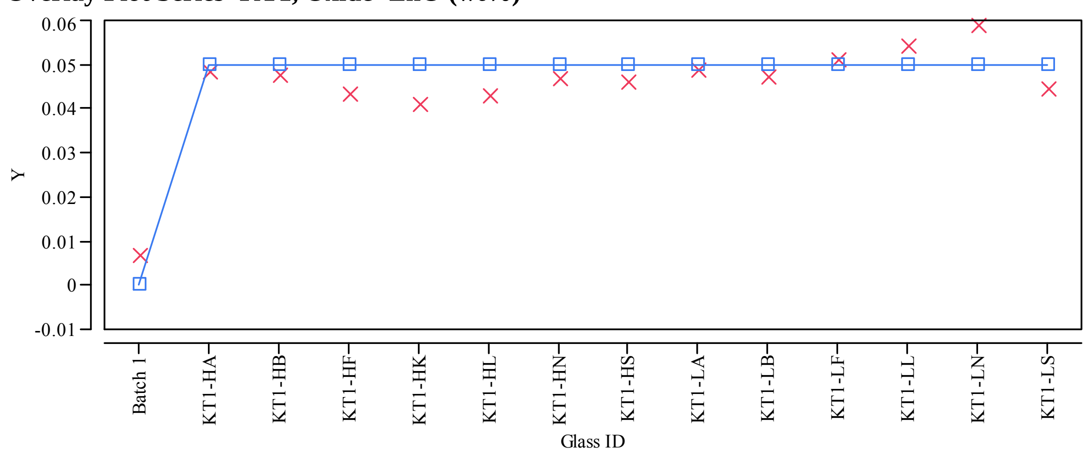
Overlay Plot Series=KT1, Oxide=SO4 (wt%)



Overlay Plot Series=KT1, Oxide=TiO2 (wt%)



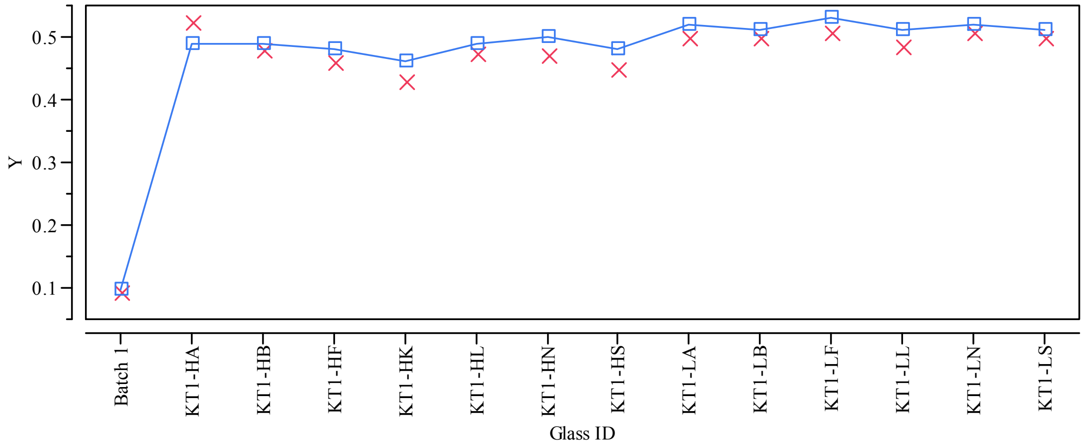
Overlay Plot Series=KT1, Oxide=ZnO (wt%)



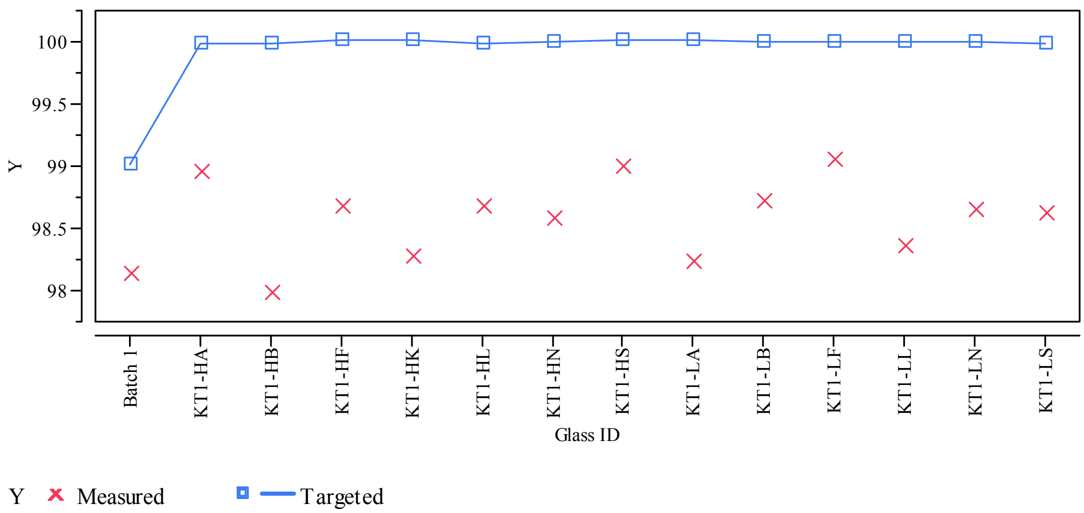
Y × Measured ▫— Targeted

Exhibit A-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide. (continued)

Overlay Plot Series=KT1, Oxide=ZrO2 (wt%)



Overlay Plot Series=KT1, Oxide=Sum of Oxides



Appendix B. Data Supporting the Chemical Composition Measurements of the KT03-Series Glasses

Table B-1. PSAL Chemical Composition Measurements of the KT03-Series of Glasses Using LM Preparation Method (Part 1).

Glass ID	Block	Sub-Blk	Seq	Lab ID	Ba (wt%)	Ca (wt%)	Ce (wt%)	Cr (wt%)	Cu (wt%)	K (wt%)	La (wt%)	Mg (wt%)	Mn (wt%)
Batch 1	1	1	1	BCHLM111	0.124	0.863	0.004	0.073	0.317	3.00	<0.010	0.807	1.34
KT03-HS	1	1	2	U05LM21	0.060	0.585	0.154	0.051	0.041	0.051	0.043	0.078	0.801
KT03-LB	1	1	3	U10LM21	0.062	0.678	0.164	0.080	0.046	0.075	0.050	0.085	0.868
KT03-HN	1	1	4	U04LM21	0.060	0.653	0.160	0.068	0.034	0.061	0.048	0.083	0.841
KT03-LB	1	1	5	U10LM11	0.062	0.688	0.165	0.065	0.044	0.078	0.049	0.085	0.844
KT03-HS	1	1	6	U05LM11	0.060	0.587	0.151	0.056	0.038	0.052	0.043	0.079	0.799
KT03-MK	1	1	7	U02LM21	0.059	0.642	0.162	0.065	0.038	8.12	0.047	0.041	0.827
KT03-LA	1	1	8	U09LM11	0.647	0.706	0.165	0.070	0.041	0.069	0.050	0.086	0.854
KT03-LL	1	1	9	U15LM21	0.058	0.680	0.164	0.064	0.039	0.064	0.050	0.085	0.853
Batch 1	1	1	10	BCHLM112	0.122	0.853	0.004	0.070	0.314	2.99	<0.010	0.787	1.30
KT03-HN	1	1	11	U04LM11	0.059	0.655	0.159	0.076	0.059	0.059	0.048	0.082	0.837
KT03-LS	1	1	12	U06LM11	0.058	0.644	0.160	0.068	0.040	0.088	0.046	0.078	0.824
KT03-MK	1	1	13	U02LM11	0.058	0.656	0.158	0.065	0.034	8.12	0.046	0.040	0.812
KT03-LA	1	1	14	U09LM21	0.615	0.715	0.163	0.061	0.046	0.070	0.049	0.082	0.828
KT03-LS	1	1	15	U06LM21	0.056	0.658	0.157	0.081	0.038	0.098	0.045	0.075	0.801
KT03-LL	1	1	16	U15LM11	0.057	0.687	0.162	0.058	0.040	0.062	0.049	0.083	0.844
KT1-HA2	1	1	17	U01LM11	0.070	0.667	0.167	0.057	0.034	0.053	0.052	0.087	0.905
KT1-HA2	1	1	18	U01LM21	0.069	0.698	0.163	0.061	0.030	0.060	0.052	0.086	0.885
Batch 1	1	1	19	BCHLM113	0.119	0.854	0.004	0.070	0.315	3.05	<0.010	0.779	1.28
Batch 1	1	2	1	BCHLM111	0.126	0.852	0.005	0.072	0.314	3.06	<0.010	0.809	1.37
KT03-HN	1	2	2	U04LM12	0.062	0.650	0.163	0.078	0.057	0.058	0.051	0.085	0.857
KT03-MK	1	2	3	U02LM12	0.061	0.651	0.159	0.067	0.033	8.34	0.048	0.042	0.832
KT03-LA	1	2	4	U09LM22	0.637	0.709	0.166	0.062	0.045	0.069	0.052	0.085	0.849
KT03-LL	1	2	5	U15LM12	0.060	0.684	0.165	0.060	0.039	0.061	0.052	0.087	0.866
KT03-MK	1	2	6	U02LM22	0.061	0.638	0.160	0.065	0.037	8.24	0.048	0.042	0.829
KT03-LS	1	2	7	U06LM12	0.060	0.642	0.162	0.069	0.039	0.088	0.048	0.080	0.828
KT03-LB	1	2	8	U10LM12	0.063	0.687	0.165	0.064	0.043	0.077	0.051	0.085	0.847
KT03-HS	1	2	9	U05LM12	0.060	0.589	0.152	0.056	0.037	0.051	0.044	0.079	0.792
Batch 1	1	2	10	BCHLM122	0.124	0.856	0.005	0.072	0.315	3.08	<0.010	0.805	1.32
KT03-LB	1	2	11	U10LM22	0.063	0.679	0.165	0.081	0.045	0.074	0.052	0.085	0.862
KT1-HA2	1	2	12	U01LM12	0.073	0.673	0.170	0.058	0.033	0.052	0.055	0.090	0.927
KT03-HN	1	2	13	U04LM22	0.059	0.657	0.159	0.068	0.033	0.060	0.049	0.081	0.831
KT03-LA	1	2	14	U09LM12	0.631	0.706	0.165	0.069	0.040	0.068	0.051	0.084	0.834
KT03-LL	1	2	15	U15LM22	0.059	0.676	0.164	0.063	0.038	0.063	0.051	0.085	0.838
KT03-HS	1	2	16	U05LM22	0.061	0.584	0.154	0.050	0.040	0.050	0.045	0.078	0.791
KT03-LS	1	2	17	U06LM22	0.058	0.654	0.158	0.082	0.037	0.095	0.047	0.077	0.807
KT1-HA2	1	2	18	U01LM22	0.071	0.699	0.165	0.061	0.029	0.060	0.054	0.086	0.895
Batch 1	1	2	19	BCHLM123	0.122	0.853	0.005	0.071	0.313	3.06	<0.010	0.785	1.32
Batch 1	2	1	1	BCHLM211	0.130	0.840	0.007	0.075	0.310	3.18	<0.010	0.823	1.31
KT03-LF	2	1	2	U12LM11	0.072	0.725	0.172	0.071	0.050	0.076	0.056	0.093	0.915
KT03-HL	2	1	3	U13LM11	0.063	0.684	0.159	0.086	0.036	0.068	0.050	0.085	0.823
KT03-LN	2	1	4	U07LM21	0.066	0.713	0.166	0.069	0.039	0.070	0.053	0.086	0.866
KT03-LF	2	1	5	U12LM21	0.071	0.686	0.181	0.067	0.042	0.069	0.057	0.097	0.966
KT03-HK	2	1	6	U11LM21	0.060	0.615	0.155	0.063	0.044	13.72	0.049	0.079	0.807
KT03-LN	2	1	7	U07LM11	0.064	0.711	0.165	0.064	0.041	0.076	0.052	0.084	0.852
KT03-HB	2	1	8	U08LM21	0.063	0.657	0.165	0.064	0.045	0.057	0.052	0.085	0.845
KT03-HL	2	1	9	U13LM21	0.063	0.659	0.162	0.069	0.040	0.058	0.051	0.086	0.837
Batch 1	2	1	10	BCHLM212	0.126	0.850	0.007	0.074	0.315	2.87	<0.010	0.804	1.36
KT03-HA	2	1	11	U14LM11	0.062	0.660	0.161	0.070	0.033	0.059	0.051	0.083	0.813
KT03-HB	2	1	12	U08LM11	0.062	0.647	0.161	0.065	0.047	0.056	0.051	0.082	0.832
KT03-HF	2	1	13	U03LM11	0.062	0.630	0.160	0.062	0.054	0.058	0.051	0.086	0.816
KT03-HK	2	1	14	U11LM11	0.056	0.623	0.147	0.117	0.041	14.35	0.045	0.073	0.759
KT03-HF	2	1	15	U03LM21	0.061	0.631	0.159	0.062	0.045	0.060	0.051	0.082	0.807
KT03-HA	2	1	16	U14LM21	0.061	0.662	0.158	0.059	0.047	0.074	0.050	0.081	0.812
Batch 1	2	1	17	BCHLM213	0.126	0.848	0.007	0.073	0.311	3.14	<0.010	0.799	1.31
Batch 1	2	2	1	BCHLM221	0.121	0.854	0.005	0.070	0.312	2.95	<0.010	0.774	1.35
KT03-HB	2	2	2	U08LM22	0.061	0.651	0.162	0.062	0.043	0.058	0.049	0.084	0.831
KT03-LN	2	2	3	U07LM12	0.062	0.710	0.161	0.061	0.039	0.077	0.050	0.082	0.833
KT03-HF	2	2	4	U03LM22	0.061	0.633	0.160	0.062	0.043	0.061	0.051	0.084	0.832
KT03-HK	2	2	5	U11LM22	0.056	0.622	0.152	0.058	0.042	15.02	0.046	0.075	0.781
KT03-HF	2	2	6	U03LM12	0.059	0.634	0.158	0.060	0.053	0.060	0.049	0.084	0.804
KT03-HL	2	2	7	U13LM12	0.058	0.690	0.153	0.080	0.034	0.071	0.047	0.079	0.798
KT03-HB	2	2	8	U08LM12	0.062	0.645	0.163	0.064	0.045	0.056	0.050	0.085	0.840
KT03-HA	2	2	9	U14LM22	0.060	0.665	0.158	0.057	0.045	0.075	0.049	0.082	0.825
Batch 1	2	2	10	BCHLM222	0.122	0.861	0.005	0.069	0.314	3.08	<0.010	0.776	1.39
KT03-LF	2	2	11	U12LM22	0.064	0.696	0.175	0.060	0.040	0.073	0.053	0.088	0.904

Table B-1. PSAL Chemical Composition Measurements of the KT03-Series of Glasses Using LM Preparation Method (Part 1). (continued)

Glass ID	Block	Sub-Blk	Seq	Lab ID	Ba (wt%)	Ca (wt%)	Ce (wt%)	Cr (wt%)	Cu (wt%)	K (wt%)	La (wt%)	Mg (wt%)	Mn (wt%)
KT03-LN	2	2	12	U07LM22	0.059	0.717	0.159	0.061	0.037	0.073	0.049	0.078	0.797
KT03-LF	2	2	13	U12LM12	0.063	0.737	0.165	0.062	0.048	0.081	0.052	0.082	0.829
KT03-HA	2	2	14	U14LM12	0.059	0.672	0.158	0.066	0.031	0.061	0.049	0.079	0.802
KT03-HL	2	2	15	U13LM22	0.057	0.671	0.156	0.062	0.038	0.062	0.047	0.078	0.798
KT03-HK	2	2	16	U11LM12	0.052	0.629	0.144	0.113	0.039	15.29	0.043	0.068	0.738
Batch 1	2	2	17	BCHLM223	0.119	0.861	0.005	0.068	0.310	3.18	<0.010	0.754	1.35

Table B-2. PSAL Chemical Composition Measurements of the KT03-Series of Glasses Using LM Preparation Method (Part 2).

Glass ID	Block	Sub-Blk	Seq	Lab ID	Mn (wt%)	Na (wt%)	Nb (wt%)	Ni (wt%)	Pb (wt%)	S (wt%)	Ti (wt%)	Zn (wt%)	Zr (wt%)
Batch 1	1	1	1	BCHLM111	1.34	6.71	<0.100	0.520	<0.010	<0.100	0.391	<0.010	0.071
KT03-HS	1	1	2	U05LM21	0.801	9.06	1.96	0.219	0.095	<0.100	4.50	0.038	1.73
KT03-LB	1	1	3	U10LM21	0.868	9.85	1.70	0.239	0.100	<0.100	4.49	0.042	1.51
KT03-HN	1	1	4	U04LM21	0.841	12.0	1.85	0.228	0.099	<0.100	4.56	0.039	1.66
KT03-LB	1	1	5	U10LM11	0.844	9.84	1.94	0.235	0.097	<0.100	4.55	0.041	1.71
KT03-HS	1	1	6	U05LM11	0.799	9.08	1.68	0.221	0.093	<0.100	4.35	0.038	1.42
KT03-MK	1	1	7	U02LM21	0.827	7.54	1.85	0.221	0.095	<0.100	4.25	0.034	1.62
KT03-LA	1	1	8	U09LM11	0.854	10.3	1.85	0.220	0.094	<0.100	4.46	0.043	1.65
KT03-LL	1	1	9	U15LM21	0.853	10.1	1.83	0.228	0.097	<0.100	4.50	0.041	1.58
Batch 1	1	1	10	BCHLM112	1.30	6.69	<0.100	0.509	<0.010	<0.100	0.381	<0.010	0.077
KT03-HN	1	1	11	U04LM11	0.837	11.60	1.79	0.333	0.095	<0.100	4.52	0.046	1.55
KT03-LS	1	1	12	U06LM11	0.824	9.46	1.91	0.220	0.094	<0.100	4.48	0.038	1.67
KT03-MK	1	1	13	U02LM11	0.812	7.39	1.83	0.215	0.094	<0.100	4.30	0.034	1.60
KT03-LA	1	1	14	U09LM21	0.828	10.2	1.93	0.214	0.090	<0.100	4.47	0.043	1.69
KT03-LS	1	1	15	U06LM21	0.801	9.64	1.91	0.208	0.090	<0.100	4.53	0.037	1.69
KT03-LL	1	1	16	U15LM11	0.844	10.1	1.91	0.225	0.097	<0.100	4.51	0.038	1.68
KT1-HA2	1	1	17	U01LM11	0.905	10.3	0.271	0.244	0.081	<0.100	4.43	0.038	0.353
KT1-HA2	1	1	18	U01LM21	0.885	10.5	0.274	0.234	0.078	<0.100	4.45	0.039	0.352
Batch 1	1	1	19	BCHLM113	1.28	6.77	<0.100	0.502	<0.010	<0.100	0.380	<0.010	0.075
Batch 1	1	2	1	BCHLM111	1.37	6.96	<0.100	0.520	<0.010	<0.100	0.390	<0.010	0.069
KT03-HN	1	2	2	U04LM12	0.857	11.9	1.65	0.340	0.097	<0.100	4.72	0.046	1.64
KT03-MK	1	2	3	U02LM12	0.832	7.66	1.61	0.220	0.096	<0.100	4.50	0.035	1.66
KT03-LA	1	2	4	U09LM22	0.849	10.6	1.76	0.221	0.092	<0.100	4.67	0.043	1.79
KT03-LL	1	2	5	U15LM12	0.866	10.3	1.78	0.232	0.100	<0.100	4.74	0.039	1.79
KT03-MK	1	2	6	U02LM22	0.829	7.55	1.72	0.222	0.098	<0.100	4.50	0.034	1.74
KT03-LS	1	2	7	U06LM12	0.828	9.90	1.76	0.222	0.095	<0.100	4.72	0.038	1.81
KT03-LB	1	2	8	U10LM12	0.847	10.4	1.79	0.234	0.098	<0.100	4.75	0.041	1.82
KT03-HS	1	2	9	U05LM12	0.792	9.28	1.53	0.219	0.092	<0.100	4.57	0.037	1.50
Batch 1	1	2	10	BCHLM122	1.32	6.96	<0.100	0.511	<0.010	<0.100	0.387	<0.010	0.071
KT03-LB	1	2	11	U10LM22	0.862	10.6	1.56	0.237	0.099	<0.100	4.63	0.042	1.57
KT1-HA2	1	2	12	U01LM12	0.927	10.8	0.278	0.248	0.082	<0.100	4.66	0.038	0.356
KT03-HN	1	2	13	U04LM22	0.831	12.3	1.73	0.224	0.094	<0.100	4.73	0.039	1.73
KT03-LA	1	2	14	U09LM12	0.834	11.2	1.78	0.217	0.091	<0.100	4.68	0.041	1.78
KT03-LL	1	2	15	U15LM22	0.838	10.3	1.63	0.227	0.097	<0.100	4.64	0.040	1.64
KT03-HS	1	2	16	U05LM22	0.791	9.34	1.77	0.218	0.094	<0.100	4.63	0.037	1.80
KT03-LS	1	2	17	U06LM22	0.807	9.93	1.77	0.212	0.091	<0.100	4.69	0.037	1.78
KT1-HA2	1	2	18	U01LM22	0.895	10.8	0.28	0.235	0.078	<0.100	4.70	0.038	0.351
Batch 1	1	2	19	BCHLM123	1.32	6.72	<0.100	0.505	<0.010	<0.100	0.382	<0.010	0.069
Batch 1	2	1	1	BCHLM211	1.31	6.99	<0.100	0.528	<0.010	<0.100	0.393	<0.010	0.071
KT03-LF	2	1	2	U12LM11	0.915	10.4	1.46	0.281	0.101	<0.100	4.44	0.044	1.37
KT03-HL	2	1	3	U13LM11	0.823	10.2	1.50	0.222	0.090	<0.100	4.53	0.040	1.43
KT03-LN	2	1	4	U07LM21	0.866	9.24	1.96	0.224	0.095	<0.100	4.59	0.043	1.74
KT03-LF	2	1	5	U12LM21	0.966	10.4	1.95	0.264	0.111	<0.100	4.61	0.046	1.76
KT03-HK	2	1	6	U11LM21	0.807	4.52	1.86	0.214	0.096	<0.100	4.12	0.042	1.63
KT03-LN	2	1	7	U07LM11	0.852	9.16	1.98	0.221	0.095	<0.100	4.52	0.043	1.76
KT03-HB	2	1	8	U08LM21	0.845	9.44	1.92	0.222	0.094	<0.100	4.64	0.046	1.75
KT03-HL	2	1	9	U13LM21	0.837	9.71	1.60	0.231	0.095	<0.100	4.61	0.040	1.38
Batch 1	2	1	10	BCHLM212	1.36	6.38	<0.100	0.519	<0.010	<0.100	0.388	<0.010	0.074
KT03-HA	2	1	11	U14LM11	0.813	9.46	1.80	0.214	0.092	<0.100	4.65	0.037	1.58
KT03-HB	2	1	12	U08LM11	0.832	9.62	2.01	0.218	0.096	<0.100	4.66	0.045	1.79
KT03-HF	2	1	13	U03LM11	0.816	9.31	2.04	0.232	0.094	<0.100	4.61	0.037	1.79
KT03-HK	2	1	14	U11LM11	0.759	4.65	1.71	0.194	0.088	<0.100	4.14	0.039	1.55
KT03-HF	2	1	15	U03LM21	0.807	9.40	2.00	0.226	0.095	<0.100	4.60	0.037	1.77
KT03-HA	2	1	16	U14LM21	0.812	9.91	1.82	0.402	0.089	<0.100	4.64	0.037	1.69
Batch 1	2	1	17	BCHLM213	1.31	6.69	<0.100	0.516	<0.010	<0.100	0.385	<0.010	0.072
Batch 1	2	2	1	BCHLM221	1.35	6.56	<0.100	0.499	<0.010	<0.100	0.379	<0.010	0.067
KT03-HB	2	2	2	U08LM22	0.831	10.6	2.16	0.219	0.093	<0.100	5.06	0.043	1.90
KT03-LN	2	2	3	U07LM12	0.833	10.5	2.18	0.216	0.092	<0.100	5.10	0.040	1.93
KT03-HF	2	2	4	U03LM22	0.832	9.54	1.97	0.230	0.094	<0.100	4.66	0.036	1.74
KT03-HK	2	2	5	U11LM22	0.781	4.77	1.84	0.205	0.094	<0.100	4.33	0.038	1.60
KT03-HF	2	2	6	U03LM12	0.804	9.67	2.01	0.228	0.091	<0.100	4.71	0.035	1.78
KT03-HL	2	2	7	U13LM12	0.798	10.1	1.47	0.209	0.083	<0.100	4.57	0.035	1.39
KT03-HB	2	2	8	U08LM12	0.840	9.81	1.96	0.224	0.094	<0.100	4.61	0.044	1.74
KT03-HA	2	2	9	U14LM22	0.825	9.92	1.78	0.404	0.088	<0.100	4.63	0.036	1.65
Batch 1	2	2	10	BCHLM222	1.39	6.85	<0.100	0.502	<0.010	<0.100	0.378	<0.010	0.071
KT03-LF	2	2	11	U12LM22	0.904	11.3	1.95	0.245	0.105	<0.100	4.76	0.040	1.75
KT03-LN	2	2	12	U07LM22	0.797	10.3	2.00	0.205	0.088	<0.100	4.75	0.038	1.77
KT03-LF	2	2	13	U12LM12	0.829	11.1	1.50	0.252	0.092	<0.100	4.67	0.037	1.40

Table B-2. PSAL Chemical Composition Measurements of the KT03-Series of Glasses Using LM Preparation Method (Part 2). (continued)

Glass ID	Block	Sub-Blk	Seq	Lab ID	Mn (wt%)	Na (wt%)	Nb (wt%)	Ni (wt%)	Pb (wt%)	S (wt%)	Ti (wt%)	Zn (wt%)	Zr (wt%)
KT03-HA	2	2	14	U14LM12	0.802	10.6	1.83	0.206	0.088	<0.100	4.73	0.033	1.60
KT03-HL	2	2	15	U13LM22	0.798	10.3	1.57	0.214	0.089	<0.100	4.81	0.035	1.34
KT03-HK	2	2	16	U11LM12	0.738	4.81	1.69	0.185	0.084	<0.100	4.31	0.035	1.52
Batch 1	2	2	17	BCHLM223	1.35	6.95	<0.100	0.490	<0.010	<0.100	0.377	<0.010	0.070

Table B-3. PSAL Chemical Composition Measurements of the KT03-Series of Glasses Using PF Preparation Method.

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Fe (wt%)	Li (wt%)	Si (wt%)
Batch 1	1	1	1	BCHPF111	2.54	2.45	9.19	2.10	23.4
KT03-LA	1	1	2	U09PF11	2.27	1.37	7.74	2.08	20.0
KT03-HN	1	1	3	U04PF11	2.75	1.32	7.49	2.00	19.1
KT03-HS	1	1	4	U05PF21	2.54	1.18	6.61	1.81	21.2
KT1-HA2	1	1	5	U01PF11	4.64	1.38	7.15	2.14	20.2
KT03-HF	1	1	6	U03PF11	2.81	1.25	10.65	1.93	19.0
KT03-HS	1	1	7	U05PF11	2.55	1.17	6.55	1.81	22.1
KT03-LA	1	1	8	U09PF21	2.33	1.36	7.92	2.08	19.2
KT03-HN	1	1	9	U04PF21	2.75	1.25	7.01	1.99	19.1
Batch 1	1	1	10	BCHPF112	2.55	2.38	8.78	2.10	23.0
KT03-LL	1	1	11	U15PF11	2.82	1.37	7.51	2.20	20.0
KT03-LB	1	1	12	U10PF21	2.83	1.45	7.35	2.05	20.5
KT03-MK	1	1	13	U02PF21	2.72	1.26	6.97	1.24	19.2
KT03-MK	1	1	14	U02PF11	2.72	1.27	6.85	1.24	18.7
KT1-HA2	1	1	15	U01PF21	4.55	1.38	7.00	2.10	20.1
KT03-LL	1	1	16	U15PF21	2.92	1.32	7.43	2.19	19.6
KT03-LB	1	1	17	U10PF11	2.84	1.44	7.28	2.06	20.3
KT03-HF	1	1	18	U03PF21	2.64	1.24	10.35	1.90	18.9
Batch 1	1	1	19	BCHPF113	2.54	2.35	8.53	2.09	23.8
Batch 1	1	2	1	BCHPF121	2.50	2.45	9.12	2.07	23.2
KT03-HF	1	2	2	U03PF12	2.78	1.27	11.18	1.92	18.9
KT03-LB	1	2	3	U10PF12	2.74	1.46	7.89	2.01	20.2
KT03-LL	1	2	4	U15PF22	2.88	1.36	7.99	2.18	19.9
KT03-LB	1	2	5	U10PF22	2.75	1.44	7.76	2.02	20.1
KT03-MK	1	2	6	U02PF22	2.66	1.27	7.35	1.23	19.0
KT03-HF	1	2	7	U03PF22	2.62	1.23	11.10	1.91	18.7
KT03-HN	1	2	8	U04PF22	2.71	1.26	7.42	1.98	19.0
KT03-LL	1	2	9	U15PF12	2.77	1.32	7.83	2.19	19.5
Batch 1	1	2	10	BCHPF122	2.50	2.33	9.87	2.07	22.9
KT03-HS	1	2	11	U05PF12	2.52	1.21	6.83	1.81	22.2
KT1-HA2	1	2	12	U01PF22	4.54	1.39	7.58	2.11	20.3
KT03-LA	1	2	13	U09PF12	2.23	1.36	7.97	2.05	19.9
KT1-HA2	1	2	14	U01PF12	4.47	1.39	7.63	2.09	20.1
KT03-HN	1	2	15	U04PF12	2.70	1.29	7.58	1.98	18.9
KT03-HS	1	2	16	U05PF22	2.49	1.15	6.82	1.80	21.9
KT03-LA	1	2	17	U09PF22	2.30	1.32	8.46	2.06	19.6
KT03-MK	1	2	18	U02PF12	2.68	1.25	7.24	1.24	18.4
Batch 1	1	2	19	BCHPF123	2.50	2.31	9.09	2.06	22.6
Batch 1	2	1	1	BCHPF211	2.52	2.47	8.36	2.08	22.2
KT03-HA	2	1	2	U14PF11	4.50	1.40	6.98	2.01	19.3
KT03-HB	2	1	3	U08PF21	2.73	2.23	7.11	2.01	19.5
KT03-LS	2	1	4	U06PF11	2.74	1.32	6.90	2.01	20.8
KT03-HB	2	1	5	U08PF11	2.75	2.17	6.92	2.01	19.4
KT03-HK	2	1	6	U11PF21	2.60	1.25	6.67	0.57	18.2
KT03-LS	2	1	7	U06PF21	2.70	1.29	6.79	1.98	20.6
KT03-LN	2	1	8	U07PF21	2.82	1.34	7.75	2.06	20.4
KT03-LF	2	1	9	U12PF11	2.88	1.38	5.60	2.12	20.8
Batch 1	2	1	10	BCHPF212	2.47	2.26	8.75	2.05	22.8
KT03-HL	2	1	11	U13PF21	2.68	1.39	7.48	3.29	19.5
KT03-HA	2	1	12	U14PF21	4.45	1.34	6.95	1.99	19.4
KT03-HL	2	1	13	U13PF11	2.71	1.33	7.32	3.34	19.7
KT03-LF	2	1	14	U12PF21	2.88	1.39	5.74	2.14	21.1
KT03-HK	2	1	15	U11PF11	2.52	1.19	6.76	0.56	18.3
KT03-LN	2	1	16	U07PF11	2.84	1.35	7.71	2.09	20.6
Batch 1	2	1	17	BCHPF213	2.49	2.29	8.75	2.09	23.0
Batch 1	2	2	1	BCHPF221	2.30	2.32	8.23	1.90	21.2
KT03-LF	2	2	2	U12PF22	2.93	1.47	5.79	2.12	21.1
KT03-LN	2	2	3	U07PF22	2.88	1.40	7.80	2.06	20.6
KT03-HB	2	2	4	U08PF12	2.69	2.18	7.39	1.94	19.8
KT03-HL	2	2	5	U13PF22	2.71	1.29	7.60	3.28	19.5
KT03-LN	2	2	6	U07PF12	2.85	1.35	7.97	2.05	20.7
KT03-HL	2	2	7	U13PF12	2.73	1.30	7.57	3.31	19.9
KT03-HA	2	2	8	U14PF12	4.48	1.25	7.35	1.95	19.9
KT03-HK	2	2	9	U11PF22	2.58	1.17	6.91	0.52	18.9
Batch 1	2	2	10	BCHPF222	2.46	2.28	9.05	2.01	23.1
KT03-LS	2	2	11	U06PF12	2.67	1.33	7.42	1.94	21.8
KT03-HA	2	2	12	U14PF22	4.41	1.28	7.20	1.93	19.7

Table B-3. PSAL Chemical Composition Measurements of the KT03-Series of Glasses Using PF Preparation Method. (continued)

Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt%)	B (wt%)	Fe (wt%)	Li (wt%)	Si (wt%)
KT03-HB	2	2	13	U08PF22	2.68	2.16	7.37	1.94	20.2
KT03-HK	2	2	14	U11PF12	2.55	1.18	6.84	0.52	18.8
KT03-LS	2	2	15	U06PF22	2.69	1.24	7.04	1.94	21.4
KT03-LF	2	2	16	U12PF12	2.93	1.34	5.50	2.12	21.2
Batch 1	2	2	17	BCHPF223	2.39	2.21	8.44	1.98	22.3

Table B-4. Comparison of Measured versus Targeted Composition for KT03 Glasses.

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
Batch 1	Al_2O_3	4.6860	4.8770	-0.1910	-3.9%
Batch 1	B_2O_3	7.5399	7.7770	-0.2371	-3.0%
Batch 1	BaO	0.1378	0.1510	-0.0132	-8.7%
Batch 1	CaO	1.1946	1.2200	-0.0254	-2.1%
Batch 1	Ce_2O_3	0.0061	0.0000	0.0061	
Batch 1	Cr_2O_3	0.1044	0.1070	-0.0026	-2.4%
Batch 1	CuO	0.3922	0.3990	-0.0068	-1.7%
Batch 1	Fe_2O_3	12.6481	12.8390	-0.1909	-1.5%
Batch 1	K_2O	3.6780	3.3270	0.3510	10.6%
Batch 1	La_2O_3	0.0059	0.0000	0.0059	
Batch 1	Li_2O	4.4134	4.4290	-0.0156	-0.4%
Batch 1	MgO	1.3131	1.4190	-0.1059	-7.5%
Batch 1	MnO	1.7216	1.7260	-0.0044	-0.3%
Batch 1	Na_2O	9.1248	9.0030	0.1218	1.4%
Batch 1	Nb_2O_5	0.0715	0.0000	0.0715	
Batch 1	NiO	0.6491	0.7510	-0.1019	-13.6%
Batch 1	PbO	0.0054	0.0000	0.0054	
Batch 1	SiO_2	48.7582	50.2200	-1.4618	-2.9%
Batch 1	SO_4	0.1498	0.0000	0.1498	
Batch 1	TiO_2	0.6409	0.6770	-0.0361	-5.3%
Batch 1	ZnO	0.0062	0.0000	0.0062	
Batch 1	ZrO_2	0.0965	0.0980	-0.0015	-1.6%
Batch 1	Sum	97.3436	99.0200	-1.6764	-1.7%
KT03-HA	Al_2O_3	8.4272	8.4200	0.0072	0.1%
KT03-HA	B_2O_3	4.2422	4.2700	-0.0278	-0.7%
KT03-HA	BaO	0.0675	0.0700	-0.0025	-3.5%
KT03-HA	CaO	0.9301	0.9000	0.0301	3.3%
KT03-HA	Ce_2O_3	0.1859	0.1900	-0.0041	-2.1%
KT03-HA	Cr_2O_3	0.0921	0.1000	-0.0079	-7.9%
KT03-HA	CuO	0.0488	0.0300	0.0188	62.7%
KT03-HA	Fe_2O_3	10.1795	10.7100	-0.5305	-5.0%
KT03-HA	K_2O	0.0810	0.0700	0.0110	15.7%
KT03-HA	La_2O_3	0.0583	0.0700	-0.0117	-16.6%
KT03-HA	Li_2O	4.2412	4.2700	-0.0288	-0.7%
KT03-HA	MgO	0.1347	0.1400	-0.0053	-3.8%
KT03-HA	MnO	1.0497	1.1500	-0.1003	-8.7%
KT03-HA	Na_2O	13.4429	13.3500	0.0929	0.7%
KT03-HA	Nb_2O_5	2.5856	3.0000	-0.4144	-13.8%
KT03-HA	NiO	0.3900	0.3200	0.0700	21.9%
KT03-HA	PbO	0.0961	0.1000	-0.0039	-3.9%
KT03-HA	SiO_2	41.8768	42.2300	-0.3532	-0.8%
KT03-HA	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-HA	TiO_2	7.7771	8.0000	-0.2230	-2.8%
KT03-HA	ZnO	0.0445	0.0500	-0.0055	-11.0%
KT03-HA	ZrO_2	2.2018	2.5000	-0.2982	-11.9%
KT03-HA	Sum	98.3031	100.0100	-1.7069	-1.7%
KT03-HB	Al_2O_3	5.1253	5.0800	0.0453	0.9%
KT03-HB	B_2O_3	7.0355	7.2000	-0.1645	-2.3%
KT03-HB	BaO	0.0692	0.0700	-0.0008	-1.1%
KT03-HB	CaO	0.9095	0.9000	0.0095	1.1%
KT03-HB	Ce_2O_3	0.1906	0.1900	0.0006	0.3%
KT03-HB	Cr_2O_3	0.0932	0.1000	-0.0068	-6.8%
KT03-HB	CuO	0.0563	0.0300	0.0263	87.8%
KT03-HB	Fe_2O_3	10.2903	10.7700	-0.4797	-4.5%
KT03-HB	K_2O	0.0684	0.0700	-0.0016	-2.3%
KT03-HB	La_2O_3	0.0592	0.0700	-0.0108	-15.4%
KT03-HB	Li_2O	4.2520	4.2900	-0.0380	-0.9%
KT03-HB	MgO	0.1393	0.1400	-0.0007	-0.5%
KT03-HB	MnO	1.0807	1.1600	-0.0793	-6.8%

Table B-4. Comparison of Measured versus Targeted Composition for KT03 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT03-HB	Na_2O	13.3014	13.4300	-0.1286	-1.0%
KT03-HB	Nb_2O_5	2.8789	3.0000	-0.1211	-4.0%
KT03-HB	NiO	0.2809	0.3300	-0.0491	-14.9%
KT03-HB	PbO	0.1015	0.1000	0.0015	1.5%
KT03-HB	SiO_2	42.1977	42.4600	-0.2623	-0.6%
KT03-HB	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-HB	TiO_2	7.9105	8.0000	-0.0895	-1.1%
KT03-HB	ZnO	0.0554	0.0500	0.0054	10.8%
KT03-HB	ZrO_2	2.4247	2.5000	-0.0753	-3.0%
KT03-HB	Sum	98.6702	100.0100	-1.3398	-1.3%
KT03-HF	Al_2O_3	5.1253	4.9100	0.2153	4.4%
KT03-HF	B_2O_3	4.0168	4.1500	-0.1332	-3.2%
KT03-HF	BaO	0.0678	0.0700	-0.0022	-3.1%
KT03-HF	CaO	0.8843	0.8700	0.0143	1.6%
KT03-HF	Ce_2O_3	0.1865	0.1800	0.0065	3.6%
KT03-HF	Cr_2O_3	0.0899	0.0900	-0.0001	-0.1%
KT03-HF	CuO	0.0610	0.0300	0.0310	103.4%
KT03-HF	Fe_2O_3	15.4694	16.0800	-0.6106	-3.8%
KT03-HF	K_2O	0.0720	0.0600	0.0120	20.0%
KT03-HF	La_2O_3	0.0592	0.0700	-0.0108	-15.4%
KT03-HF	Li_2O	4.1228	4.1500	-0.0272	-0.7%
KT03-HF	MgO	0.1393	0.1300	0.0093	7.2%
KT03-HF	MnO	1.0520	1.1200	-0.0680	-6.1%
KT03-HF	Na_2O	12.7790	12.9800	-0.2010	-1.5%
KT03-HF	Nb_2O_5	2.8682	3.0000	-0.1318	-4.4%
KT03-HF	NiO	0.2914	0.3100	-0.0186	-6.0%
KT03-HF	PbO	0.1007	0.1000	0.0007	0.7%
KT03-HF	SiO_2	40.3793	41.0600	-0.6807	-1.7%
KT03-HF	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-HF	TiO_2	7.7479	8.0000	-0.2521	-3.2%
KT03-HF	ZnO	0.0451	0.0500	-0.0049	-9.8%
KT03-HF	ZrO_2	2.3909	2.5000	-0.1091	-4.4%
KT03-HF	Sum	98.0986	99.9800	-1.8814	-1.9%
KT03-HK	Al_2O_3	4.8418	4.7600	0.0818	1.7%
KT03-HK	B_2O_3	3.8558	4.0200	-0.1642	-4.1%
KT03-HK	BaO	0.0625	0.0700	-0.0075	-10.7%
KT03-HK	CaO	0.8707	0.8500	0.0207	2.4%
KT03-HK	Ce_2O_3	0.1751	0.1800	-0.0049	-2.7%
KT03-HK	Cr_2O_3	0.1283	0.0900	0.0383	42.5%
KT03-HK	CuO	0.0519	0.0300	0.0219	73.2%
KT03-HK	Fe_2O_3	9.7148	10.0800	-0.3652	-3.6%
KT03-HK	K_2O	17.5811	18.7400	-1.1589	-6.2%
KT03-HK	La_2O_3	0.0537	0.0600	-0.0063	-10.6%
KT03-HK	Li_2O	1.1679	1.0400	0.1279	12.3%
KT03-HK	MgO	0.1223	0.1300	-0.0077	-5.9%
KT03-HK	MnO	0.9958	1.0900	-0.0942	-8.6%
KT03-HK	Na_2O	6.3188	6.3900	-0.0713	-1.1%
KT03-HK	Nb_2O_5	2.5391	2.7100	-0.1709	-6.3%
KT03-HK	NiO	0.2539	0.3000	-0.0461	-15.4%
KT03-HK	PbO	0.0975	0.1000	-0.0025	-2.5%
KT03-HK	SiO_2	39.6840	39.7500	-0.0660	-0.2%
KT03-HK	SO_4	0.1498	0.0600	0.0898	149.7%
KT03-HK	TiO_2	7.0473	7.2400	-0.1927	-2.7%
KT03-HK	ZnO	0.0479	0.0400	0.0079	19.8%
KT03-HK	ZrO_2	2.1275	2.2600	-0.1325	-5.9%
KT03-HK	Sum	97.8876	99.9900	-2.1024	-2.1%
KT03-HL	Al_2O_3	5.1158	5.0800	0.0358	0.7%
KT03-HL	B_2O_3	4.2744	4.2900	-0.0156	-0.4%

Table B-4. Comparison of Measured versus Targeted Composition for KT03 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT03-HL	BaO	0.0673	0.0700	-0.0027	-3.9%
KT03-HL	CaO	0.9459	0.9000	0.0459	5.1%
KT03-HL	Ce_2O_3	0.1845	0.1900	-0.0055	-2.9%
KT03-HL	Cr_2O_3	0.1085	0.1000	0.0085	8.5%
KT03-HL	CuO	0.0463	0.0300	0.0163	54.4%
KT03-HL	Fe_2O_3	10.7120	10.7700	-0.0580	-0.5%
KT03-HL	K_2O	0.0780	0.0700	0.0080	11.4%
KT03-HL	La_2O_3	0.0572	0.0700	-0.0128	-18.3%
KT03-HL	Li_2O	7.1153	7.2000	-0.0847	-1.2%
KT03-HL	MgO	0.1360	0.1400	-0.0040	-2.9%
KT03-HL	MnO	1.0510	1.1600	-0.1090	-9.4%
KT03-HL	Na_2O	13.5845	13.4300	0.1545	1.2%
KT03-HL	Nb_2O_5	2.1958	3.0000	-0.8042	-26.8%
KT03-HL	NiO	0.2787	0.3300	-0.0513	-15.6%
KT03-HL	PbO	0.0961	0.1000	-0.0039	-3.9%
KT03-HL	SiO_2	42.0372	42.4600	-0.4228	-1.0%
KT03-HL	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-HL	TiO_2	7.7228	8.0000	-0.2772	-3.5%
KT03-HL	ZnO	0.0467	0.0500	-0.0033	-6.6%
KT03-HL	ZrO_2	1.8709	2.5000	-0.6291	-25.2%
KT03-HL	Sum	97.8748	100.0100	-2.1352	-2.1%
KT03-HN	Al_2O_3	5.1536	5.0800	0.0736	1.4%
KT03-HN	B_2O_3	4.1215	4.2800	-0.1585	-3.7%
KT03-HN	BaO	0.0670	0.0700	-0.0030	-4.3%
KT03-HN	CaO	0.9147	0.9000	0.0147	1.6%
KT03-HN	Ce_2O_3	0.1877	0.1900	-0.0023	-1.2%
KT03-HN	Cr_2O_3	0.1060	0.1000	0.0060	6.0%
KT03-HN	CuO	0.0573	0.0300	0.0273	90.9%
KT03-HN	Fe_2O_3	10.5440	10.7600	-0.2160	-2.0%
KT03-HN	K_2O	0.0717	0.0700	0.0017	2.4%
KT03-HN	La_2O_3	0.0575	0.0700	-0.0125	-17.9%
KT03-HN	Li_2O	4.2789	4.2800	-0.0011	0.0%
KT03-HN	MgO	0.1372	0.1400	-0.0028	-2.0%
KT03-HN	MnO	1.0865	1.1600	-0.0735	-6.3%
KT03-HN	Na_2O	16.1086	16.4100	-0.3014	-1.8%
KT03-HN	Nb_2O_5	2.5105	3.0000	-0.4895	-16.3%
KT03-HN	NiO	0.3579	0.3300	0.0279	8.5%
KT03-HN	PbO	0.1037	0.1000	0.0037	3.7%
KT03-HN	SiO_2	40.7002	42.4100	-1.7098	-4.0%
KT03-HN	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-HN	TiO_2	7.7270	8.0000	-0.2730	-3.4%
KT03-HN	ZnO	0.0529	0.0500	0.0029	5.8%
KT03-HN	ZrO_2	2.2221	2.5000	-0.2779	-11.1%
KT03-HN	Sum	96.7162	100.0000	-3.2838	-3.3%
KT03-HS	Al_2O_3	4.7710	4.6000	0.1710	3.7%
KT03-HS	B_2O_3	3.7914	3.8900	-0.0986	-2.5%
KT03-HS	BaO	0.0673	0.0700	-0.0027	-3.9%
KT03-HS	CaO	0.8203	0.8200	0.0003	0.0%
KT03-HS	Ce_2O_3	0.1789	0.1700	0.0089	5.2%
KT03-HS	Cr_2O_3	0.0778	0.0900	-0.0122	-13.5%
KT03-HS	CuO	0.0488	0.0300	0.0188	62.7%
KT03-HS	Fe_2O_3	9.5826	9.7600	-0.1774	-1.8%
KT03-HS	K_2O	0.0614	0.0600	0.0014	2.4%
KT03-HS	La_2O_3	0.0513	0.0600	-0.0087	-14.5%
KT03-HS	Li_2O	3.8914	3.8900	0.0014	0.0%
KT03-HS	MgO	0.1302	0.1200	0.0102	8.5%
KT03-HS	MnO	1.0275	1.0500	-0.0225	-2.1%
KT03-HS	Na_2O	12.3881	12.1600	0.2281	1.9%

Table B-4. Comparison of Measured versus Targeted Composition for KT03 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT03-HS	Nb_2O_5	2.4819	3.0000	-0.5181	-17.3%
KT03-HS	NiO	0.2790	0.3000	-0.0210	-7.0%
KT03-HS	PbO	0.1007	0.0900	0.0107	11.9%
KT03-HS	SiO_2	46.7437	49.2400	-2.4963	-5.1%
KT03-HS	SO_4	0.1498	0.0600	0.0898	149.7%
KT03-HS	TiO_2	7.5269	8.0000	-0.4732	-5.9%
KT03-HS	ZnO	0.0467	0.0400	0.0067	16.7%
KT03-HS	ZrO_2	2.1782	2.5000	-0.3218	-12.9%
KT03-HS	Sum	96.3948	100.0000	-3.6052	-3.6%
KT03-LA	Al_2O_3	4.3128	4.1900	0.1228	2.9%
KT03-LA	B_2O_3	4.3549	4.5000	-0.1451	-3.2%
KT03-LA	BaO	0.7062	0.0800	0.6262	782.7%
KT03-LA	CaO	0.9920	0.9500	0.0420	4.4%
KT03-LA	Ce_2O_3	0.1930	0.2000	-0.0070	-3.5%
KT03-LA	Cr_2O_3	0.0957	0.1000	-0.0043	-4.3%
KT03-LA	CuO	0.0538	0.0300	0.0238	79.4%
KT03-LA	Fe_2O_3	11.4698	11.2900	0.1798	1.6%
KT03-LA	K_2O	0.0831	0.0700	0.0131	18.7%
KT03-LA	La_2O_3	0.0592	0.0700	-0.0108	-15.4%
KT03-LA	Li_2O	4.4511	4.5000	-0.0489	-1.1%
KT03-LA	MgO	0.1397	0.1400	-0.0003	-0.2%
KT03-LA	MnO	1.0862	1.2200	-0.1338	-11.0%
KT03-LA	Na_2O	14.2551	14.0800	0.1751	1.2%
KT03-LA	Nb_2O_5	2.6178	3.0000	-0.3822	-12.7%
KT03-LA	NiO	0.2774	0.3400	-0.0626	-18.4%
KT03-LA	PbO	0.0988	0.1100	-0.0112	-10.2%
KT03-LA	SiO_2	42.0907	44.5200	-2.4293	-5.5%
KT03-LA	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-LA	TiO_2	7.6228	8.0000	-0.3772	-4.7%
KT03-LA	ZnO	0.0529	0.0500	0.0029	5.8%
KT03-LA	ZrO_2	2.3335	2.5000	-0.1665	-6.7%
KT03-LA	Sum	97.4965	100.0100	-2.5135	-2.5%
KT03-LB	Al_2O_3	5.2717	5.2400	0.0317	0.6%
KT03-LB	B_2O_3	4.6608	4.8000	-0.1392	-2.9%
KT03-LB	BaO	0.0698	0.0800	-0.0102	-12.8%
KT03-LB	CaO	0.9557	0.9300	0.0257	2.8%
KT03-LB	Ce_2O_3	0.1930	0.1900	0.0030	1.6%
KT03-LB	Cr_2O_3	0.1060	0.1000	0.0060	6.0%
KT03-LB	CuO	0.0557	0.0300	0.0257	85.7%
KT03-LB	Fe_2O_3	10.8228	11.0900	-0.2672	-2.4%
KT03-LB	K_2O	0.0915	0.0700	0.0215	30.8%
KT03-LB	La_2O_3	0.0592	0.0700	-0.0108	-15.4%
KT03-LB	Li_2O	4.3812	4.4200	-0.0388	-0.9%
KT03-LB	MgO	0.1410	0.1400	0.0010	0.7%
KT03-LB	MnO	1.1043	1.2000	-0.0957	-8.0%
KT03-LB	Na_2O	13.7125	13.8300	-0.1175	-0.8%
KT03-LB	Nb_2O_5	2.4998	3.0000	-0.5002	-16.7%
KT03-LB	NiO	0.3006	0.3400	-0.0394	-11.6%
KT03-LB	PbO	0.1061	0.1100	-0.0039	-3.5%
KT03-LB	SiO_2	43.3743	43.7400	-0.3657	-0.8%
KT03-LB	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-LB	TiO_2	7.6811	8.0000	-0.3189	-4.0%
KT03-LB	ZnO	0.0517	0.0500	0.0017	3.3%
KT03-LB	ZrO_2	2.2322	2.5000	-0.2678	-10.7%
KT03-LB	Sum	98.0208	100.0000	-1.9792	-2.0%
KT03-LF	Al_2O_3	5.4890	5.4600	0.0290	0.5%
KT03-LF	B_2O_3	4.4918	4.6100	-0.1182	-2.6%
KT03-LF	BaO	0.0754	0.0800	-0.0046	-5.8%

Table B-4. Comparison of Measured versus Targeted Composition for KT03 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT03-LF	CaO	0.9948	0.9700	0.0248	2.6%
KT03-LF	Ce_2O_3	0.2029	0.2000	0.0029	1.5%
KT03-LF	Cr_2O_3	0.0950	0.1100	-0.0150	-13.6%
KT03-LF	CuO	0.0563	0.0300	0.0263	87.8%
KT03-LF	Fe_2O_3	8.0885	8.2400	-0.1515	-1.8%
KT03-LF	K_2O	0.0900	0.0700	0.0200	28.6%
KT03-LF	La_2O_3	0.0639	0.0700	-0.0061	-8.7%
KT03-LF	Li_2O	4.5749	4.6100	-0.0351	-0.8%
KT03-LF	MgO	0.1492	0.1500	-0.0008	-0.5%
KT03-LF	MnO	1.1666	1.2500	-0.0834	-6.7%
KT03-LF	Na_2O	14.5584	14.4300	0.1284	0.9%
KT03-LF	Nb_2O_5	2.4533	3.0000	-0.5467	-18.2%
KT03-LF	NiO	0.3315	0.3500	-0.0185	-5.3%
KT03-LF	PbO	0.1101	0.1100	0.0001	0.1%
KT03-LF	SiO_2	45.0323	45.6300	-0.5977	-1.3%
KT03-LF	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-LF	TiO_2	7.7062	8.0000	-0.2938	-3.7%
KT03-LF	ZnO	0.0520	0.0500	0.0020	3.9%
KT03-LF	ZrO_2	2.1208	2.5000	-0.3792	-15.2%
KT03-LF	Sum	98.0527	99.9900	-1.9373	-1.9%
KT03-LL	Al_2O_3	5.3804	5.2400	0.1404	2.7%
KT03-LL	B_2O_3	4.3227	4.4200	-0.0973	-2.2%
KT03-LL	BaO	0.0653	0.0800	-0.0147	-18.4%
KT03-LL	CaO	0.9539	0.9300	0.0239	2.6%
KT03-LL	Ce_2O_3	0.1918	0.1900	0.0018	0.9%
KT03-LL	Cr_2O_3	0.0895	0.1000	-0.0105	-10.5%
KT03-LL	CuO	0.0488	0.0300	0.0188	62.7%
KT03-LL	Fe_2O_3	10.9944	11.0900	-0.0956	-0.9%
KT03-LL	K_2O	0.0753	0.0700	0.0053	7.6%
KT03-LL	La_2O_3	0.0592	0.0700	-0.0108	-15.4%
KT03-LL	Li_2O	4.7149	4.8000	-0.0851	-1.8%
KT03-LL	MgO	0.1410	0.1400	0.0010	0.7%
KT03-LL	MnO	1.0978	1.2000	-0.1022	-8.5%
KT03-LL	Na_2O	13.7496	13.8300	-0.0804	-0.6%
KT03-LL	Nb_2O_5	2.5570	3.0000	-0.4430	-14.8%
KT03-LL	NiO	0.2901	0.3400	-0.0499	-14.7%
KT03-LL	PbO	0.1053	0.1100	-0.0047	-4.3%
KT03-LL	SiO_2	42.2512	43.7400	-1.4888	-3.4%
KT03-LL	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-LL	TiO_2	7.6686	8.0000	-0.3314	-4.1%
KT03-LL	ZnO	0.0492	0.0500	-0.0008	-1.7%
KT03-LL	ZrO_2	2.2592	2.5000	-0.2408	-9.6%
KT03-LL	Sum	97.2150	100.0000	-2.7850	-2.8%
KT03-LN	Al_2O_3	5.3804	5.3200	0.0604	1.1%
KT03-LN	B_2O_3	4.3791	4.4900	-0.1109	-2.5%
KT03-LN	BaO	0.0701	0.0800	-0.0099	-12.4%
KT03-LN	CaO	0.9973	0.9500	0.0473	5.0%
KT03-LN	Ce_2O_3	0.1906	0.2000	-0.0094	-4.7%
KT03-LN	Cr_2O_3	0.0932	0.1000	-0.0068	-6.8%
KT03-LN	CuO	0.0488	0.0300	0.0188	62.7%
KT03-LN	Fe_2O_3	11.1624	11.2700	-0.1076	-1.0%
KT03-LN	K_2O	0.0891	0.0700	0.0191	27.3%
KT03-LN	La_2O_3	0.0598	0.0700	-0.0102	-14.6%
KT03-LN	Li_2O	4.4457	4.4900	-0.0443	-1.0%
KT03-LN	MgO	0.1368	0.1400	-0.0032	-2.3%
KT03-LN	MnO	1.0807	1.2200	-0.1393	-11.4%
KT03-LN	Na_2O	13.2104	13.0700	0.1404	1.1%
KT03-LN	Nb_2O_5	2.9039	3.0000	-0.0961	-3.2%

Table B-4. Comparison of Measured versus Targeted Composition for KT03 Glasses. (continued)

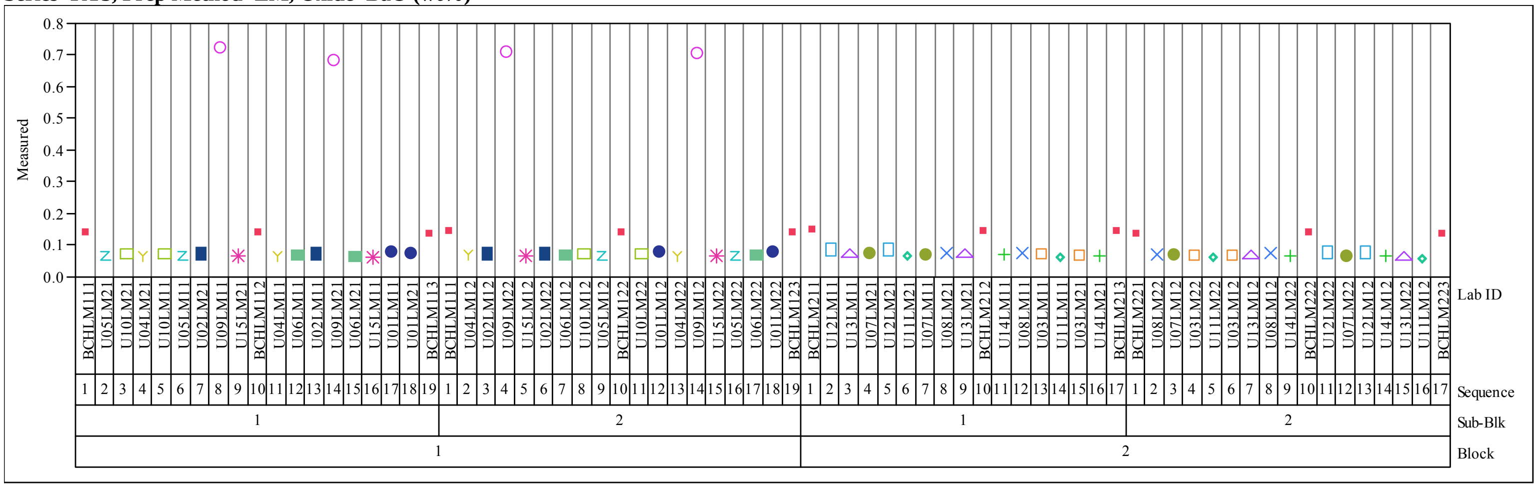
Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT03-LN	NiO	0.2755	0.3400	-0.0645	-19.0%
KT03-LN	PbO	0.0996	0.1100	-0.0104	-9.4%
KT03-LN	SiO_2	44.0161	44.4400	-0.4239	-1.0%
KT03-LN	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-LN	TiO_2	7.9063	8.0000	-0.0937	-1.2%
KT03-LN	ZnO	0.0510	0.0500	0.0010	2.1%
KT03-LN	ZrO_2	2.4314	2.5000	-0.0686	-2.7%
KT03-LN	Sum	99.1781	100.0100	-0.8319	-0.8%
KT03-LS	Al_2O_3	5.1017	5.0100	0.0917	1.8%
KT03-LS	B_2O_3	4.1698	4.2300	-0.0602	-1.4%
KT03-LS	BaO	0.0648	0.0700	-0.0052	-7.5%
KT03-LS	CaO	0.9088	0.8900	0.0188	2.1%
KT03-LS	Ce_2O_3	0.1865	0.1900	-0.0035	-1.8%
KT03-LS	Cr_2O_3	0.1096	0.1000	0.0096	9.6%
KT03-LS	CuO	0.0482	0.0300	0.0182	60.6%
KT03-LS	Fe_2O_3	10.0615	10.6200	-0.5585	-5.3%
KT03-LS	K_2O	0.1111	0.0700	0.0411	58.7%
KT03-LS	La_2O_3	0.0545	0.0700	-0.0155	-22.1%
KT03-LS	Li_2O	4.2358	4.2300	0.0058	0.1%
KT03-LS	MgO	0.1285	0.1300	-0.0015	-1.1%
KT03-LS	MnO	1.0523	1.1400	-0.0877	-7.7%
KT03-LS	Na_2O	13.1194	13.2400	-0.1206	-0.9%
KT03-LS	Nb_2O_5	2.6285	3.0000	-0.3715	-12.4%
KT03-LS	NiO	0.2742	0.3200	-0.0458	-14.3%
KT03-LS	PbO	0.0996	0.1000	-0.0004	-0.4%
KT03-LS	SiO_2	45.2462	45.9600	-0.7138	-1.6%
KT03-LS	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-LS	TiO_2	7.6811	8.0000	-0.3189	-4.0%
KT03-LS	ZnO	0.0467	0.0500	-0.0033	-6.6%
KT03-LS	ZrO_2	2.3470	2.5000	-0.1530	-6.1%
KT03-LS	Sum	97.8258	100.0200	-2.1942	-2.2%
KT03-MK	Al_2O_3	5.0922	5.0000	0.0922	1.8%
KT03-MK	B_2O_3	4.0651	4.2200	-0.1549	-3.7%
KT03-MK	BaO	0.0667	0.0700	-0.0033	-4.7%
KT03-MK	CaO	0.9049	0.8900	0.0149	1.7%
KT03-MK	Ce_2O_3	0.1871	0.1900	-0.0029	-1.5%
KT03-MK	Cr_2O_3	0.0957	0.1000	-0.0043	-4.3%
KT03-MK	CuO	0.0444	0.0300	0.0144	48.1%
KT03-MK	Fe_2O_3	10.1544	10.5900	-0.4356	-4.1%
KT03-MK	K_2O	9.8837	9.8500	0.0337	0.3%
KT03-MK	La_2O_3	0.0554	0.0700	-0.0146	-20.8%
KT03-MK	Li_2O	2.6642	2.6500	0.0142	0.5%
KT03-MK	MgO	0.0684	0.1300	-0.0616	-47.4%
KT03-MK	MnO	1.0652	1.1400	-0.0748	-6.6%
KT03-MK	Na_2O	10.1572	9.9600	0.1972	2.0%
KT03-MK	Nb_2O_5	2.5070	2.8500	-0.3430	-12.0%
KT03-MK	NiO	0.2793	0.3200	-0.0407	-12.7%
KT03-MK	PbO	0.1031	0.1000	0.0031	3.1%
KT03-MK	SiO_2	40.2723	41.7600	-1.4877	-3.6%
KT03-MK	SO_4	0.1498	0.0700	0.0798	114.0%
KT03-MK	TiO_2	7.3184	7.6000	-0.2817	-3.7%
KT03-MK	ZnO	0.0426	0.0500	-0.0074	-14.7%
KT03-MK	ZrO_2	2.2356	2.3800	-0.1444	-6.1%
KT03-MK	Sum	97.4130	100.0200	-2.6070	-2.6%
KT1-HA2	Al_2O_3	8.5972	8.4200	0.1772	2.1%
KT1-HA2	B_2O_3	4.4596	4.5200	-0.0604	-1.3%
KT1-HA2	BaO	0.0790	0.0800	-0.0010	-1.3%
KT1-HA2	CaO	0.9574	0.9500	0.0074	0.8%

Table B-4. Comparison of Measured versus Targeted Composition for KT03 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT1-HA2	Ce_2O_3	0.1947	0.2000	-0.0053	-2.6%
KT1-HA2	Cr_2O_3	0.0866	0.1000	-0.0134	-13.4%
KT1-HA2	CuO	0.0394	0.0300	0.0094	31.4%
KT1-HA2	Fe_2O_3	10.4940	11.3400	-0.8460	-7.5%
KT1-HA2	K_2O	0.0678	0.0700	-0.0022	-3.2%
KT1-HA2	La_2O_3	0.0625	0.0700	-0.0075	-10.8%
KT1-HA2	Li_2O	4.5426	4.5200	0.0226	0.5%
KT1-HA2	MgO	0.1447	0.1400	0.0047	3.3%
KT1-HA2	MnO	1.1660	1.2200	-0.0540	-4.4%
KT1-HA2	Na_2O	14.2888	14.1400	0.1488	1.1%
KT1-HA2	Nb_2O_5	0.3945	0.4100	-0.0155	-3.8%
KT1-HA2	NiO	0.3057	0.3400	-0.0343	-10.1%
KT1-HA2	PbO	0.0859	0.1100	-0.0241	-21.9%
KT1-HA2	SiO_2	43.1604	44.7200	-1.5596	-3.5%
KT1-HA2	SO_4	0.1498	0.0700	0.0798	114.0%
KT1-HA2	TiO_2	7.6061	8.0000	-0.3939	-4.9%
KT1-HA2	ZnO	0.0476	0.0500	-0.0024	-4.8%
KT1-HA2	ZrO_2	0.4768	0.4900	-0.0132	-2.7%
KT1-HA2	Sum	97.4070	99.9900	-2.5830	-2.6%

Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide.

Series=KT3, Prep Method=LM, Oxide=BaO (wt%)



Series=KT3, Prep Method=LM, Oxide=CaO (wt%)

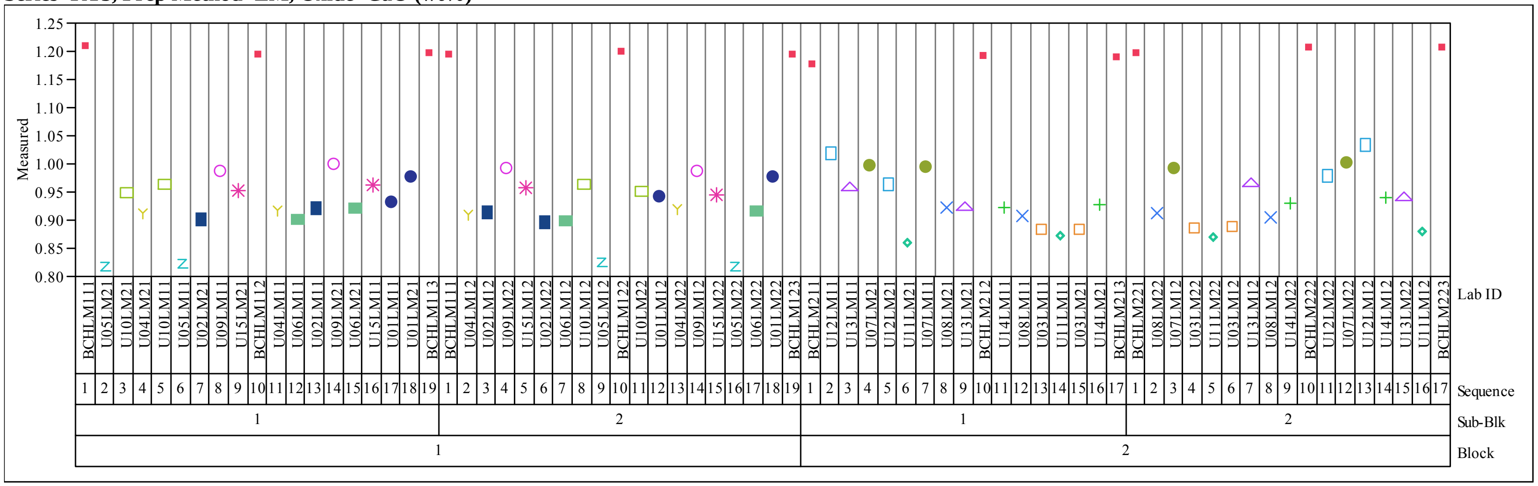
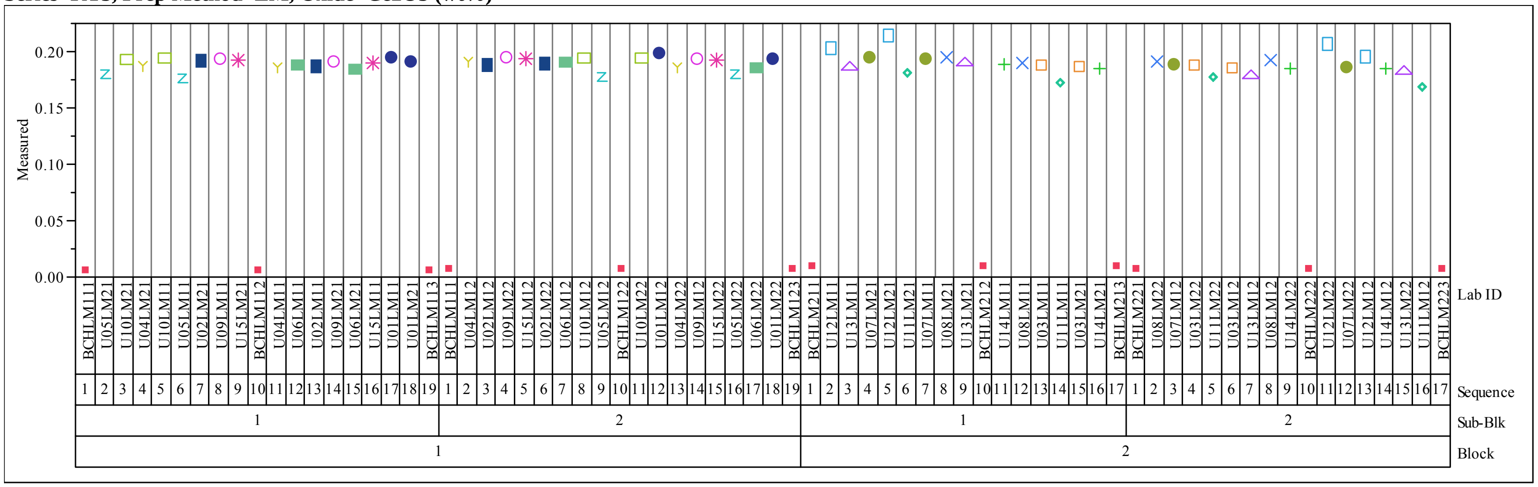


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=LM, Oxide=Ce2O3 (wt%)



Series=KT3, Prep Method=LM, Oxide=Cr2O3 (wt%)

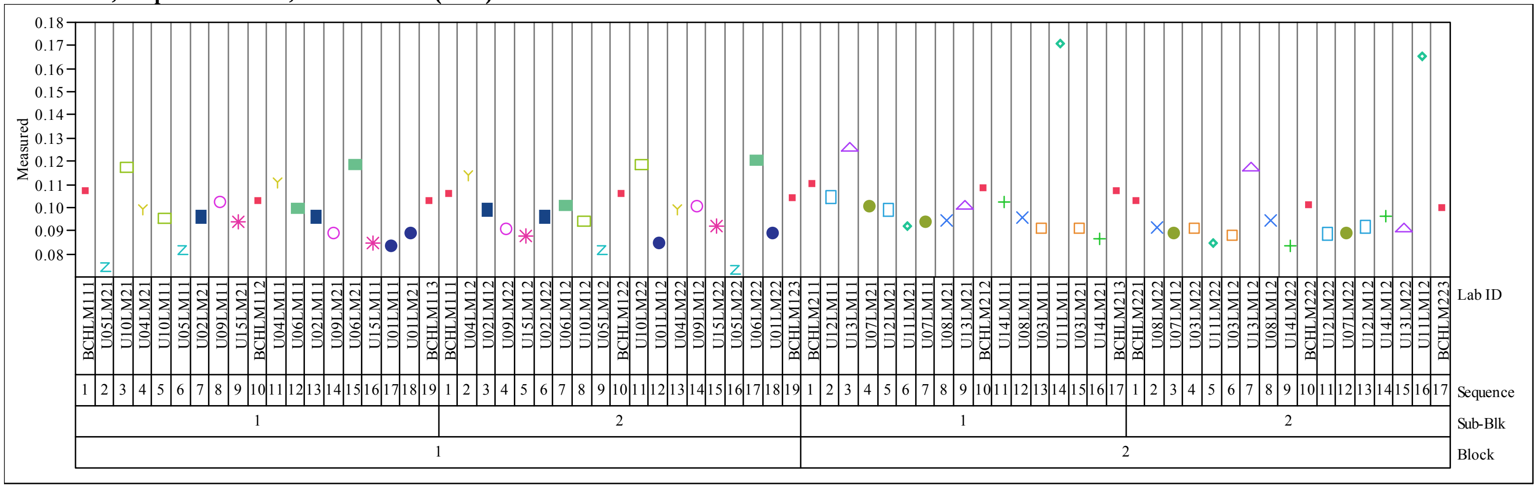
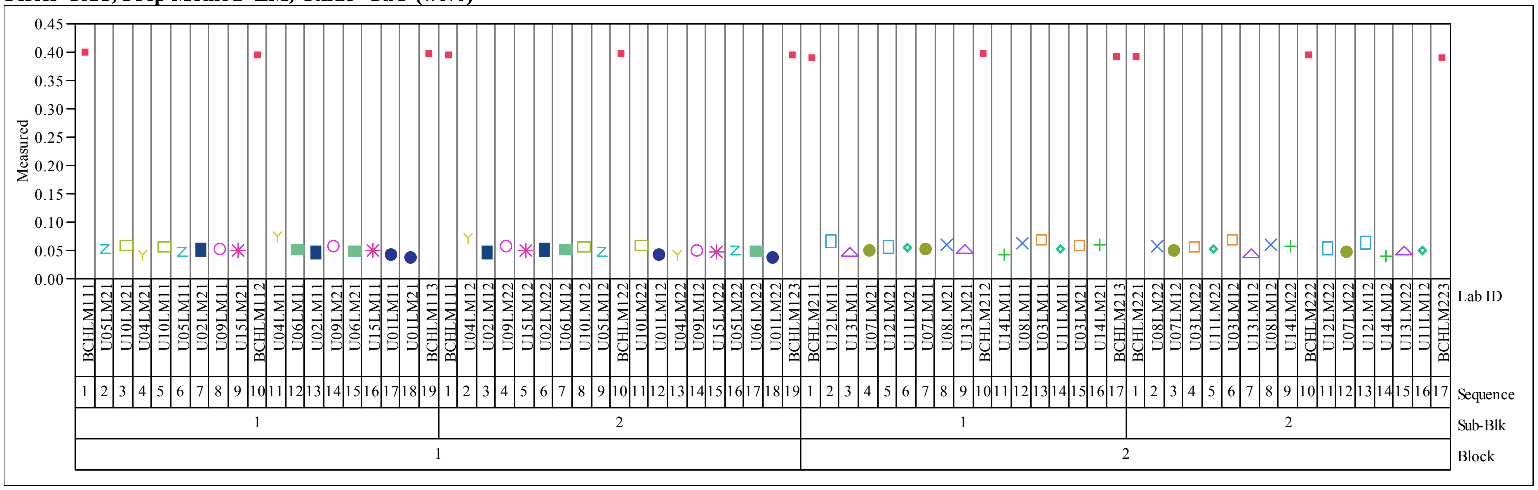


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=LM, Oxide=CuO (wt%)



Series=KT3, Prep Method=LM, Oxide=K2O (wt%)

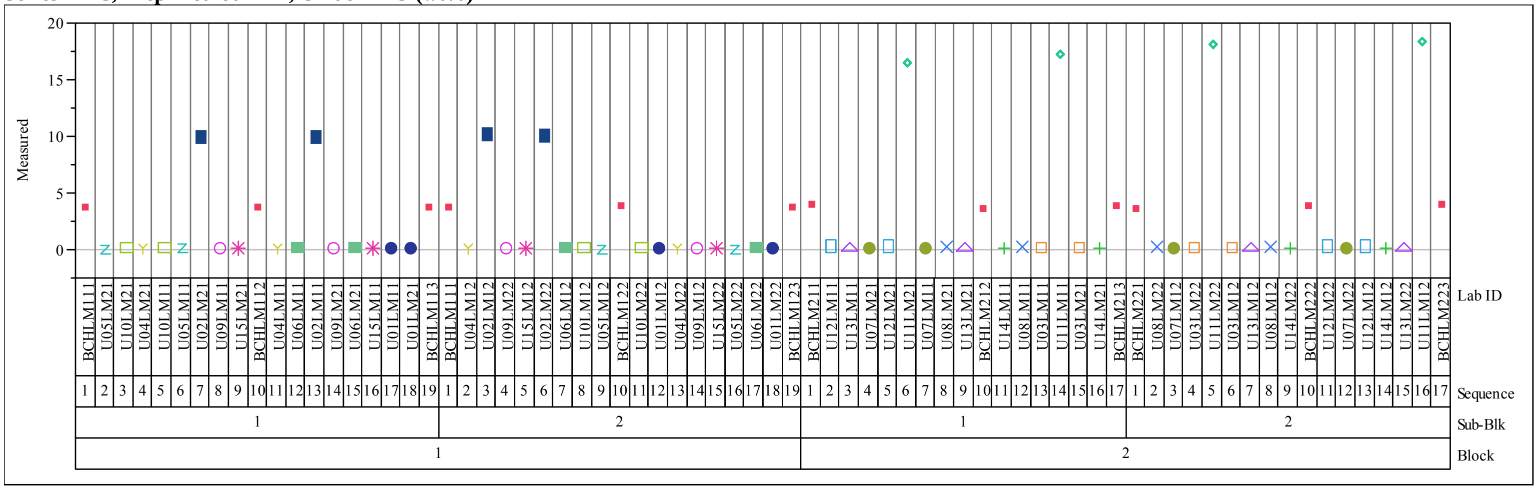
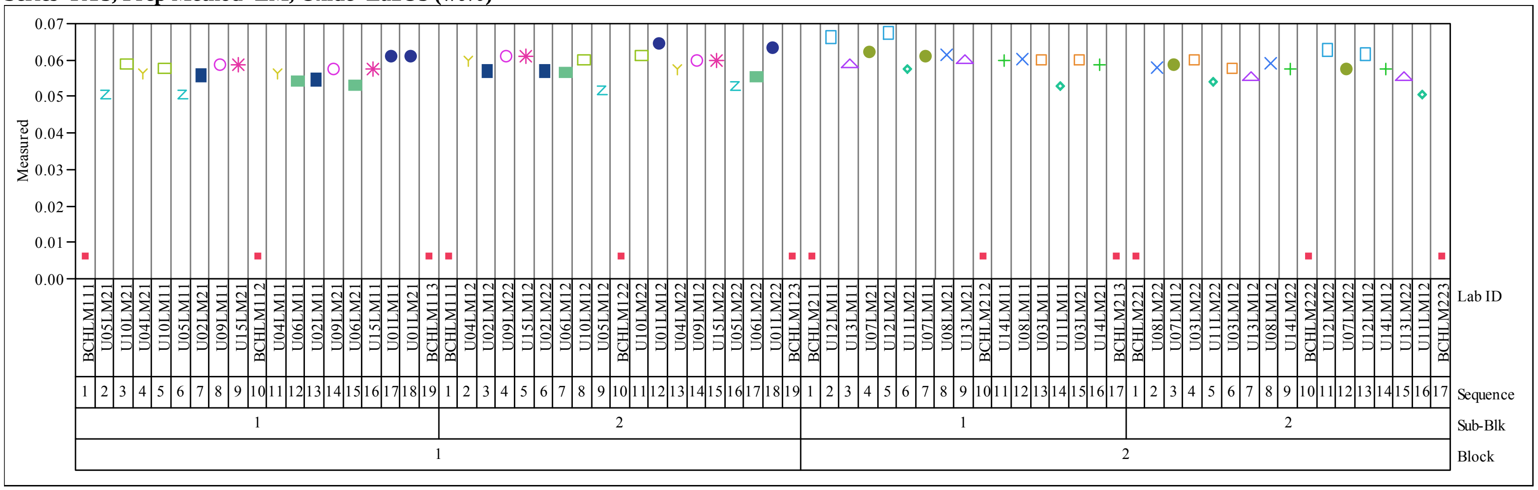


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=LM, Oxide=La2O3 (wt%)



Series=KT3, Prep Method=LM, Oxide=MgO (wt%)

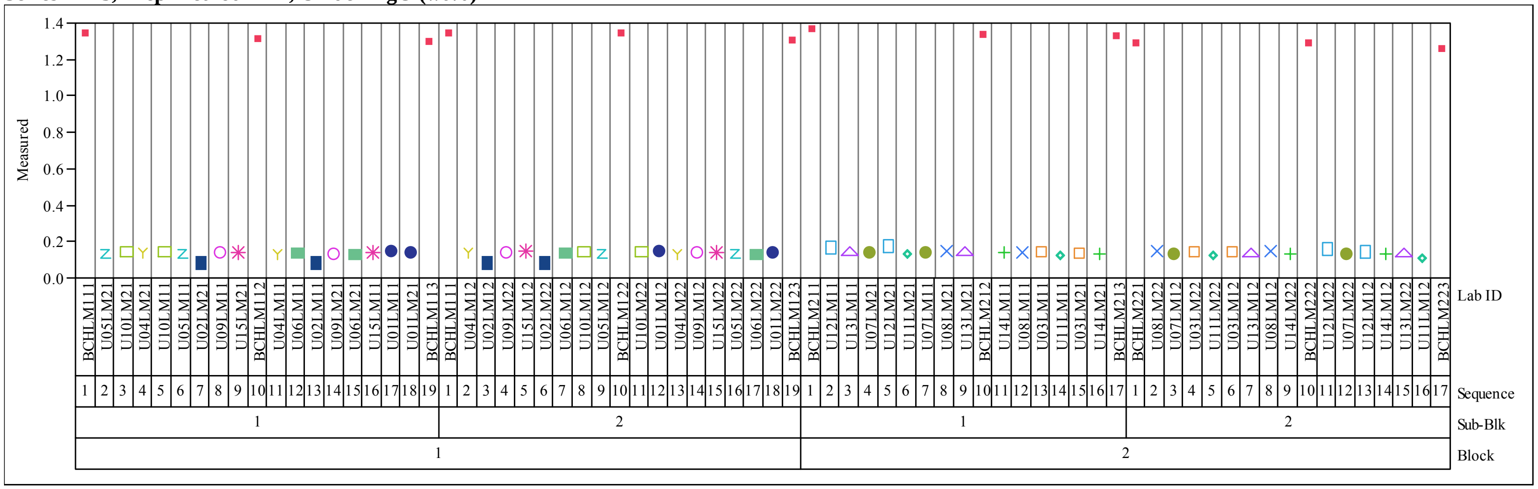
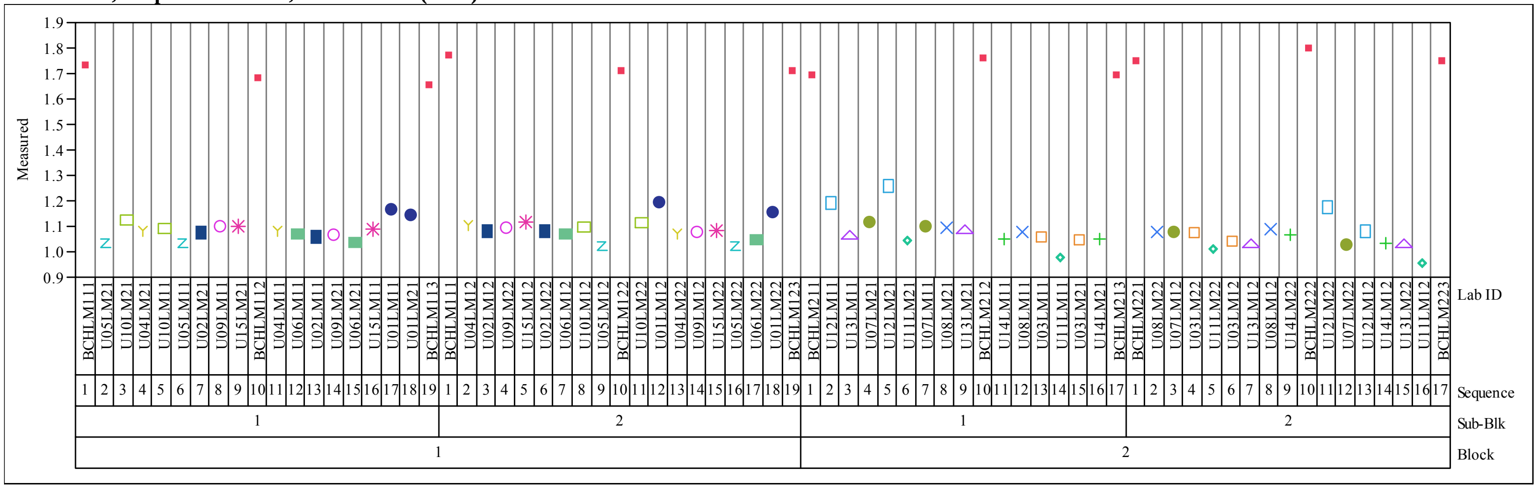


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=LM, Oxide=MnO (wt%)



Series=KT3, Prep Method=LM, Oxide=Na2O (wt%)

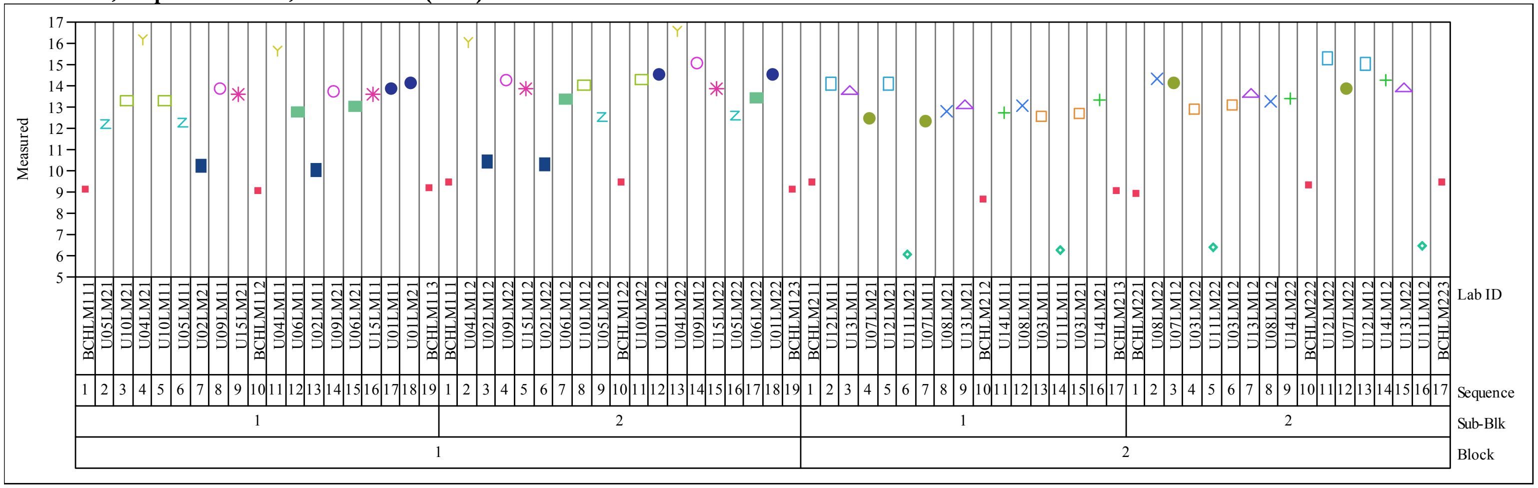
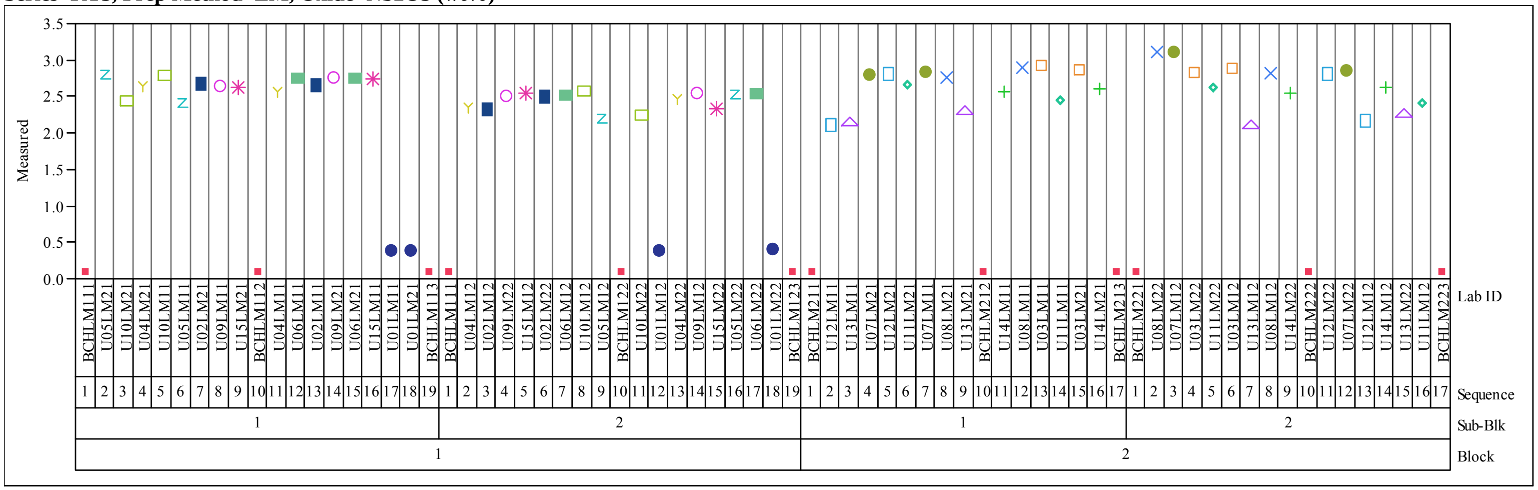


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=LM, Oxide=Nb2O5 (wt%)



Series=KT3, Prep Method=LM, Oxide=NiO (wt%)

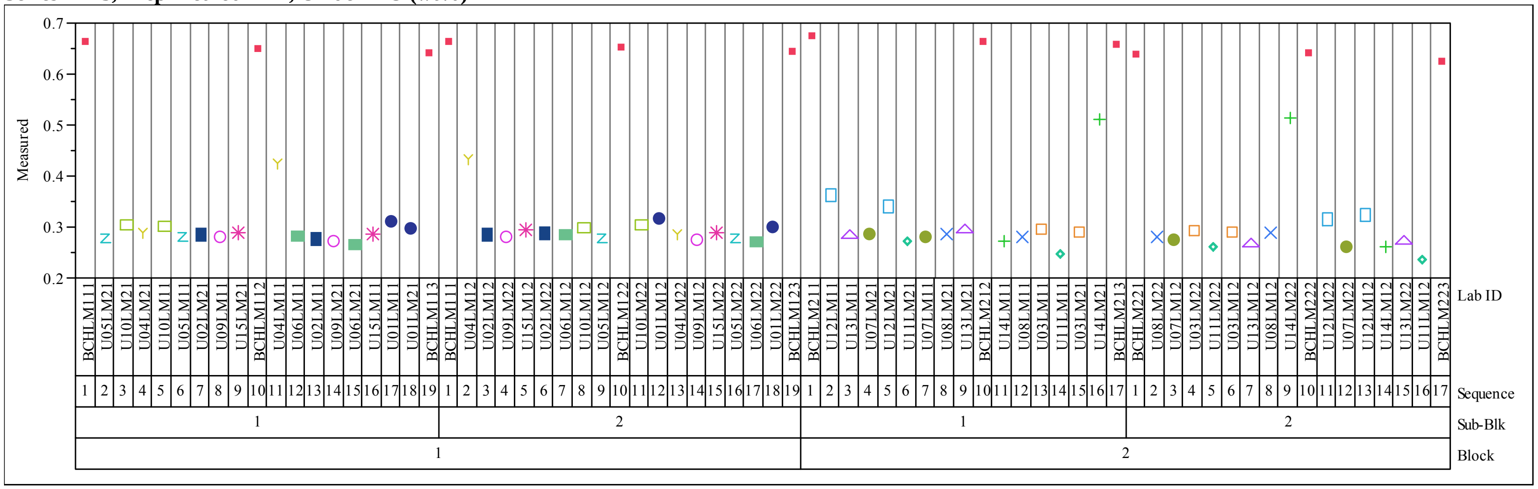
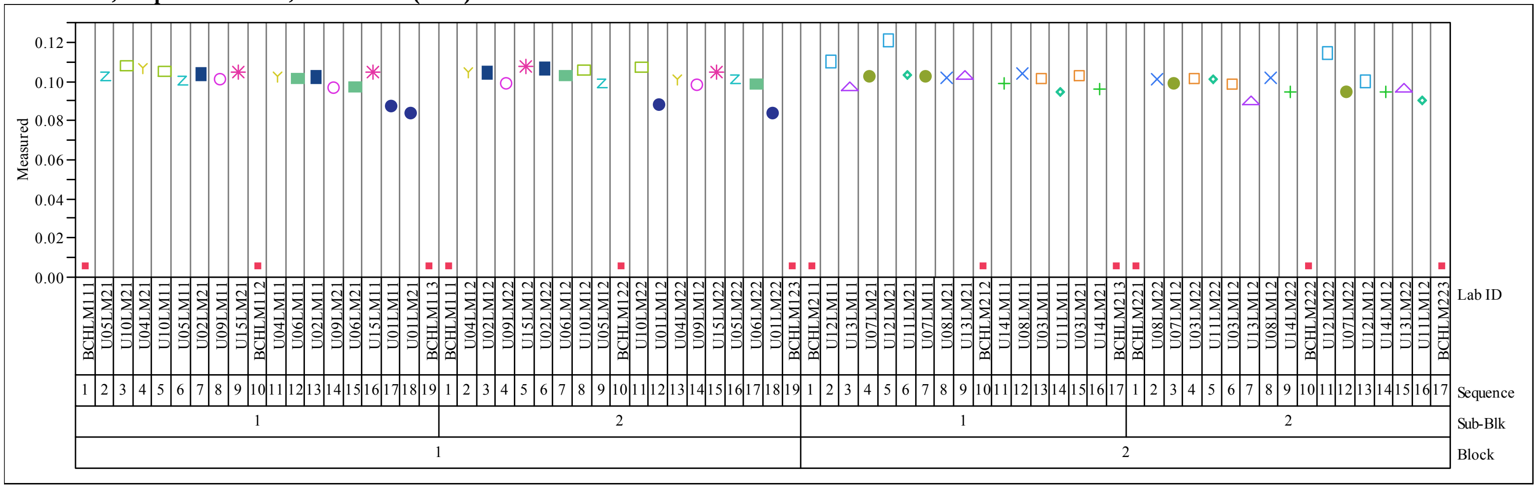


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=LM, Oxide=PbO (wt%)



Series=KT3, Prep Method=LM, Oxide=SO4 (wt%)

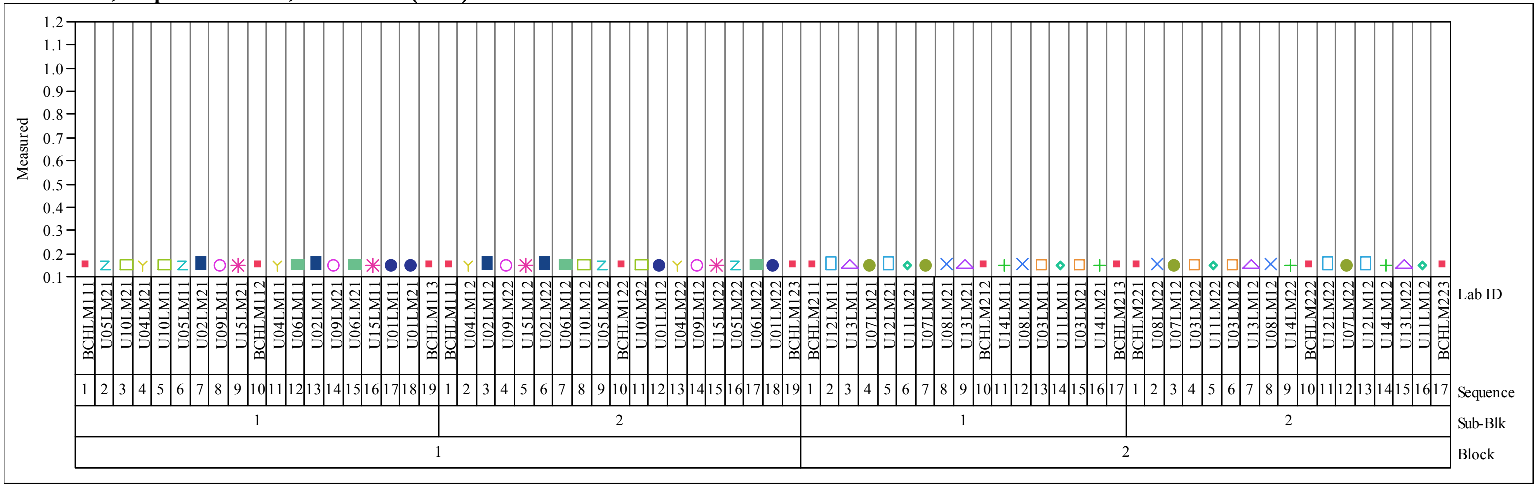
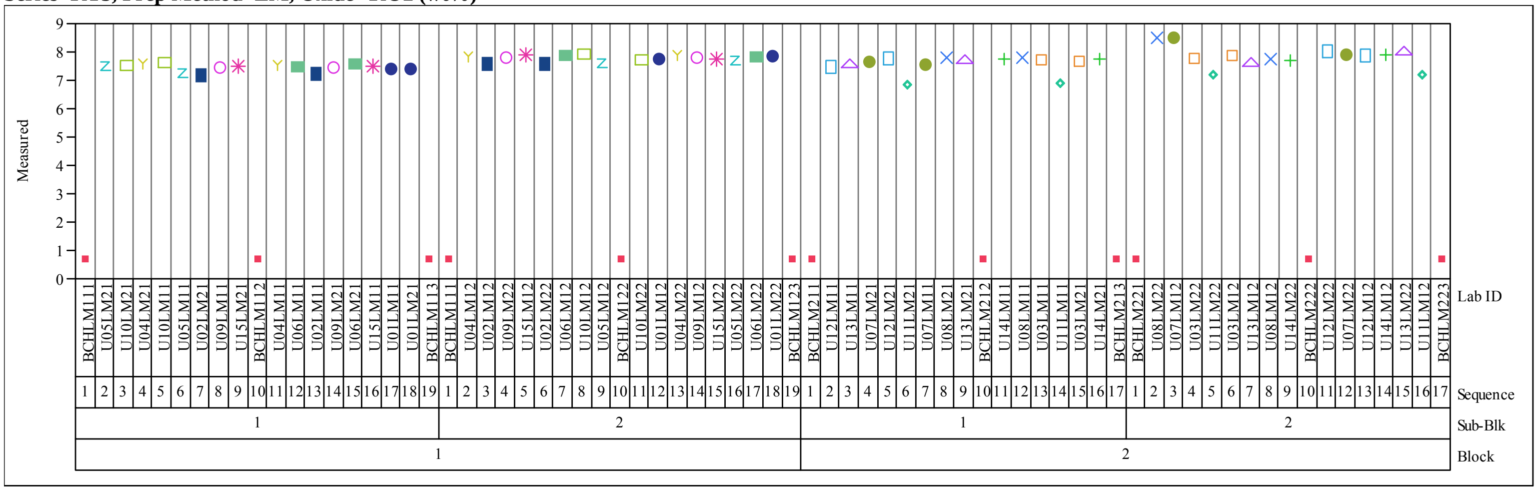


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=LM, Oxide=TiO2 (wt%)



Series=KT3, Prep Method=LM, Oxide=ZnO (wt%)

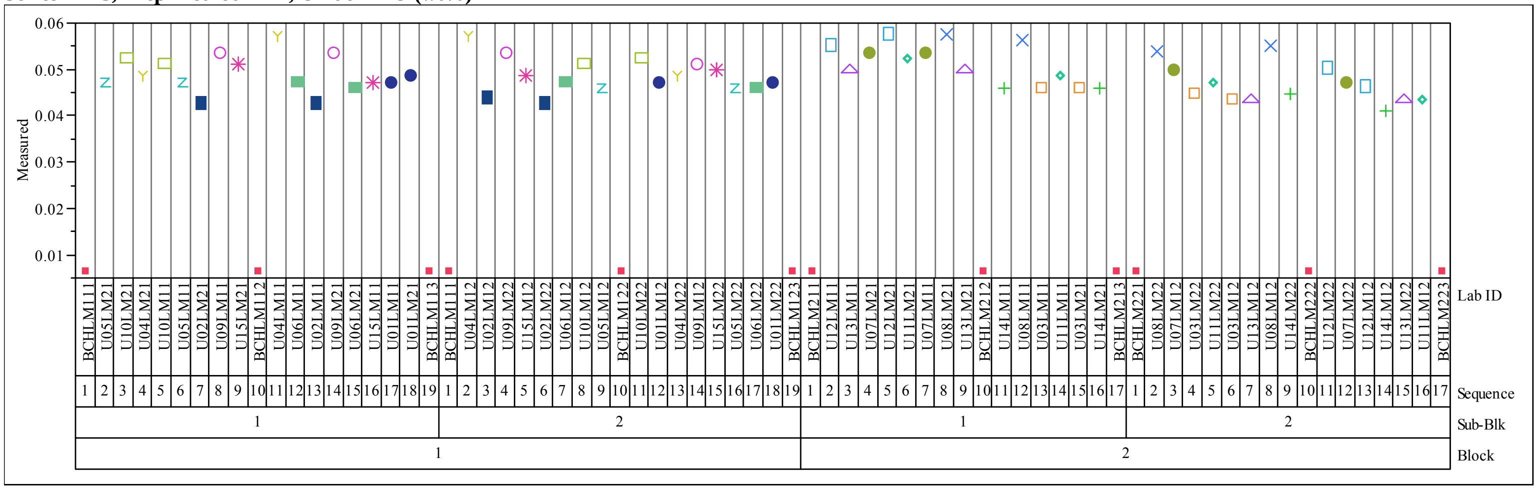
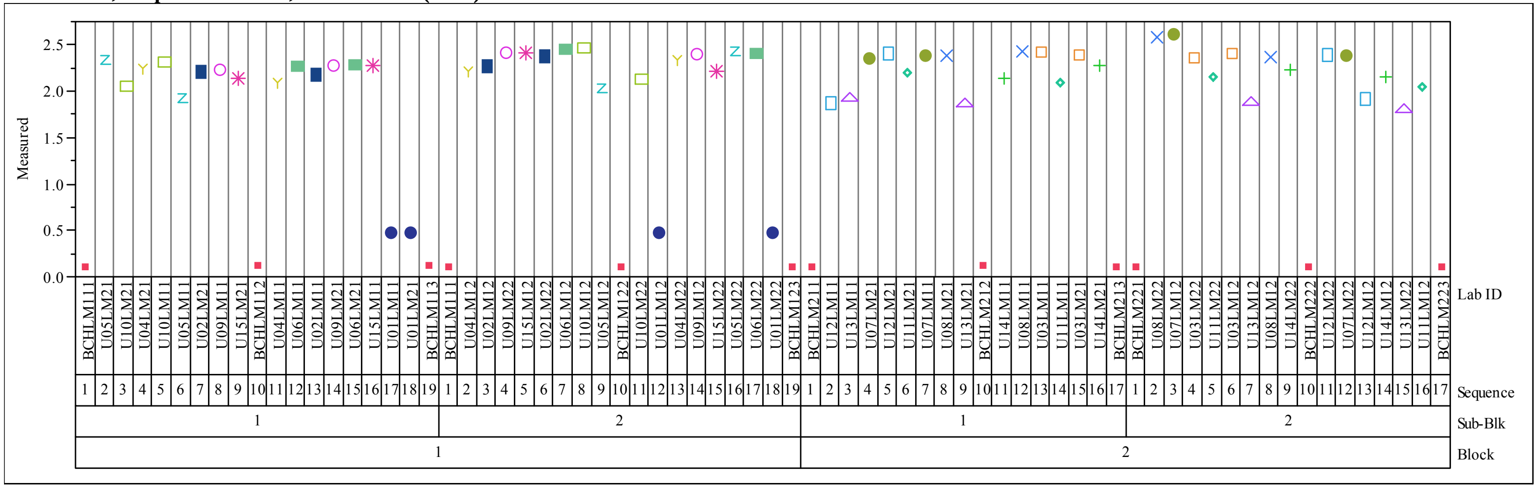


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=LM, Oxide=ZrO2 (wt%)



Series=KT3, Prep Method=PF, Oxide=Al2O3 (wt%)

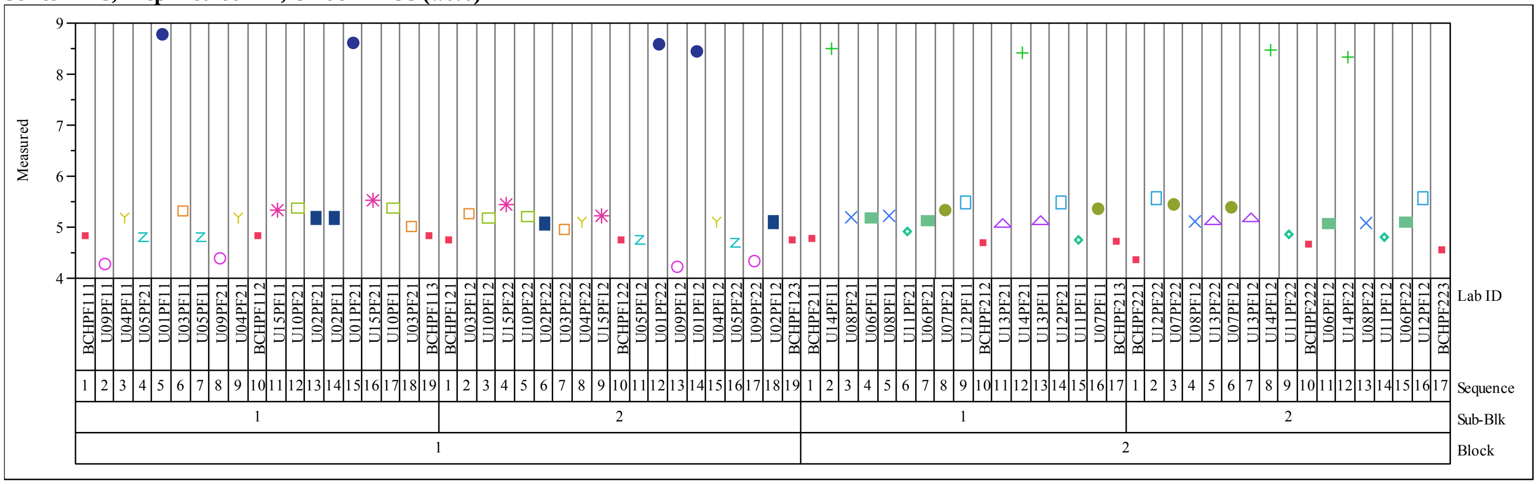
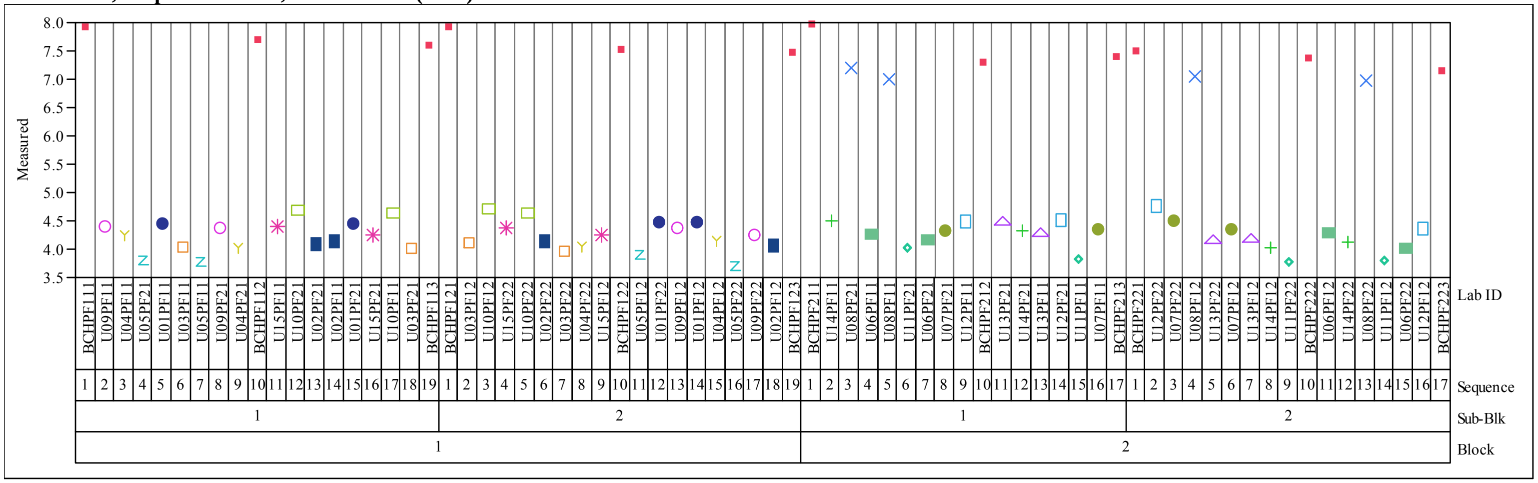


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=PF, Oxide=B2O3 (wt%)



Series=KT3, Prep Method=PF, Oxide=Fe2O3 (wt%)

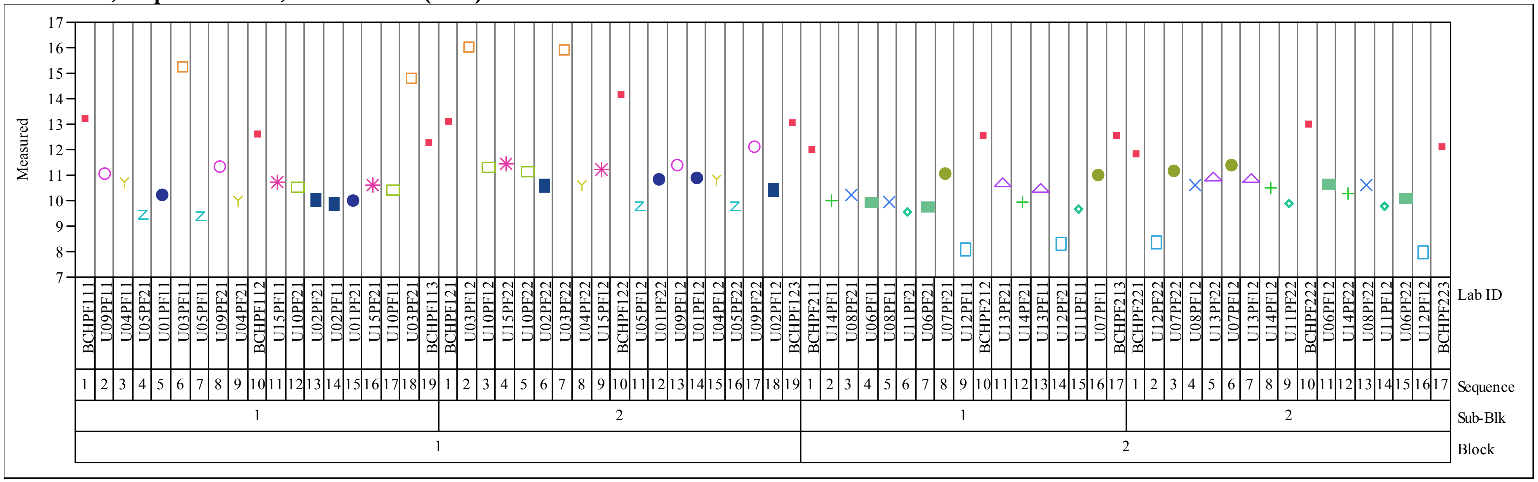
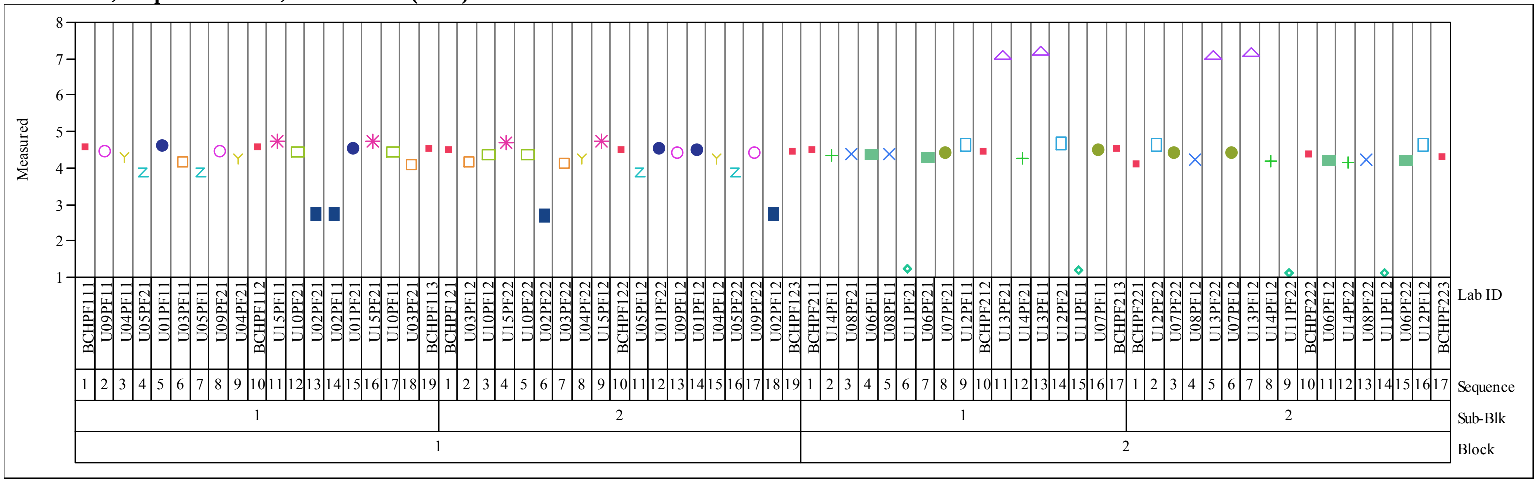


Exhibit B-1. Measurements in Analytical Sequence for KT03-Series by Preparation Method by Oxide. (continued)

Series=KT3, Prep Method=PF, Oxide=Li2O (wt%)



Series=KT3, Prep Method=PF, Oxide=SiO2 (wt%)

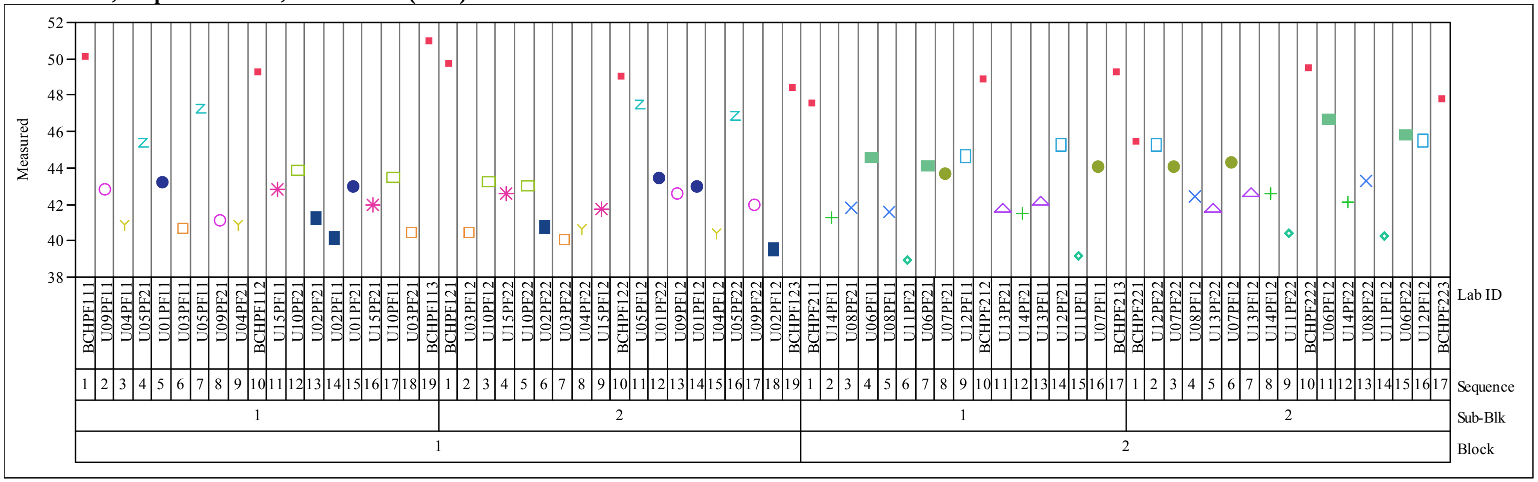
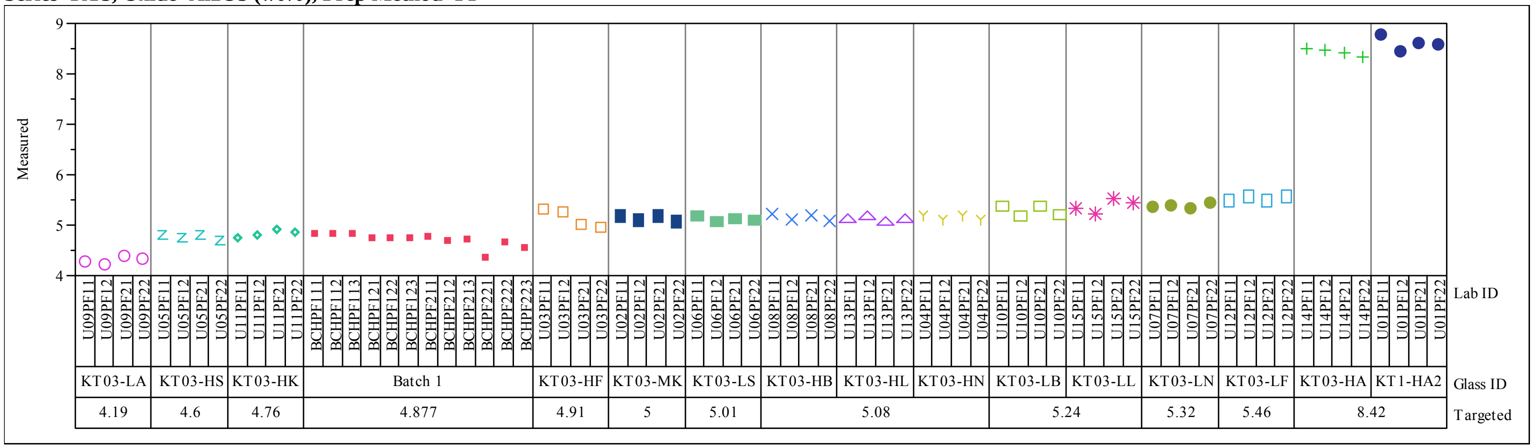


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide.

Series=KT3, Oxide=Al2O3 (wt%), Prep Method=PF



Series=KT3, Oxide=B2O3 (wt%), Prep Method=PF

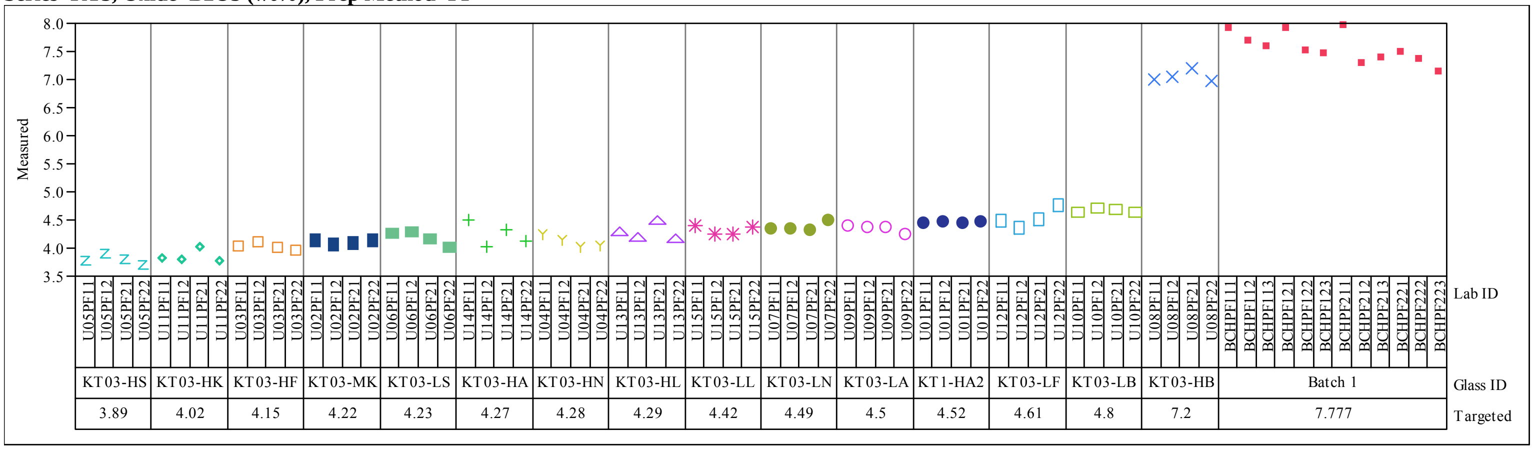
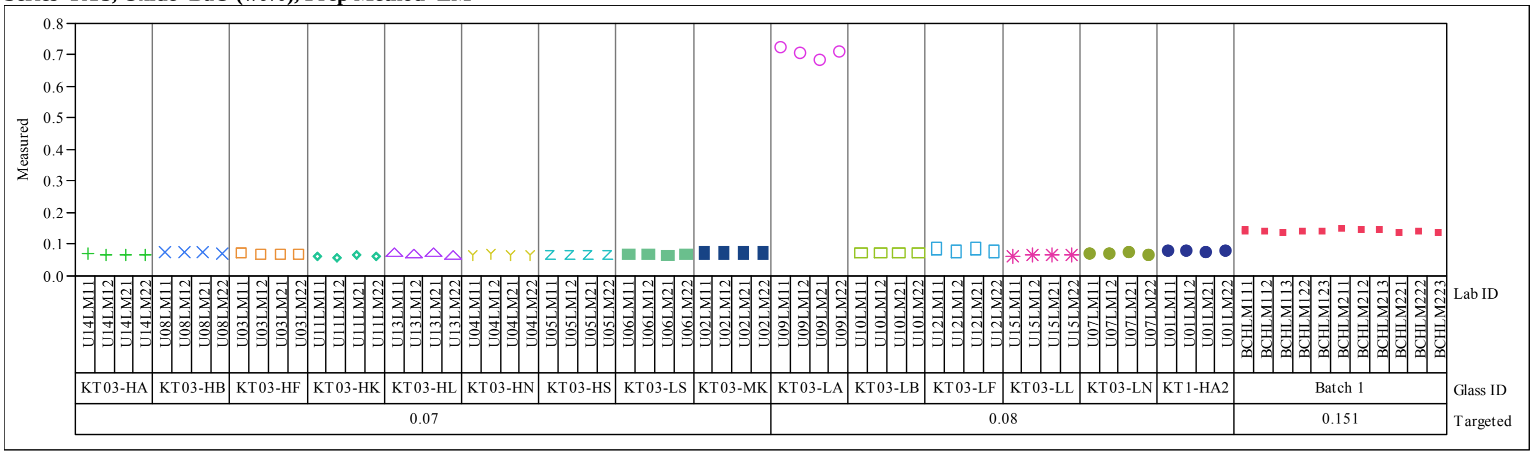


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=BaO (wt%), Prep Method=LM



Series=KT3, Oxide=CaO (wt%), Prep Method=LM

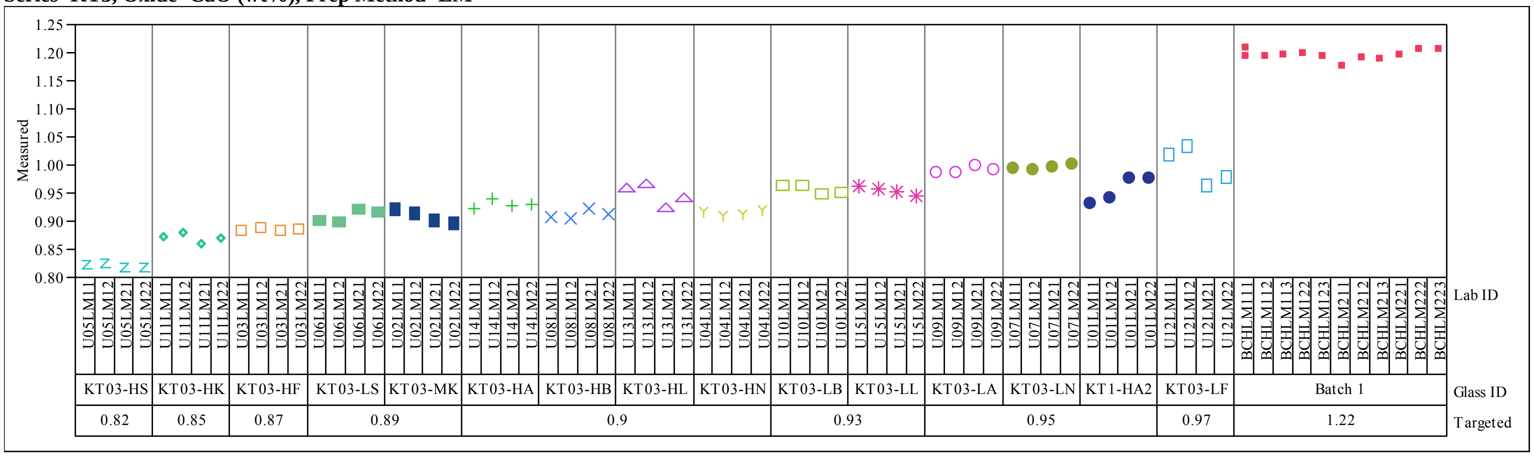
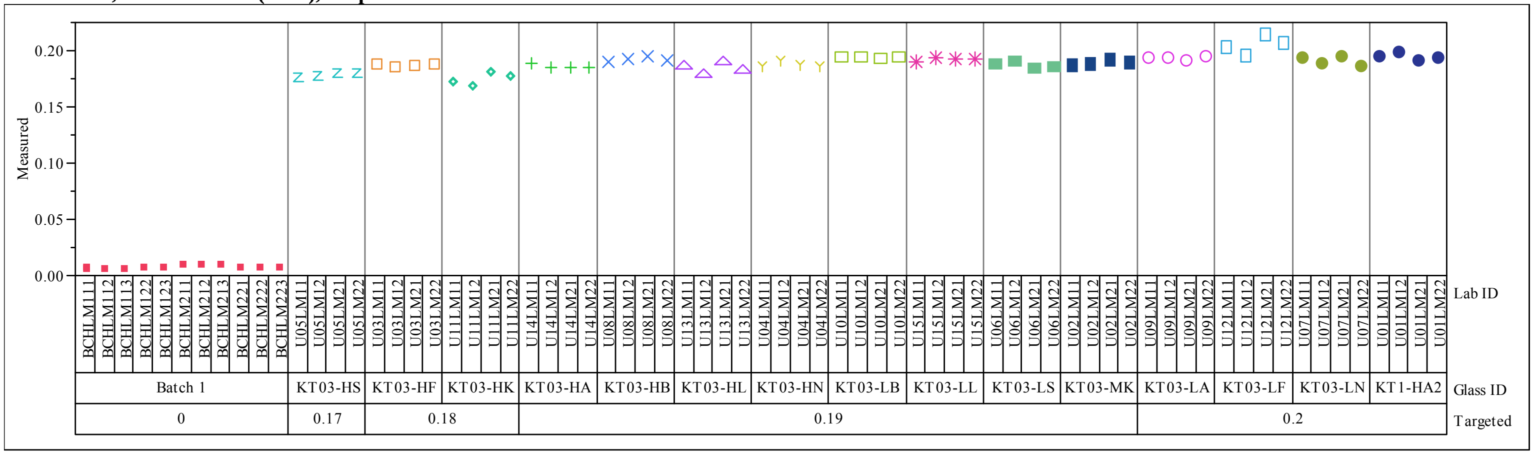


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=Ce2O3 (wt%), Prep Method=LM



Series=KT3, Oxide=Cr2O3 (wt%), Prep Method=LM

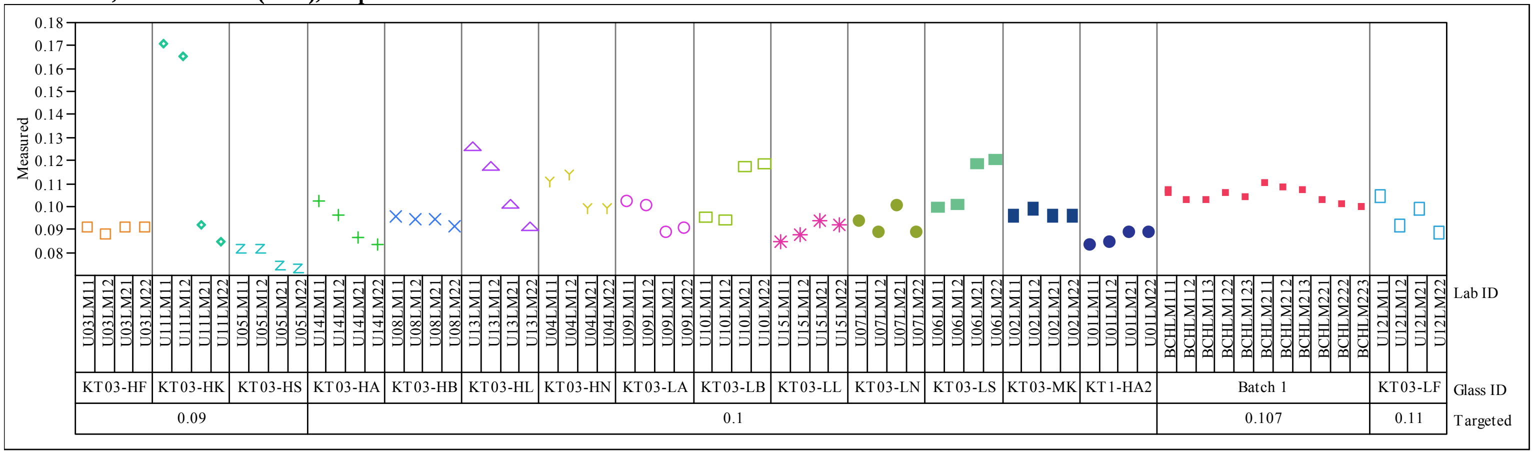
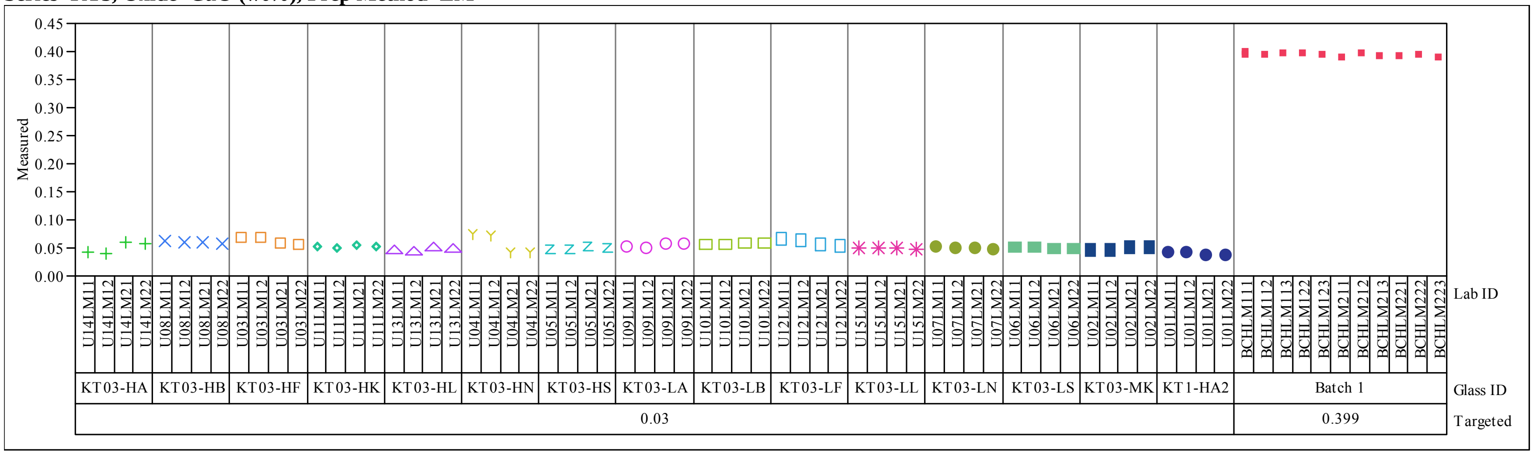


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=CuO (wt%), Prep Method=LM



Series=KT3, Oxide=Fe2O3 (wt%), Prep Method=PF

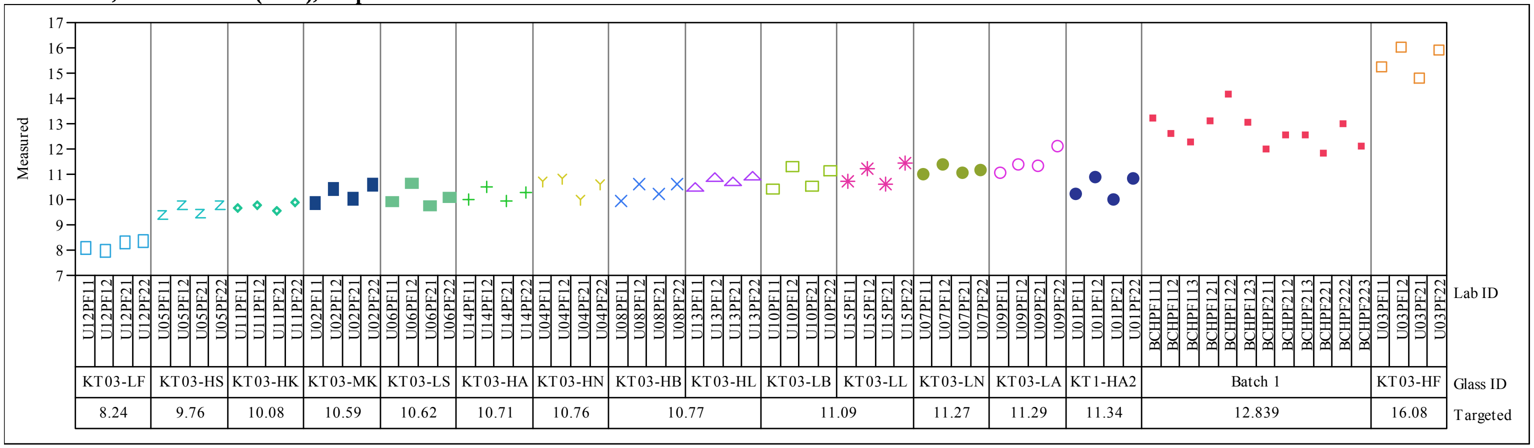
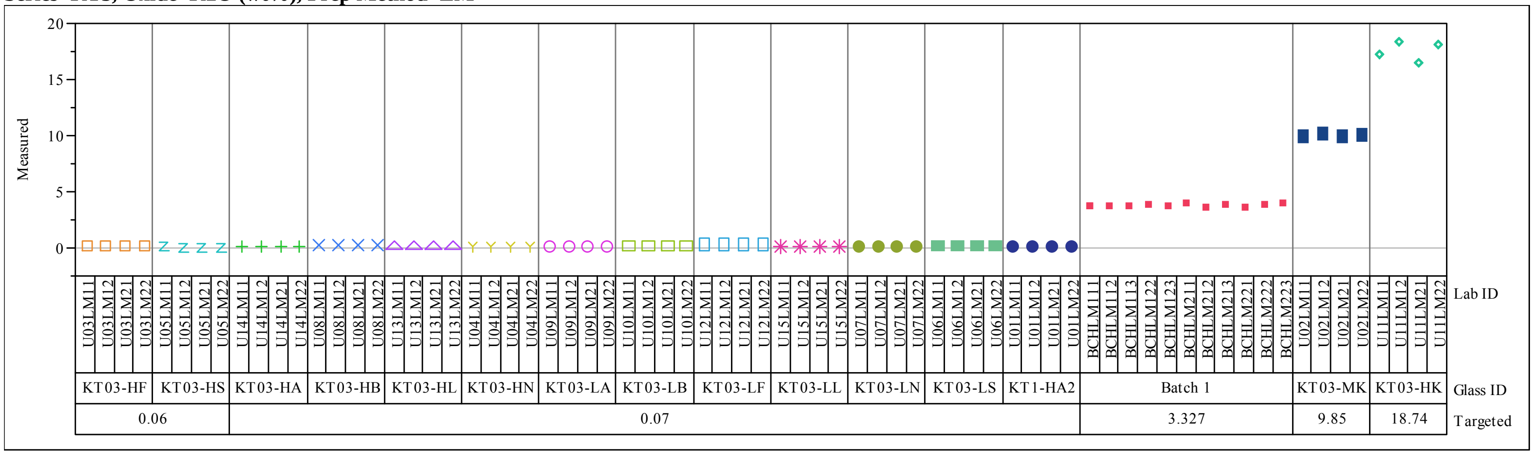


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=K2O (wt%), Prep Method=LM



Series=KT3, Oxide=La2O3 (wt%), Prep Method=LM

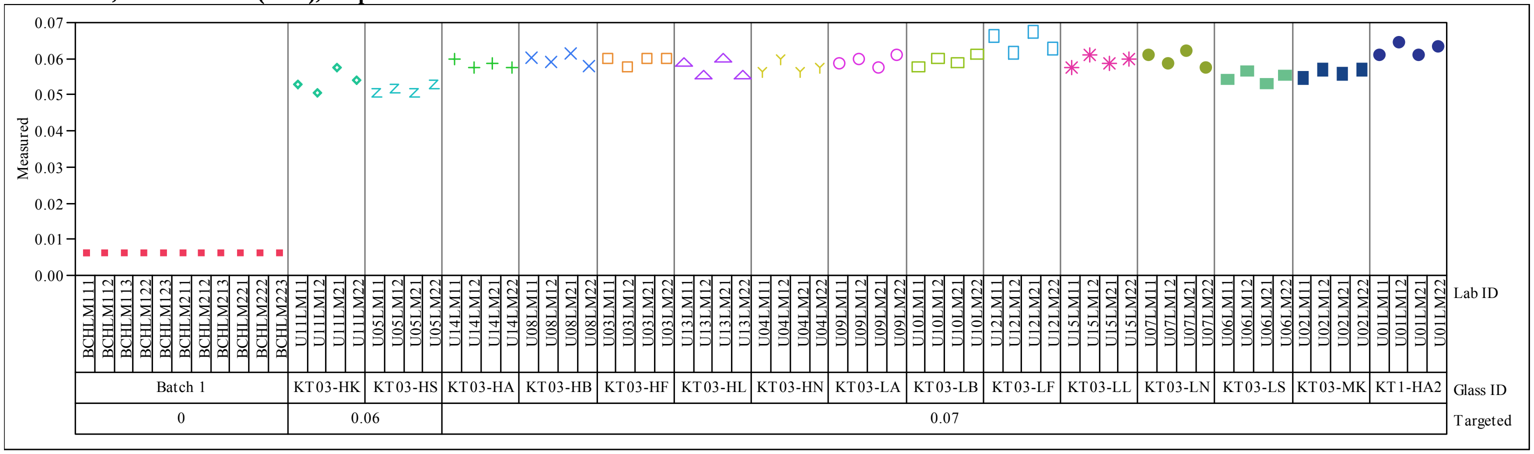
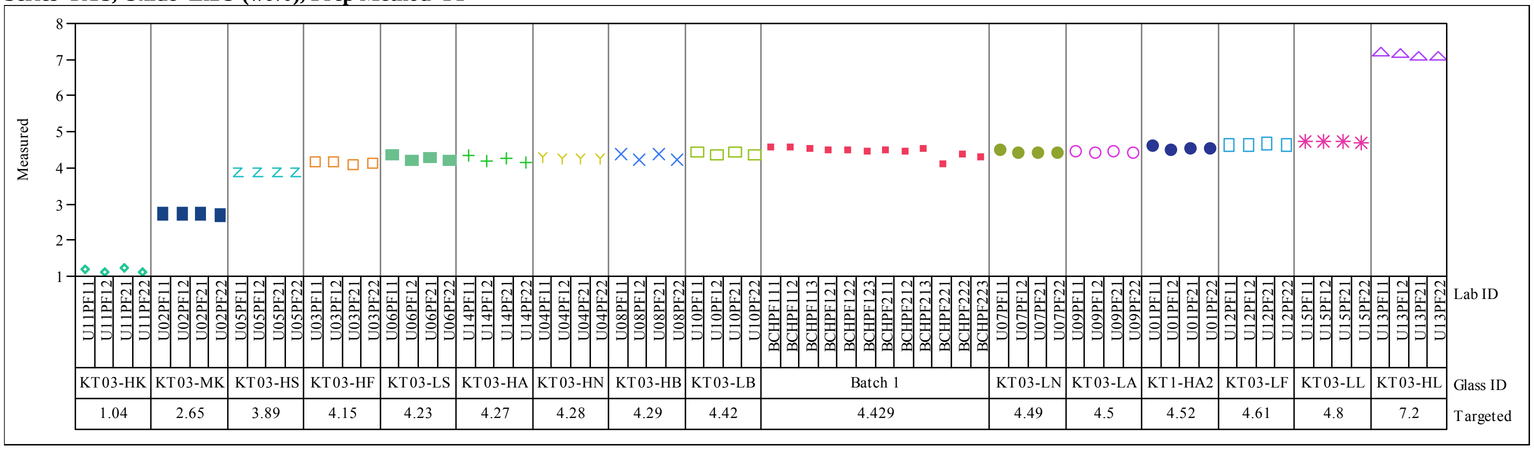


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=Li2O (wt%), Prep Method=PF



Series=KT3, Oxide=MgO (wt%), Prep Method=LM

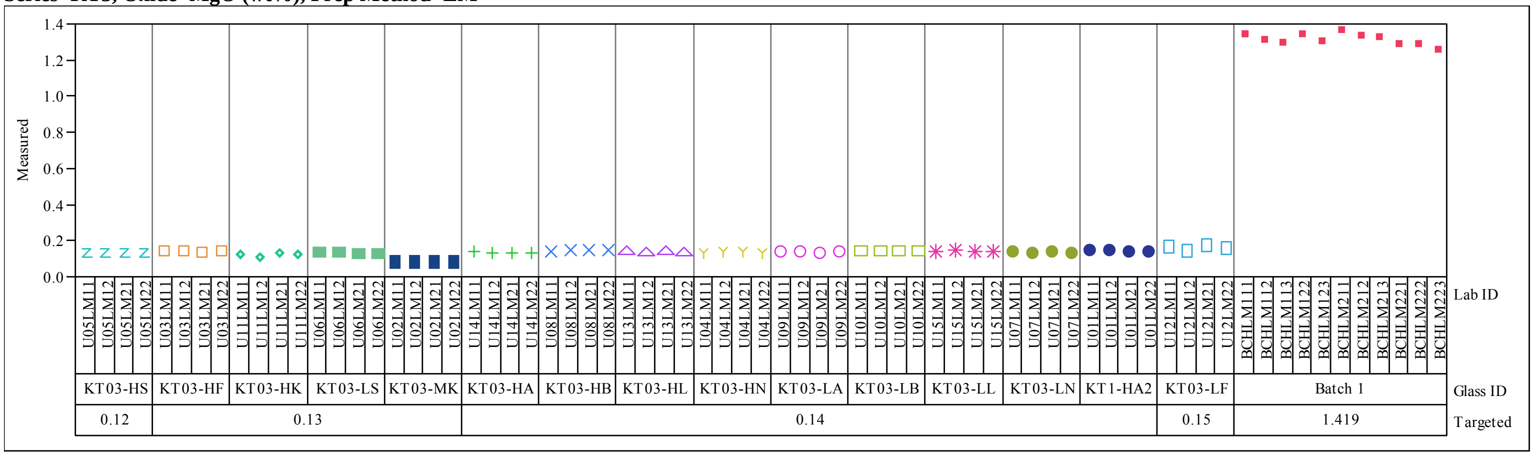
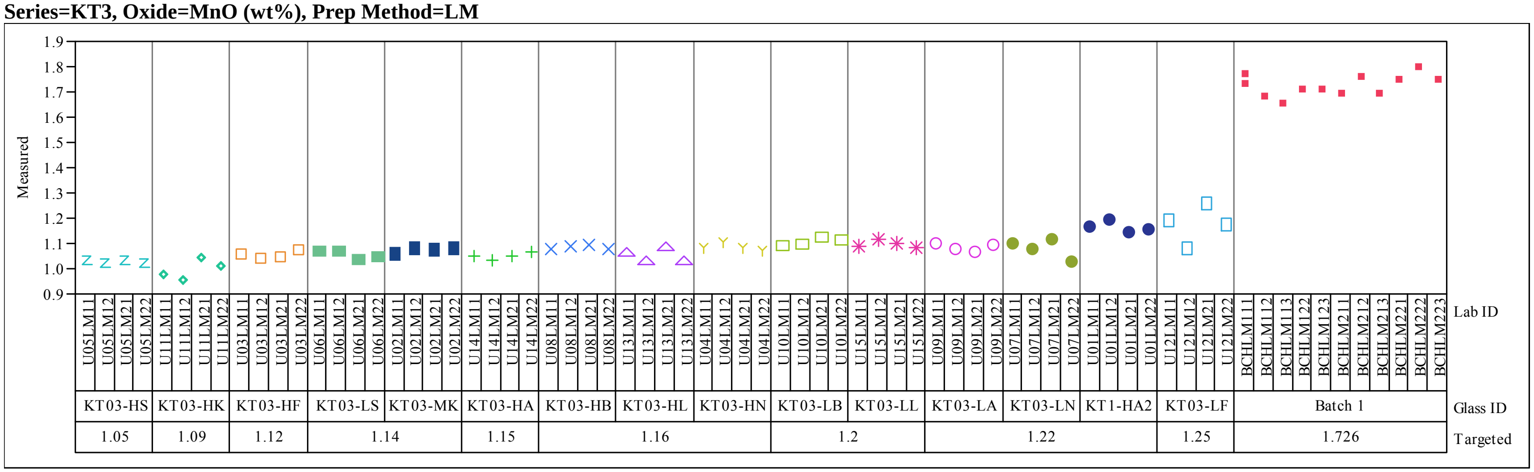


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=MnO (wt%), Prep Method=LM



Series=KT3, Oxide=Na2O (wt%), Prep Method=LM

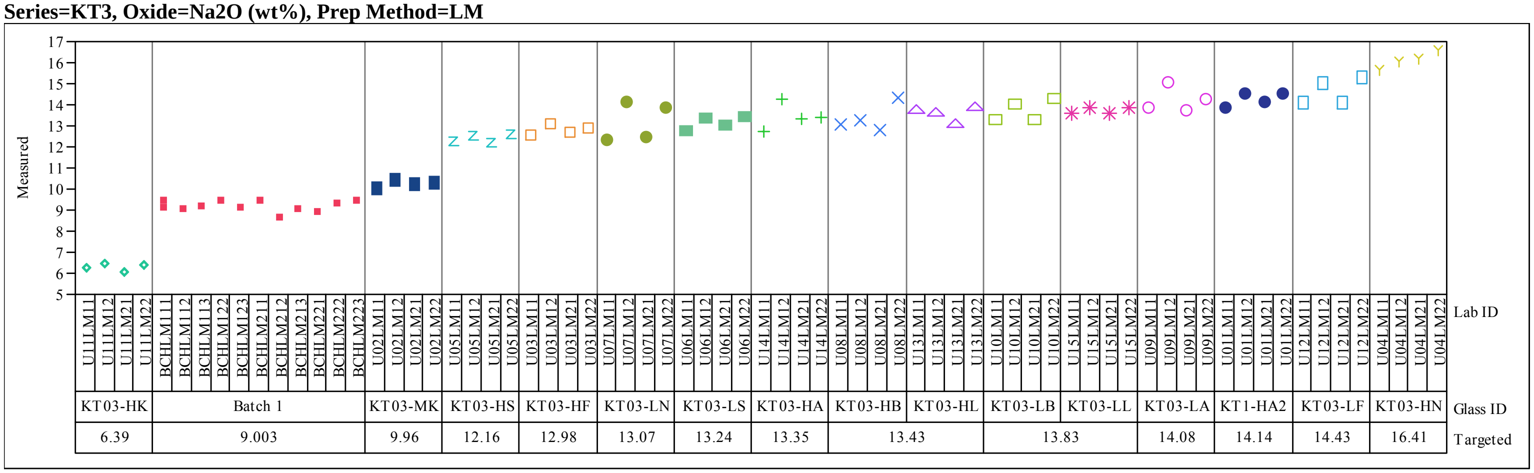
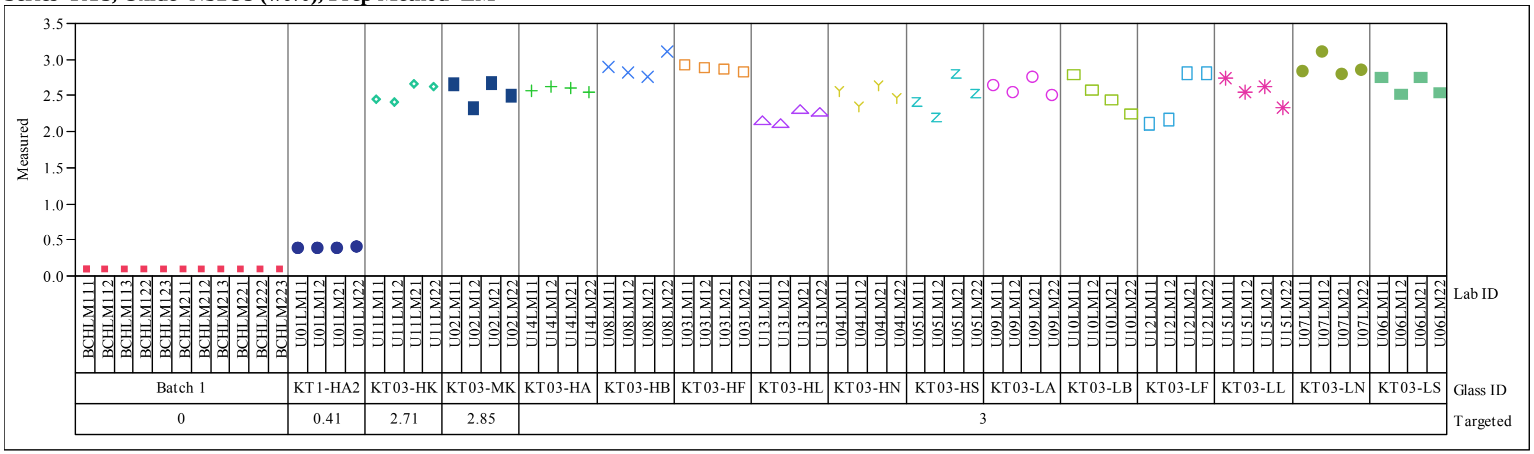


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=Nb2O5 (wt%), Prep Method=LM



Series=KT3, Oxide=NiO (wt%), Prep Method=LM

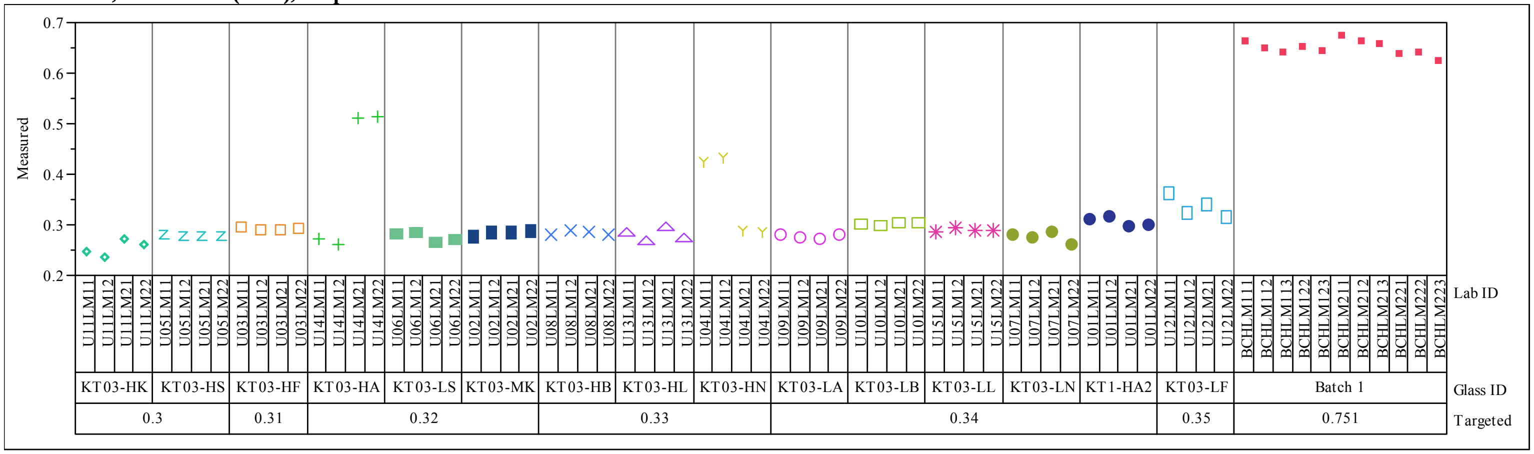
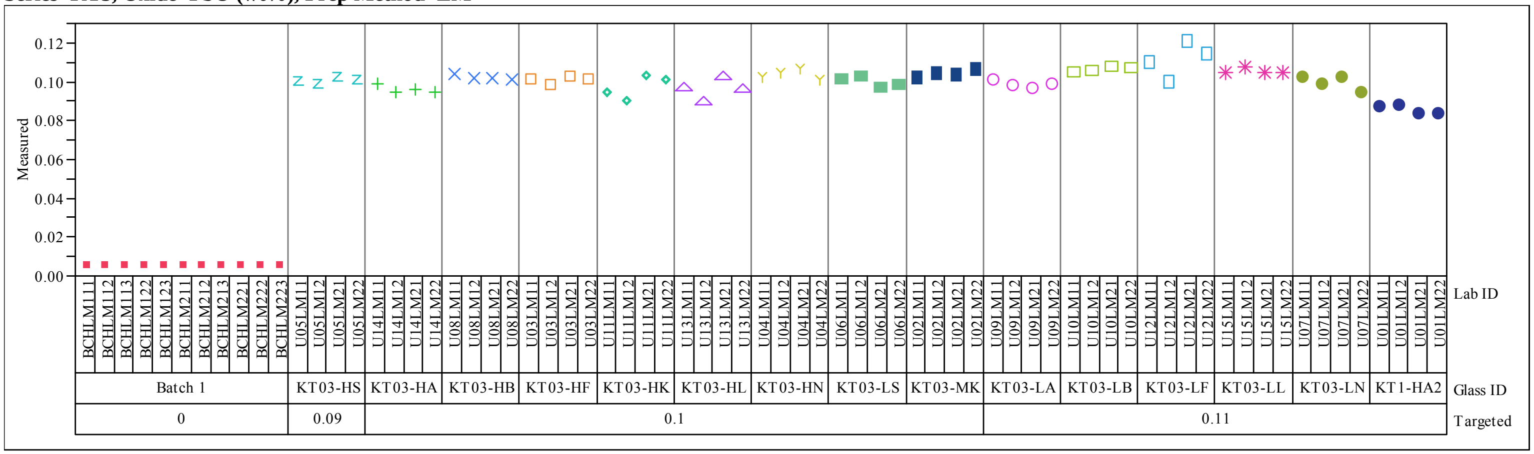


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=PbO (wt%), Prep Method=LM



Series=KT3, Oxide=SiO2 (wt%), Prep Method=PF

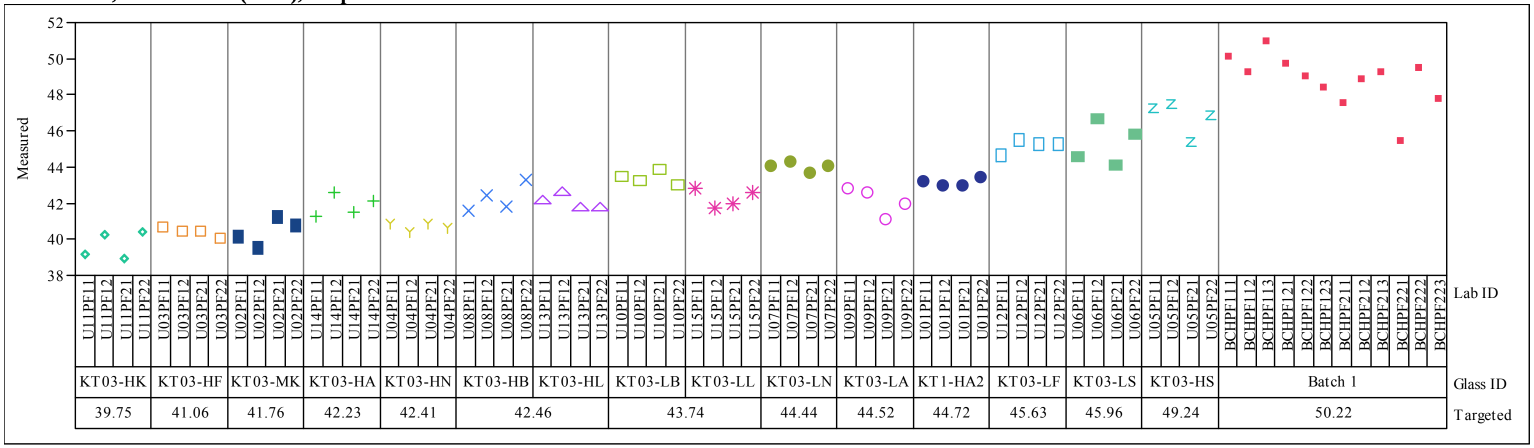
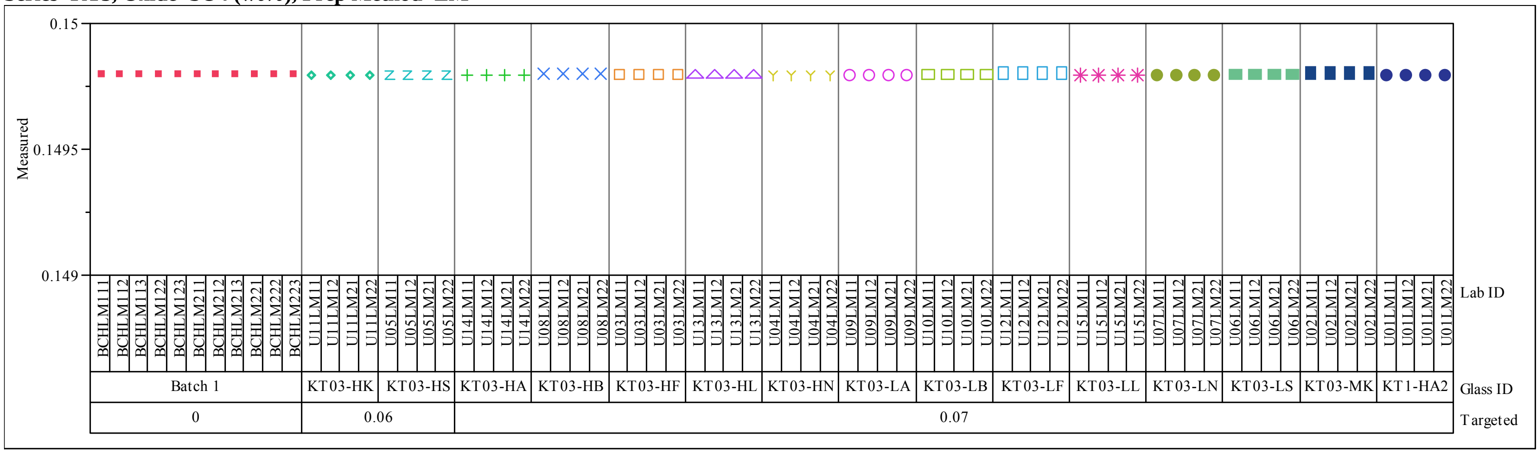


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=SO4 (wt%), Prep Method=LM



Series=KT3, Oxide=TiO2 (wt%), Prep Method=LM

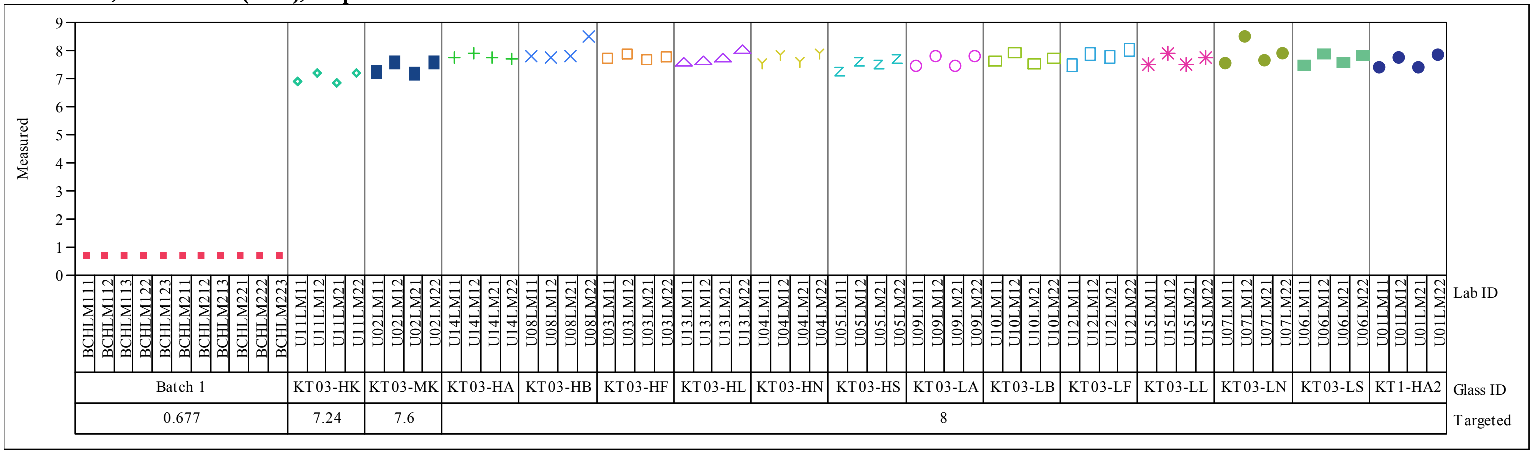
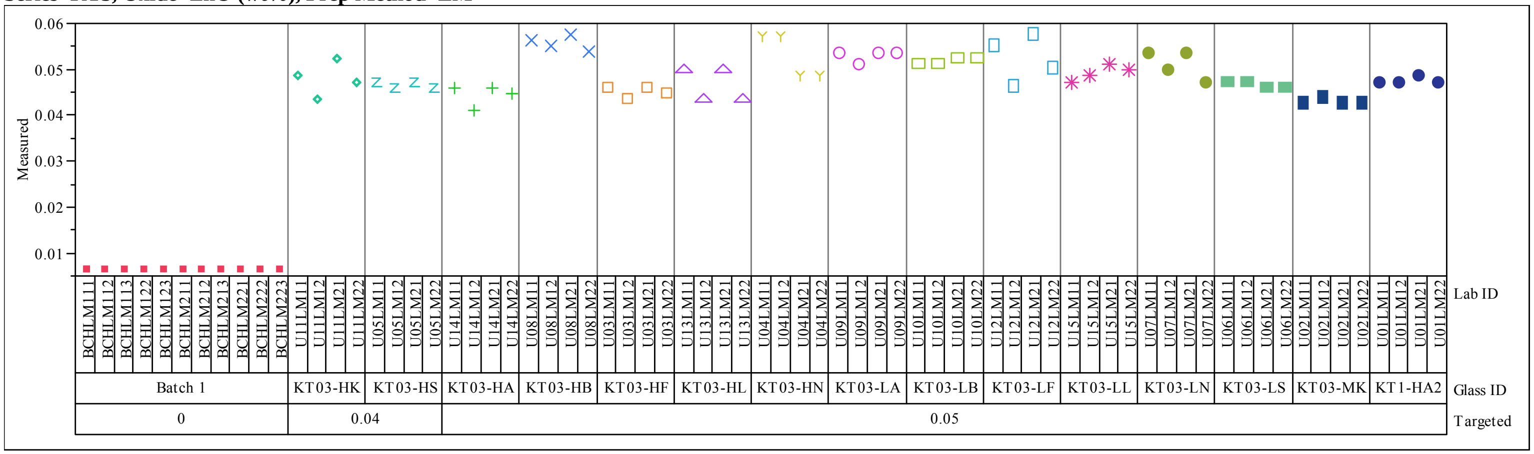


Exhibit B-2 Measurements for Each KT03-Series Glass ID by Preparation Method by Oxide. (continued)

Series=KT3, Oxide=ZnO (wt%), Prep Method=LM



Series=KT3, Oxide=ZrO2 (wt%), Prep Method=LM

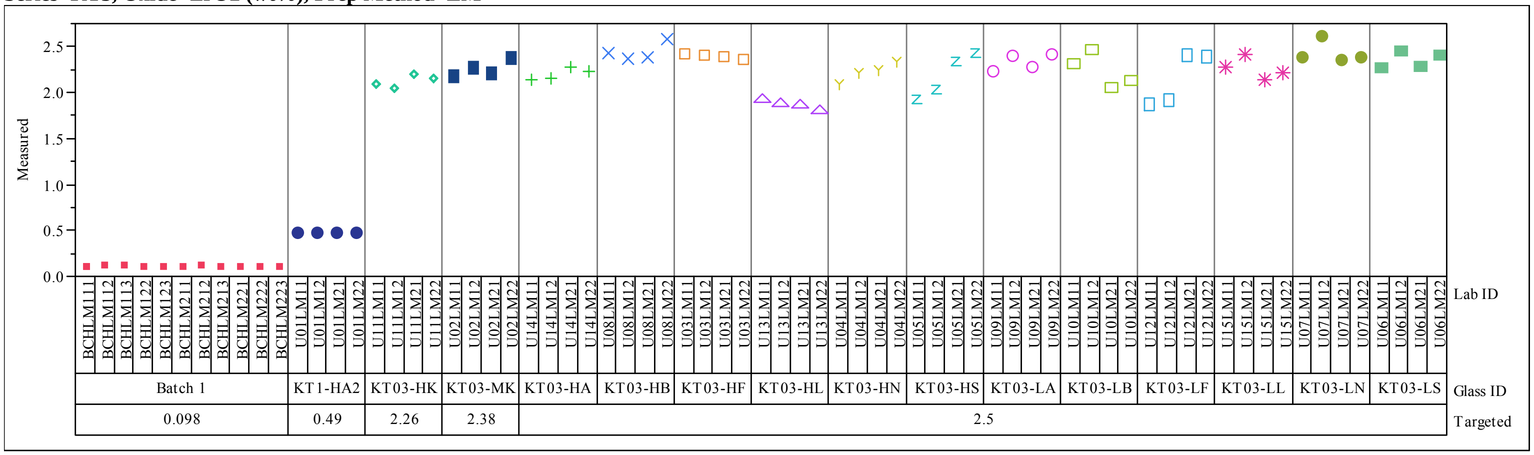
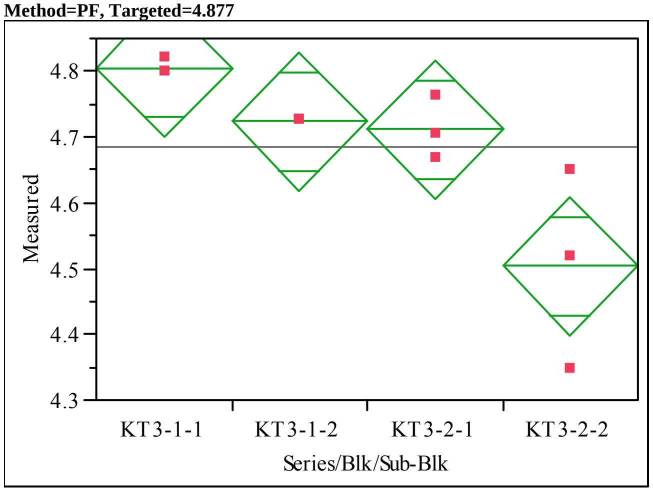


Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide.

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=Al2O3 (wt%), Prep Method=PF, Targeted=4.877



Oneway Anova
Summary of Fit

Rsquare	0.746429
Adj Rsquare	0.651339
Root Mean Square Error	0.079606
Mean of Response	4.68596
Observations (or Sum Wgts)	12

Analysis of Variance

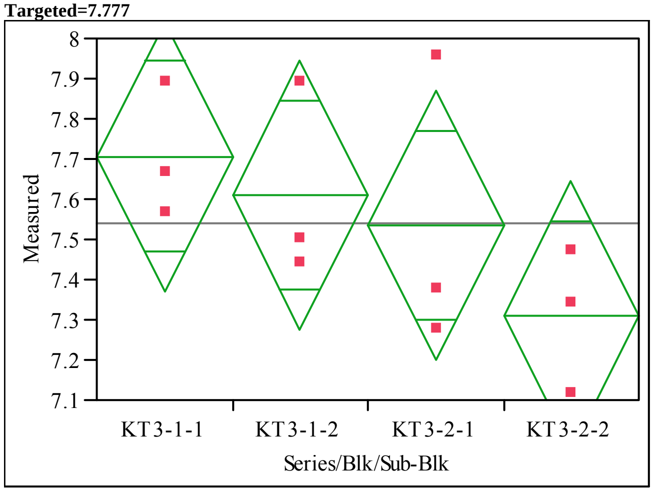
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.14923479	0.049745	7.8498	0.0091
Error	8	0.05069699	0.006337		
C. Total	11	0.19993177			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	4.80563	0.04596	4.6996	4.9116
KT3-1-2	3	4.72375	0.04596	4.6178	4.8297
KT3-2-1	3	4.71115	0.04596	4.6052	4.8171
KT3-2-2	3	4.50331	0.04596	4.3973	4.6093

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=B2O3 (wt%), Prep Method=PF, Targeted=7.777



Oneway Anova
Summary of Fit

Rsquare	0.337562
Adj Rsquare	0.089148
Root Mean Square Error	0.25131
Mean of Response	7.539933
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.25746594	0.085822	1.3589	0.3229
Error	8	0.50525531	0.063157		
C. Total	11	0.76272125			

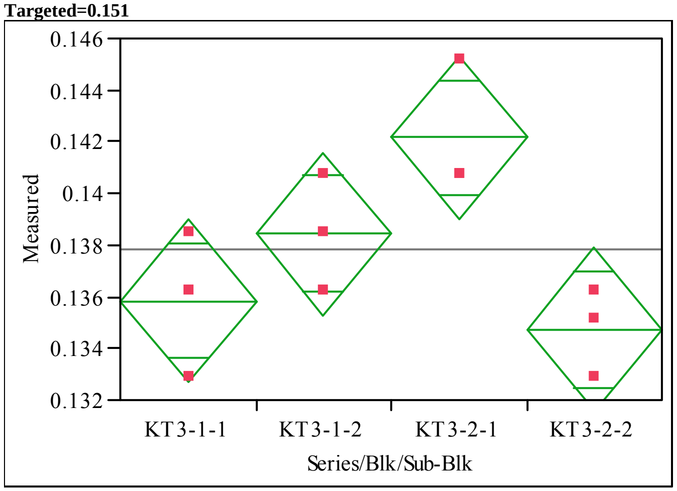
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	7.70629	0.14509	7.3717	8.0409
KT3-1-2	3	7.60970	0.14509	7.2751	7.9443
KT3-2-1	3	7.53457	0.14509	7.2000	7.8692
KT3-2-2	3	7.30917	0.14509	6.9746	7.6438

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=BaO (wt%), Prep Method=LM, Targeted=0.151



Oneway Anova
Summary of Fit

Rsquare	0.68673
Adj Rsquare	0.569253
Root Mean Square Error	0.002368
Mean of Response	0.137795
Observations (or Sum Wgts)	12

Analysis of Variance

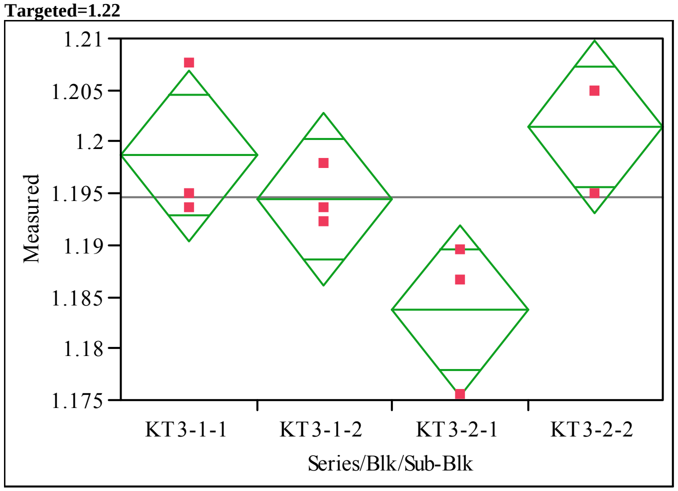
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00009838	0.000033	5.8457	0.0205
Error	8	0.00004488	5.61e-6		
C. Total	11	0.00014325			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.135841	0.00137	0.13269	0.13899
KT3-1-2	3	0.138446	0.00137	0.13529	0.14160
KT3-2-1	3	0.142168	0.00137	0.13901	0.14532
KT3-2-2	3	0.134724	0.00137	0.13157	0.13788

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=CaO (wt%), Prep Method=LM, Targeted=1.22



Oneway Anova
Summary of Fit

Rsquare	0.637822
Adj Rsquare	0.502006
Root Mean Square Error	0.006218
Mean of Response	1.194567
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00054475	0.000182	4.6962	0.0357
Error	8	0.00030933	0.000039		
C. Total	11	0.00085407			

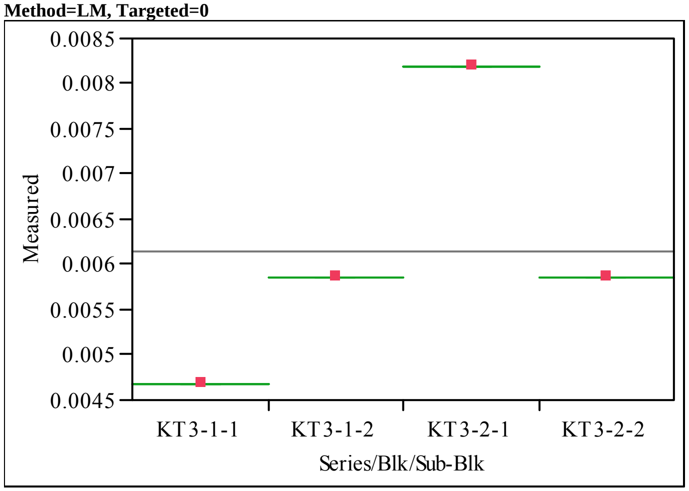
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	1.19865	0.00359	1.1904	1.2069
KT3-1-2	3	1.19445	0.00359	1.1862	1.2027
KT3-2-1	3	1.18372	0.00359	1.1754	1.1920
KT3-2-2	3	1.20145	0.00359	1.1932	1.2097

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=Ce2O3 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	1
Adj Rsquare	1
Root Mean Square Error	2.06e-11
Mean of Response	0.006149
Observations (or Sum Wgts)	12

Analysis of Variance

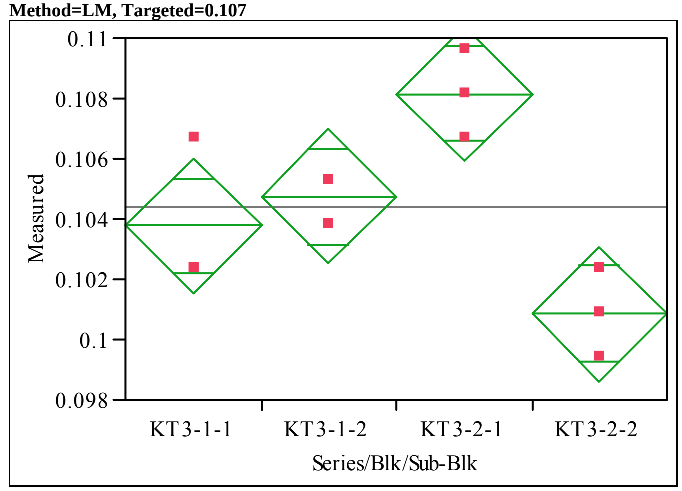
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001955	6.5167e-6	1.54e+16	<.0001
Error	8	3.3881e-21	4.235e-22		
C. Total	11	0.00001955			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.004685	1.188e-11	0.00469	0.00469
KT3-1-2	3	0.005857	1.188e-11	0.00586	0.00586
KT3-2-1	3	0.008199	1.188e-11	0.00820	0.00820
KT3-2-2	3	0.005857	1.188e-11	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=Cr2O3 (wt%), Prep Method=LM, Targeted=0.107



Oneway Anova
Summary of Fit

Rsquare	0.781942
Adj Rsquare	0.70017
Root Mean Square Error	0.001688
Mean of Response	0.104383
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00008171	0.000027	9.5625	0.0051
Error	8	0.00002279	2.848e-6		
C. Total	11	0.00010450			

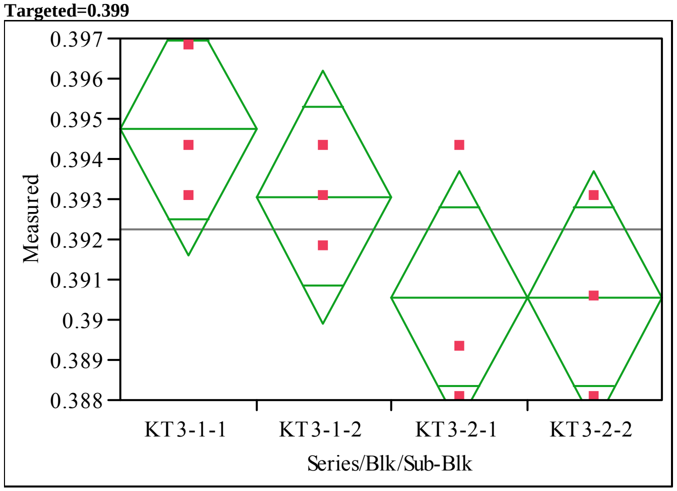
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.103774	0.00097	0.10153	0.10602
KT3-1-2	3	0.104748	0.00097	0.10250	0.10699
KT3-2-1	3	0.108158	0.00097	0.10591	0.11041
KT3-2-2	3	0.100850	0.00097	0.09860	0.10310

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=CuO (wt%), Prep Method=LM, Targeted=0.399



Oneway Anova
Summary of Fit

Rsquare	0.455696
Adj Rsquare	0.251582
Root Mean Square Error	0.00237
Mean of Response	0.392231
Observations (or Sum Wgts)	12

Analysis of Variance

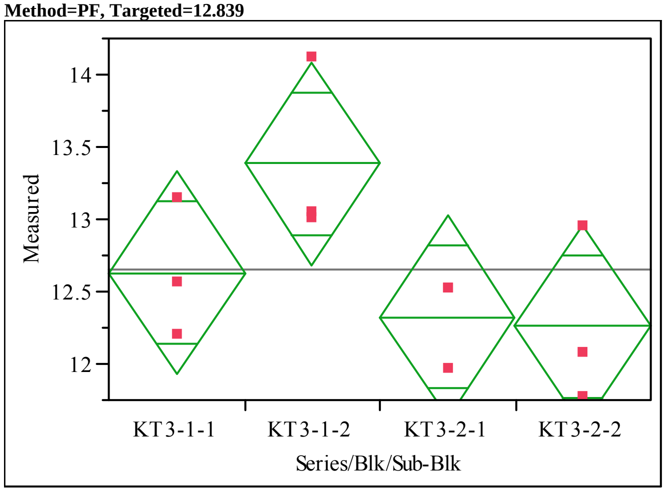
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00003761	0.000013	2.2326	0.1618
Error	8	0.00004492	5.615e-6		
C. Total	11	0.00008253			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.394734	0.00137	0.39158	0.39789
KT3-1-2	3	0.393065	0.00137	0.38991	0.39622
KT3-2-1	3	0.390562	0.00137	0.38741	0.39372
KT3-2-2	3	0.390562	0.00137	0.38741	0.39372

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=Fe2O3 (wt%), Prep Method=PF, Targeted=12.839



Oneway Anova
Summary of Fit

Rsquare	0.520567
Adj Rsquare	0.34078
Root Mean Square Error	0.524559
Mean of Response	12.64808
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	2.3901666	0.796722	2.8955	0.1019
Error	8	2.2012971	0.275162		
C. Total	11	4.5914636			

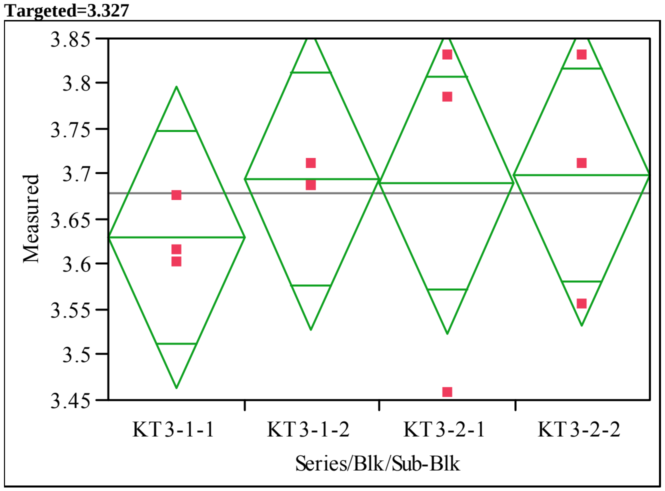
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	12.6290	0.30285	11.931	13.327
KT3-1-2	3	13.3820	0.30285	12.684	14.080
KT3-2-1	3	12.3240	0.30285	11.626	13.022
KT3-2-2	3	12.2573	0.30285	11.559	12.956

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=K2O (wt%), Prep Method=LM, Targeted=3.327



Oneway Anova
Summary of Fit

Rsquare	0.070087
Adj Rsquare	-0.27863
Root Mean Square Error	0.12475
Mean of Response	3.678045
Observations (or Sum Wgts)	12

Analysis of Variance

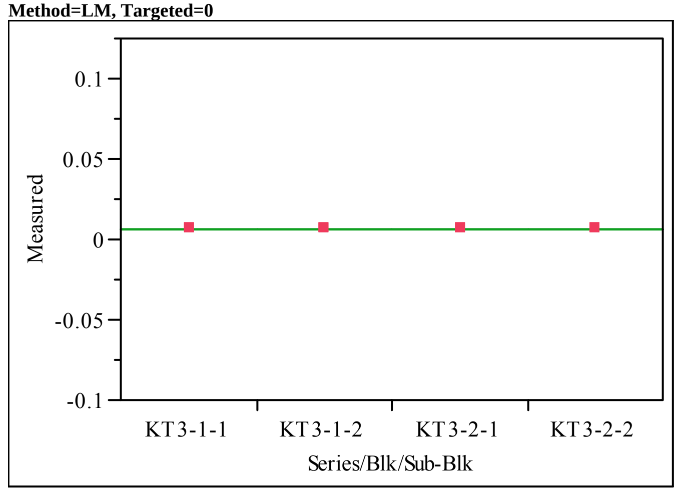
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00938353	0.003128	0.2010	0.8928
Error	8	0.12450105	0.015563		
C. Total	11	0.13388458			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	3.62986	0.07202	3.4638	3.7960
KT3-1-2	3	3.69411	0.07202	3.5280	3.8602
KT3-2-1	3	3.69009	0.07202	3.5240	3.8562
KT3-2-2	3	3.69812	0.07202	3.5320	3.8642

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=La2O3 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005864
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

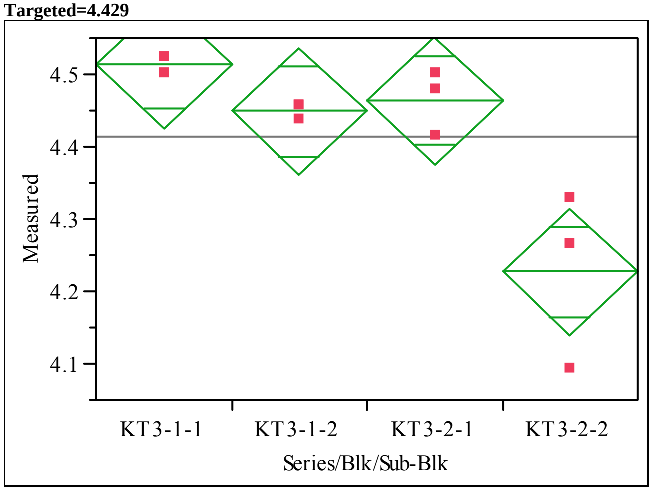
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.005864	0	0.00586	0.00586
KT3-1-2	3	0.005864	0	0.00586	0.00586
KT3-2-1	3	0.005864	0	0.00586	0.00586
KT3-2-2	3	0.005864	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=Li2O (wt%), Prep Method=PF, Targeted=4.429



Oneway Anova
Summary of Fit

Rsquare	0.808547
Adj Rsquare	0.736752
Root Mean Square Error	0.065772
Mean of Response	4.413445
Observations (or Sum Wgts)	12

Analysis of Variance

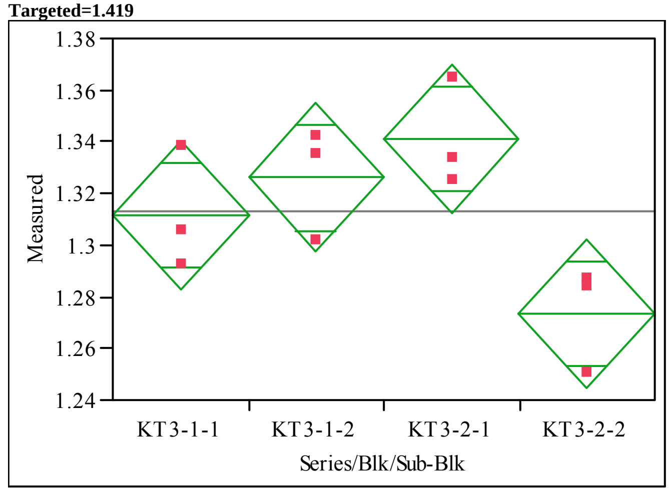
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.14615632	0.048719	11.2619	0.0030
Error	8	0.03460784	0.004326		
C. Total	11	0.18076416			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	4.51391	0.03797	4.4263	4.6015
KT3-1-2	3	4.44933	0.03797	4.3618	4.5369
KT3-2-1	3	4.46368	0.03797	4.3761	4.5512
KT3-2-2	3	4.22686	0.03797	4.1393	4.3144

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=MgO (wt%), Prep Method=LM, Targeted=1.419



Oneway Anova
Summary of Fit

Rsquare	0.667777
Adj Rsquare	0.543193
Root Mean Square Error	0.021648
Mean of Response	1.313097
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00753580	0.002512	5.3601	0.0257
Error	8	0.00374911	0.000469		
C. Total	11	0.01128491			

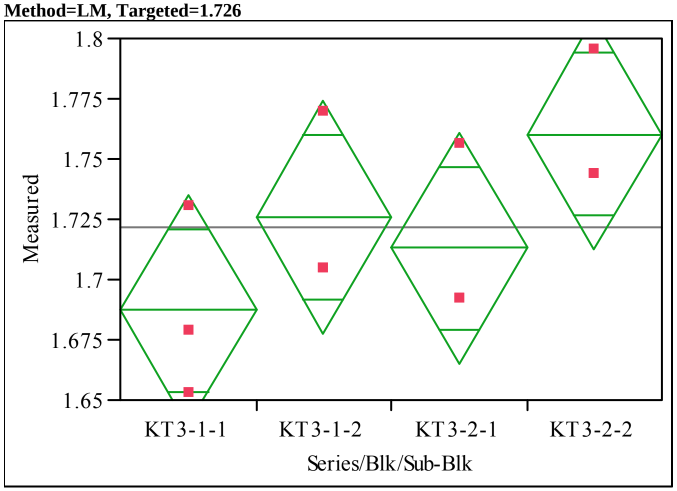
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	1.31172	0.01250	1.2829	1.3405
KT3-1-2	3	1.32609	0.01250	1.2973	1.3549
KT3-2-1	3	1.34101	0.01250	1.3122	1.3698
KT3-2-2	3	1.27357	0.01250	1.2448	1.3024

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=MnO (wt%), Prep Method=LM, Targeted=1.726



Oneway Anova
Summary of Fit

Rsquare	0.443787
Adj Rsquare	0.235207
Root Mean Square Error	0.036138
Mean of Response	1.7216
Observations (or Sum Wgts)	12

Analysis of Variance

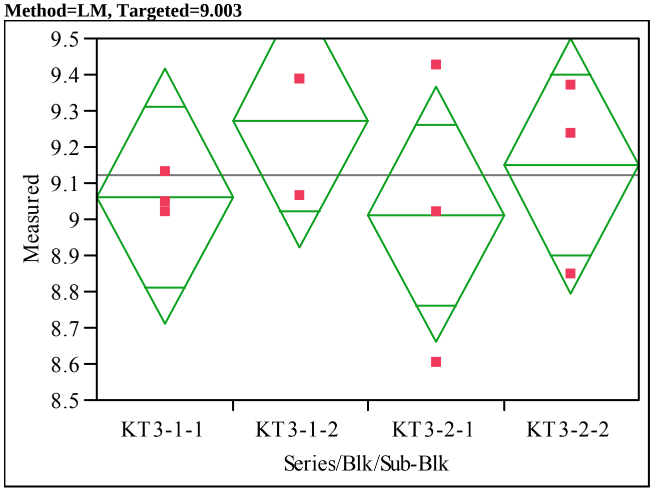
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00833599	0.002779	2.1277	0.1749
Error	8	0.01044777	0.001306		
C. Total	11	0.01878376			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	1.68717	0.02086	1.6391	1.7353
KT3-1-2	3	1.72590	0.02086	1.6778	1.7740
KT3-2-1	3	1.71299	0.02086	1.6649	1.7611
KT3-2-2	3	1.76034	0.02086	1.7122	1.8084

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=Na2O (wt%), Prep Method=LM, Targeted=9.003



Oneway Anova
Summary of Fit

Rsquare	0.172211
Adj Rsquare	-0.13821
Root Mean Square Error	0.265354
Mean of Response	9.124837
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.11718807	0.039063	0.5548	0.6593
Error	8	0.56330224	0.070413		
C. Total	11	0.68049031			

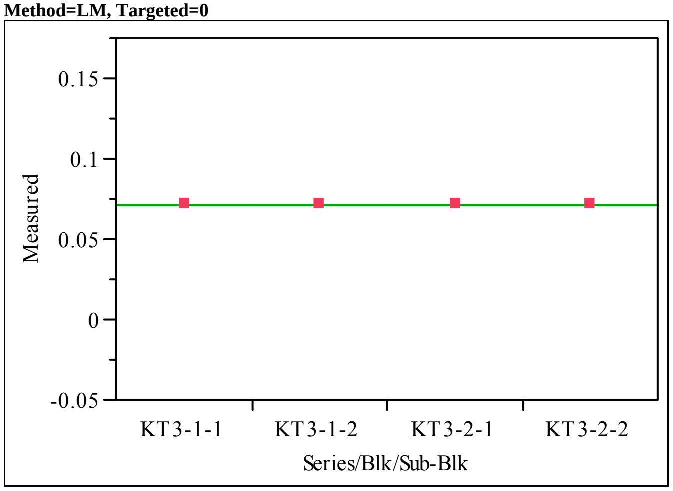
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	9.06305	0.15320	8.7098	9.4163
KT3-1-2	3	9.27424	0.15320	8.9210	9.6275
KT3-2-1	3	9.01363	0.15320	8.6603	9.3669
KT3-2-2	3	9.14843	0.15320	8.7951	9.5017

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=Nb2O5 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.071525
Observations (or Sum Wgts)	12

Analysis of Variance

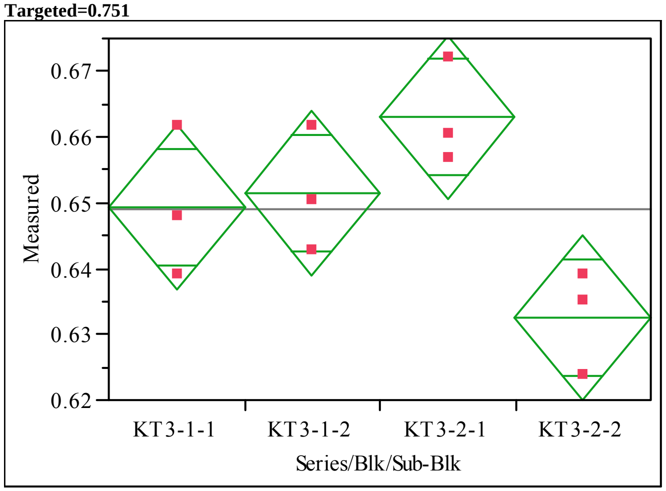
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.071525	0	0.07153	0.07153
KT3-1-2	3	0.071525	0	0.07153	0.07153
KT3-2-1	3	0.071525	0	0.07153	0.07153
KT3-2-2	3	0.071525	0	0.07153	0.07153

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=NiO (wt%), Prep Method=LM, Targeted=0.751



Oneway Anova
Summary of Fit

Rsquare	0.669936
Adj Rsquare	0.546162
Root Mean Square Error	0.00938
Mean of Response	0.649081
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00142859	0.000476	5.4126	0.0250
Error	8	0.00070384	0.000088		
C. Total	11	0.00213243			

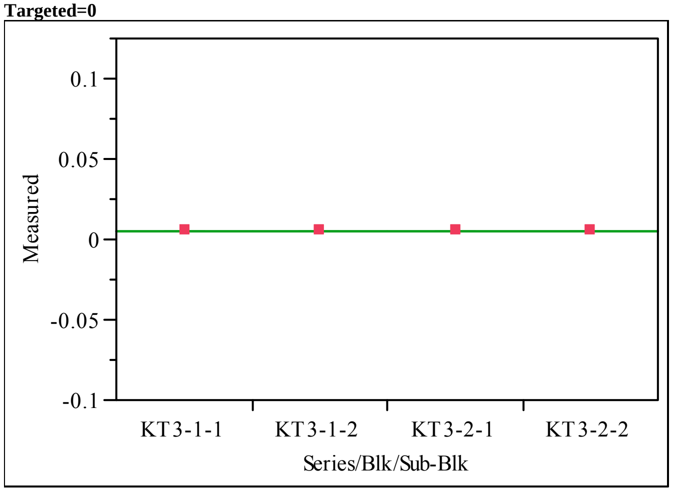
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.649399	0.00542	0.63691	0.66189
KT3-1-2	3	0.651520	0.00542	0.63903	0.66401
KT3-2-1	3	0.662973	0.00542	0.65048	0.67546
KT3-2-2	3	0.632433	0.00542	0.61994	0.64492

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=PbO (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.375
Root Mean Square Error	1.06e-18
Mean of Response	0.005386
Observations (or Sum Wgts)	12

Analysis of Variance

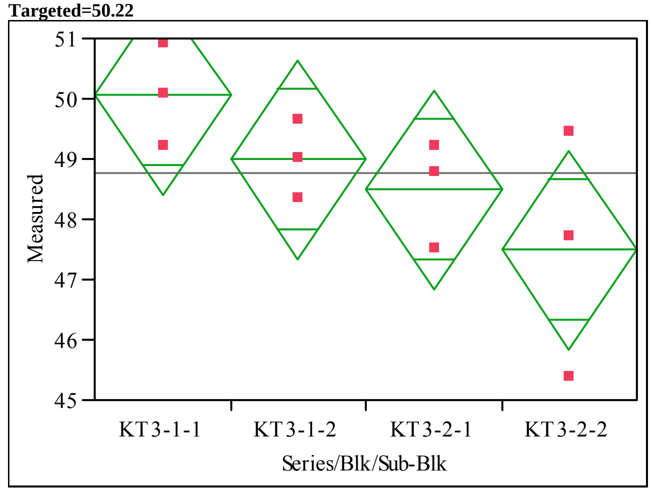
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	9.0278e-36	1.128e-36		
C. Total	11	9.0278e-36			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.005386	6.133e-19	0.00539	0.00539
KT3-1-2	3	0.005386	6.133e-19	0.00539	0.00539
KT3-2-1	3	0.005386	6.133e-19	0.00539	0.00539
KT3-2-2	3	0.005386	6.133e-19	0.00539	0.00539

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=SiO2 (wt%), Prep Method=PF, Targeted=50.22



Oneway Anova
Summary of Fit

Rsquare	0.456799
Adj Rsquare	0.253098
Root Mean Square Error	1.235125
Mean of Response	48.75821
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	10.263036	3.42101	2.2425	0.1606
Error	8	12.204279	1.52553		
C. Total	11	22.467314			

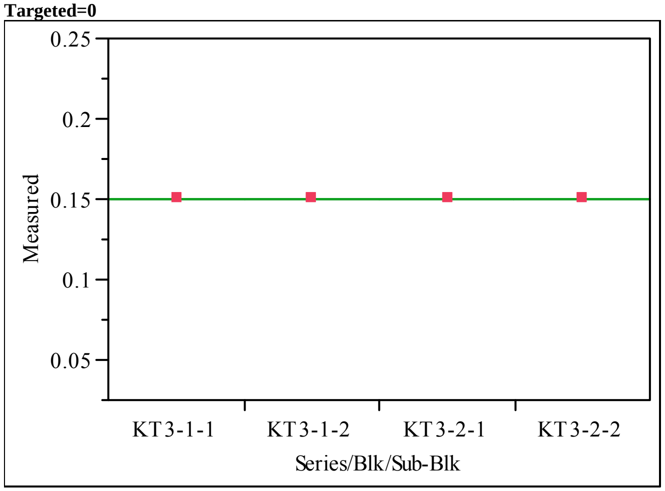
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	50.0596	0.71310	48.415	51.704
KT3-1-2	3	48.9900	0.71310	47.346	50.634
KT3-2-1	3	48.4908	0.71310	46.846	50.135
KT3-2-2	3	47.4925	0.71310	45.848	49.137

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=SO4 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.149795
Observations (or Sum Wgts)	12

Analysis of Variance

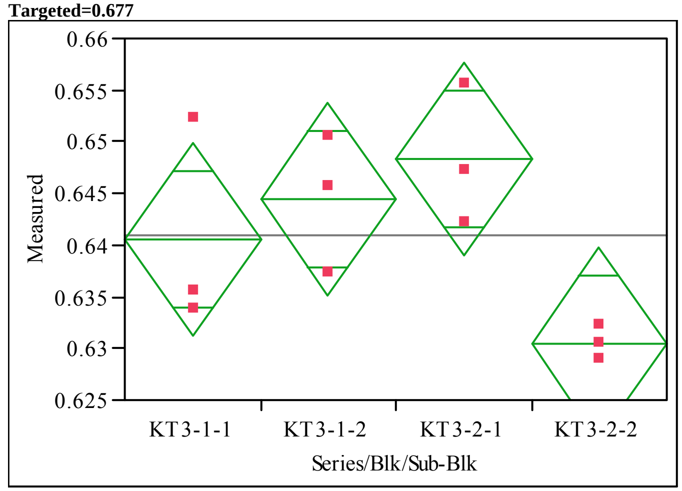
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.149795	0	0.14980	0.14980
KT3-1-2	3	0.149795	0	0.14980	0.14980
KT3-2-1	3	0.149795	0	0.14980	0.14980
KT3-2-2	3	0.149795	0	0.14980	0.14980

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=TiO2 (wt%), Prep Method=LM, Targeted=0.677



Oneway Anova
Summary of Fit

Rsquare	0.572041
Adj Rsquare	0.411557
Root Mean Square Error	0.007011
Mean of Response	0.640929
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00052561	0.000175	3.5645	0.0669
Error	8	0.00039322	0.000049		
C. Total	11	0.00091883			

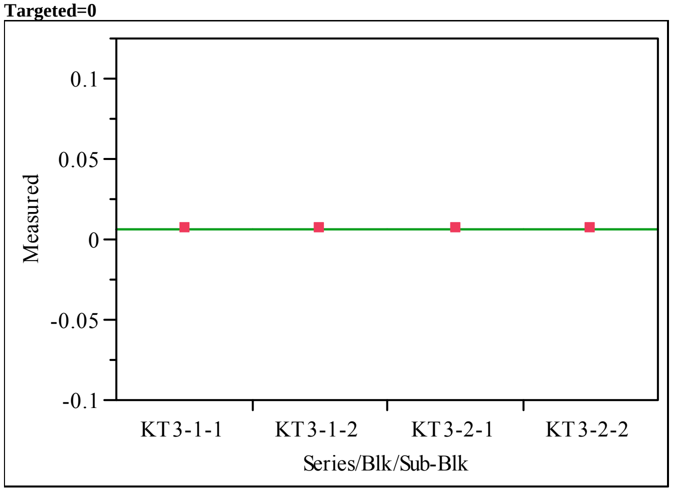
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.640512	0.00405	0.63118	0.64985
KT3-1-2	3	0.644404	0.00405	0.63507	0.65374
KT3-2-1	3	0.648296	0.00405	0.63896	0.65763
KT3-2-2	3	0.630504	0.00405	0.62117	0.63984

Std Error uses a pooled estimate of error variance

Exhibit B-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=ZnO (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006224
Observations (or Sum Wgts)	12

Analysis of Variance

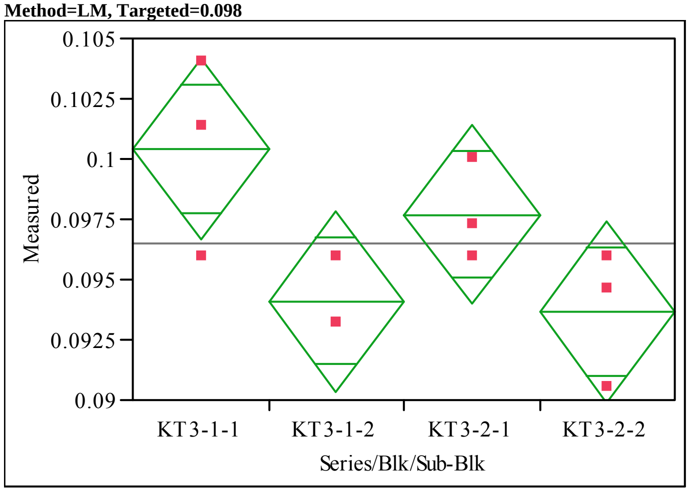
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.006224	0	0.00622	0.00622
KT3-1-2	3	0.006224	0	0.00622	0.00622
KT3-2-1	3	0.006224	0	0.00622	0.00622
KT3-2-2	3	0.006224	0	0.00622	0.00622

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT3, Oxide=ZrO2 (wt%), Prep Method=LM, Targeted=0.098



Oneway Anova
Summary of Fit

Rsquare	0.591757
Adj Rsquare	0.438665
Root Mean Square Error	0.002812
Mean of Response	0.09647
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00009169	0.000031	3.8654	0.0560
Error	8	0.00006325	7.907e-6		
C. Total	11	0.00015494			

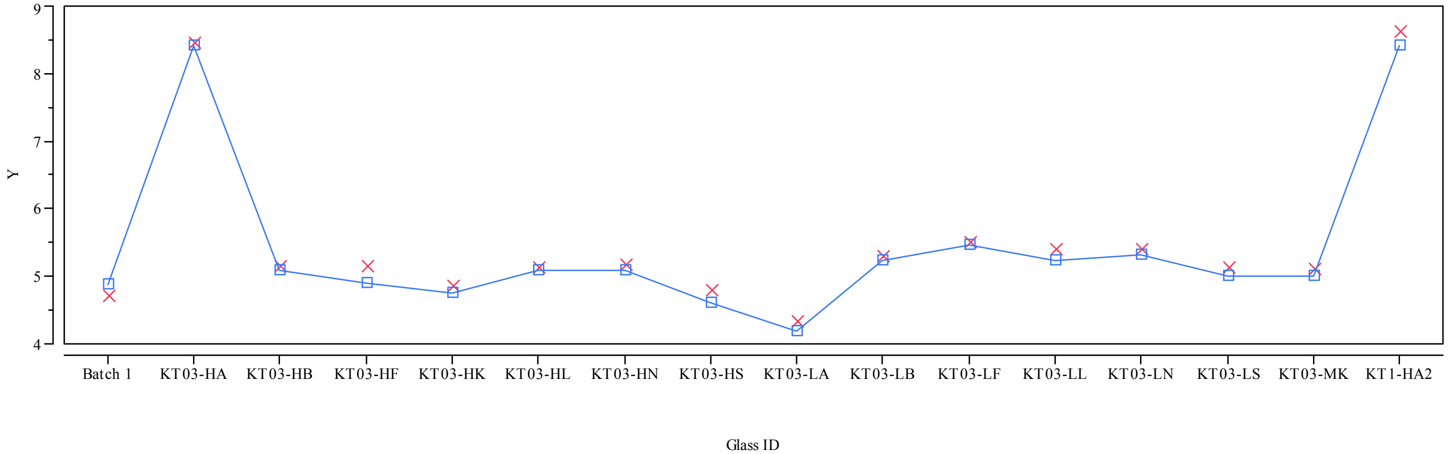
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT3-1-1	3	0.100409	0.00162	0.09667	0.10415
KT3-1-2	3	0.094106	0.00162	0.09036	0.09785
KT3-2-1	3	0.097708	0.00162	0.09396	0.10145
KT3-2-2	3	0.093655	0.00162	0.08991	0.09740

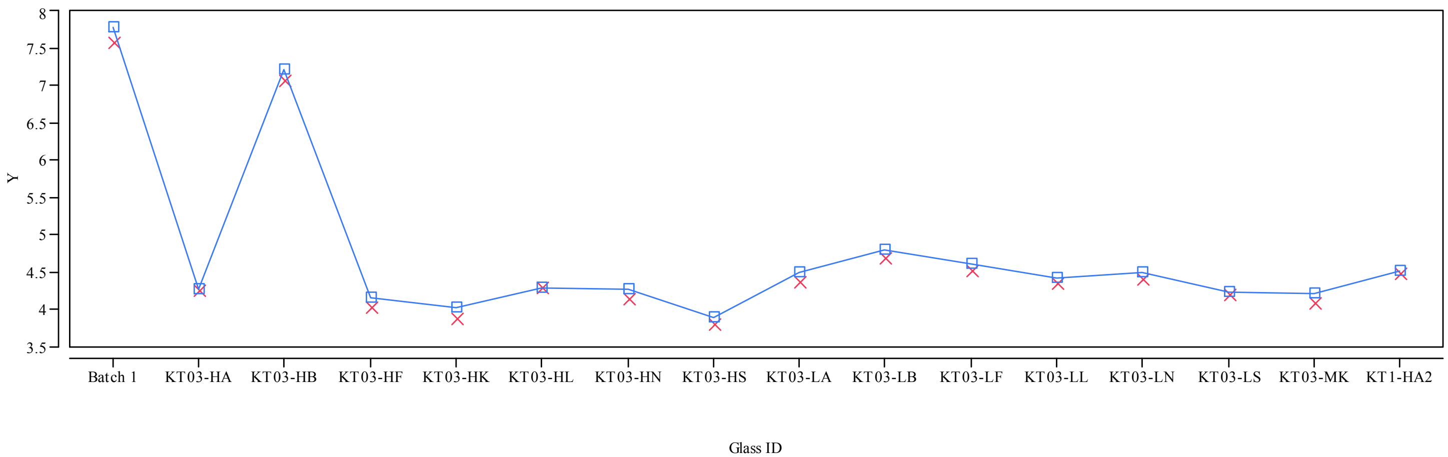
Std Error uses a pooled estimate of error variance

Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series.

Oxide=Al2O3 (wt%)

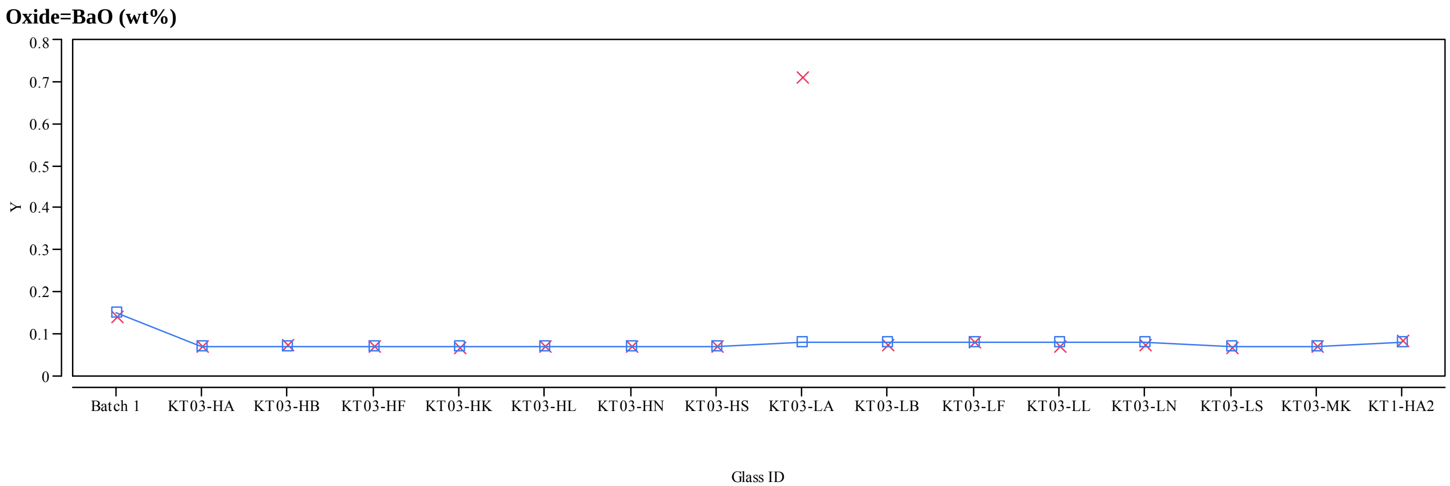


Oxide=B2O3 (wt%)



Y × Measured ▫ — Targeted

Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**



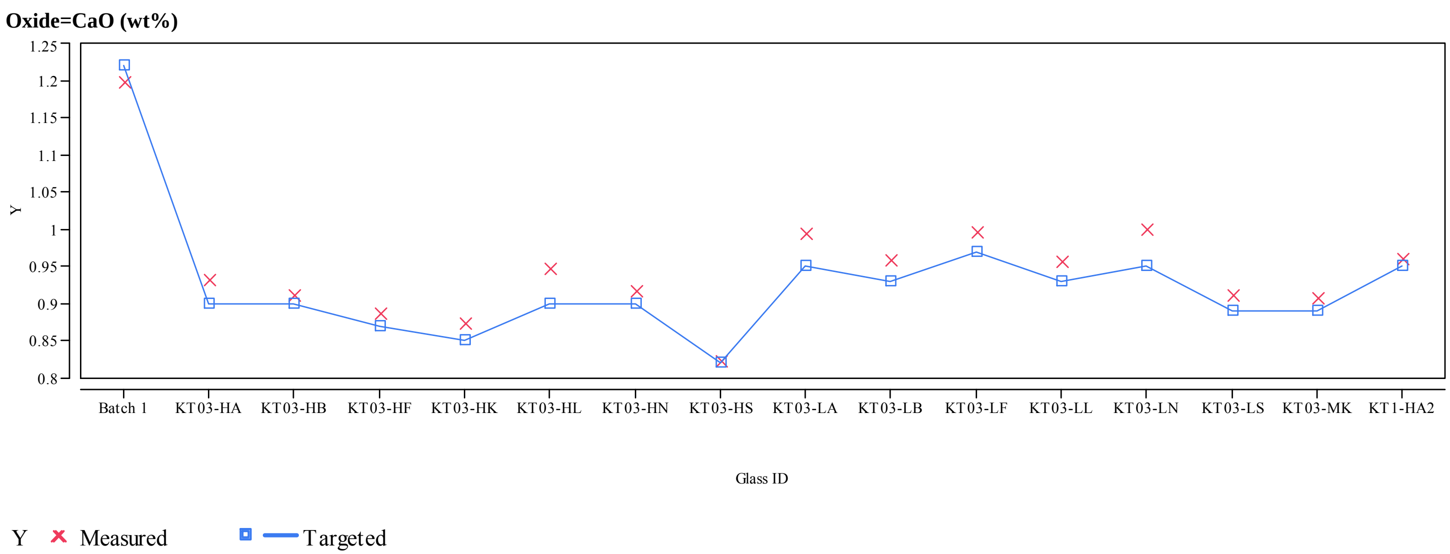
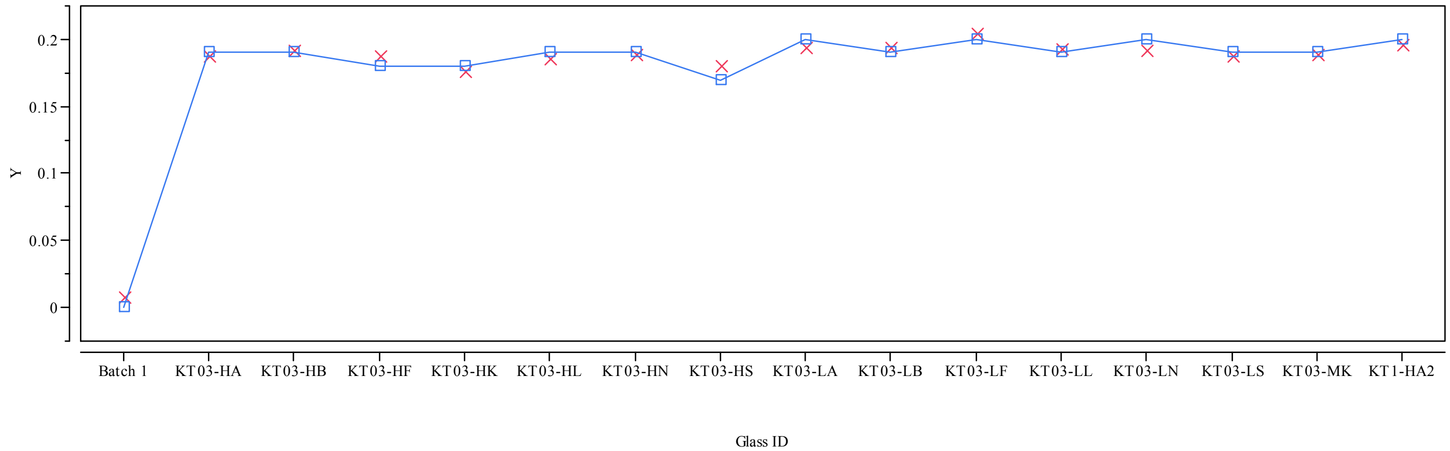


Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=Ce2O3 (wt%)



Oxide=Cr2O3 (wt%)

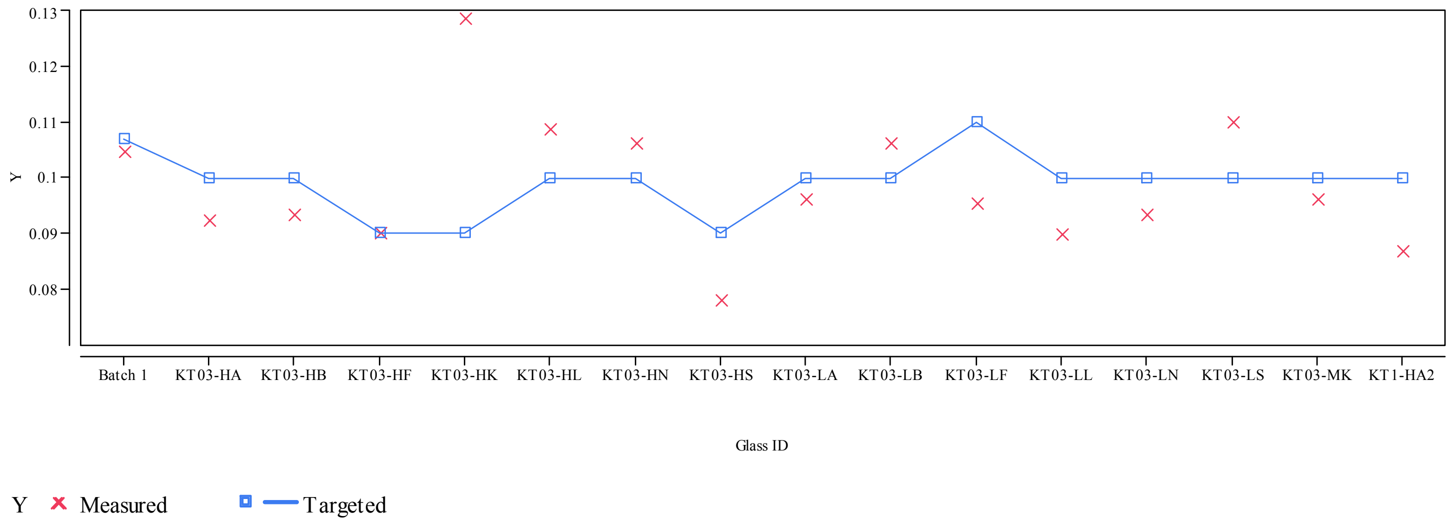
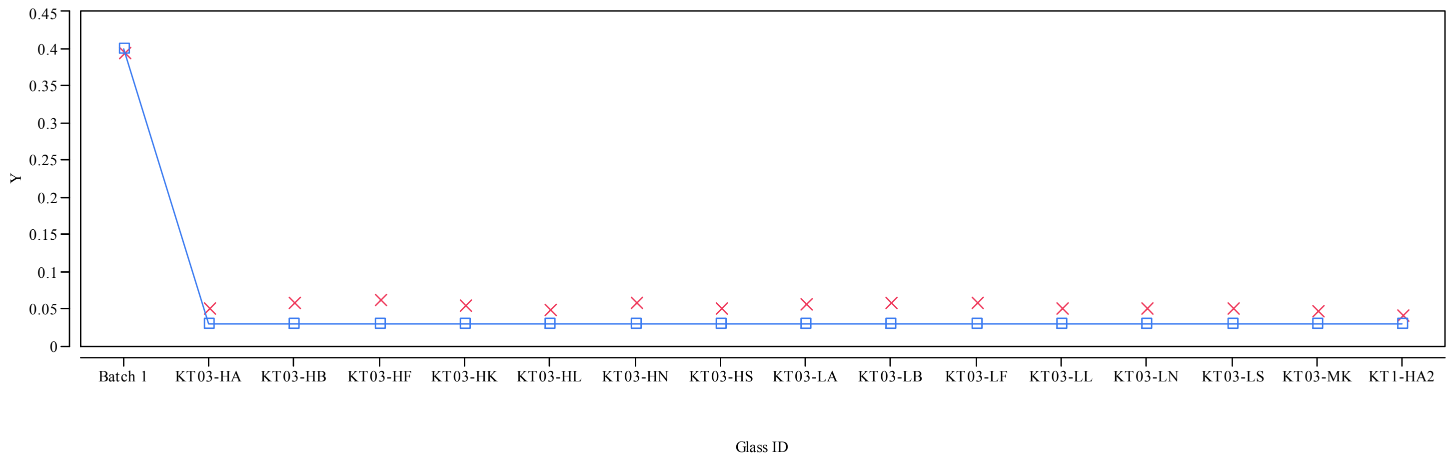
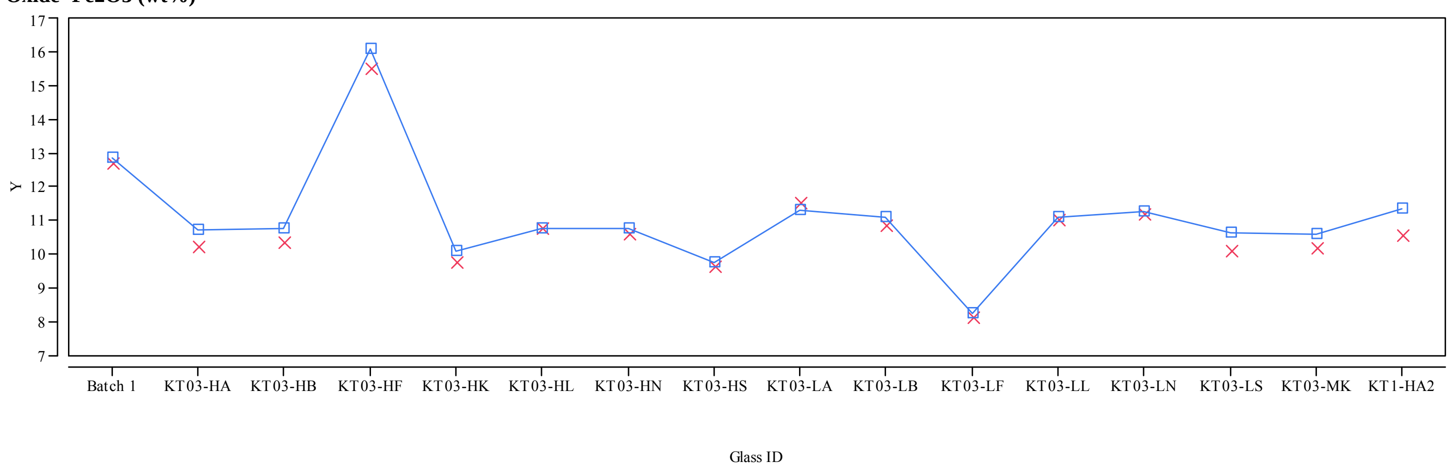


Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=CuO (wt%)



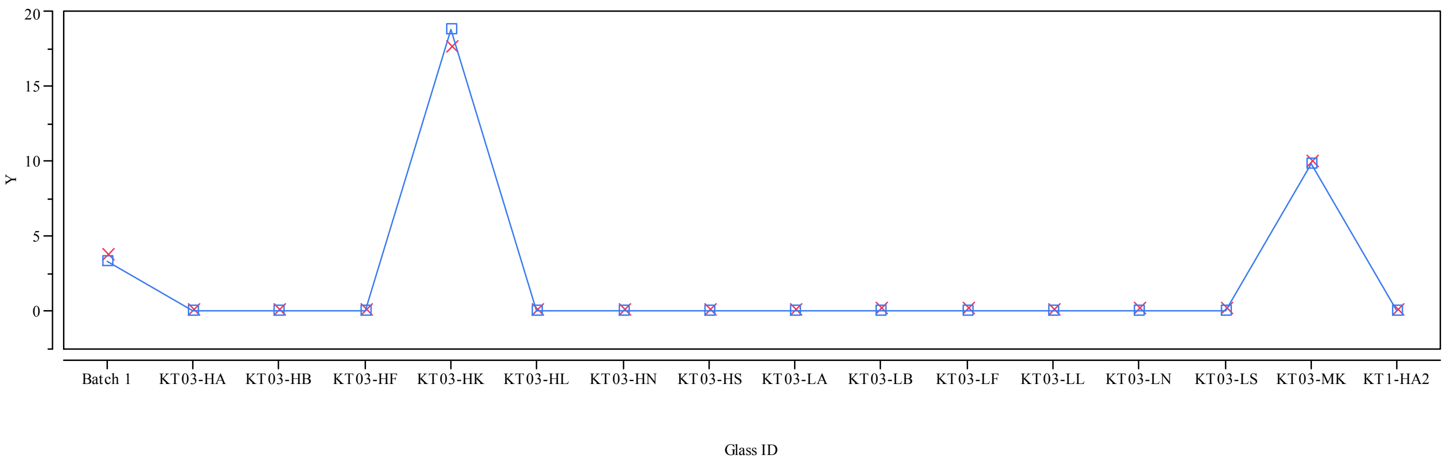
Oxide=Fe2O3 (wt%)



Y ✕ Measured ▫ — Targeted

Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=K2O (wt%)



Oxide=La2O3 (wt%)

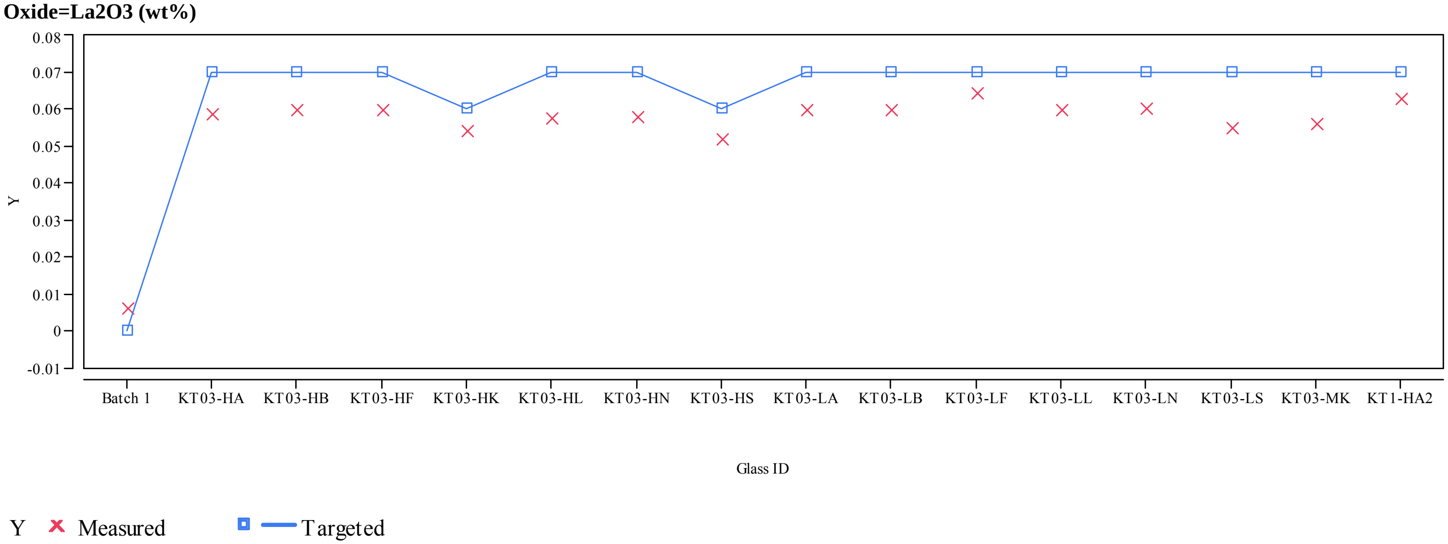
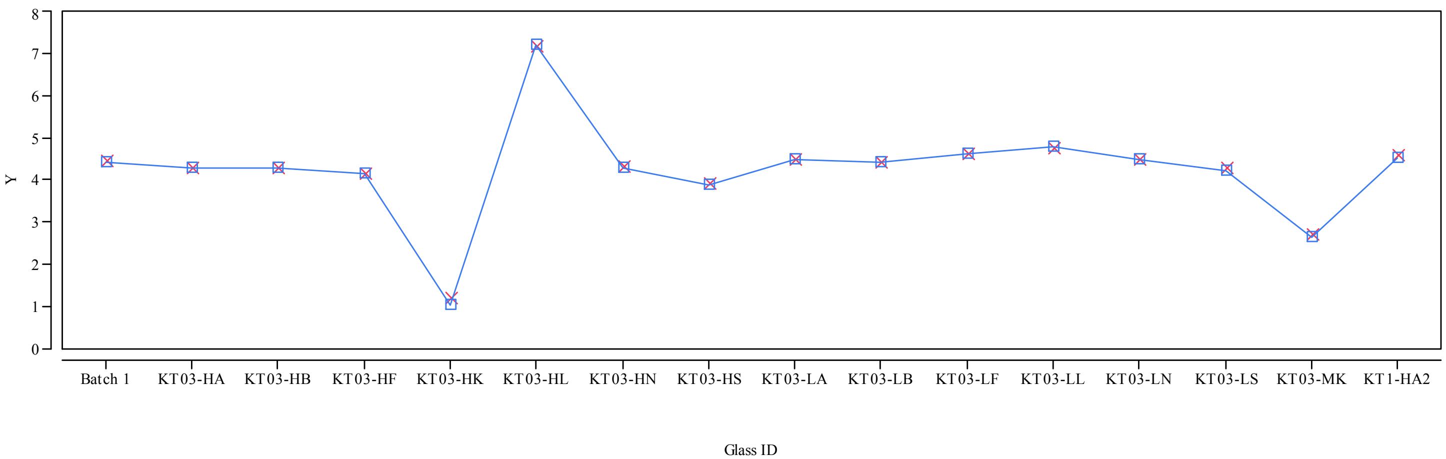


Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=Li2O (wt%)

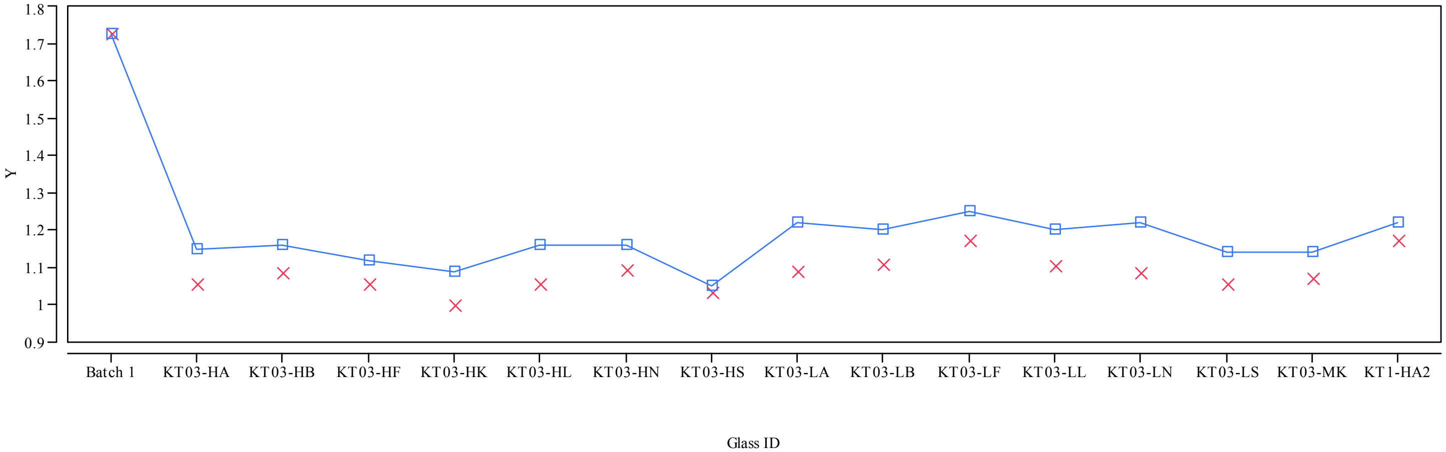


Oxide=MgO (wt%)

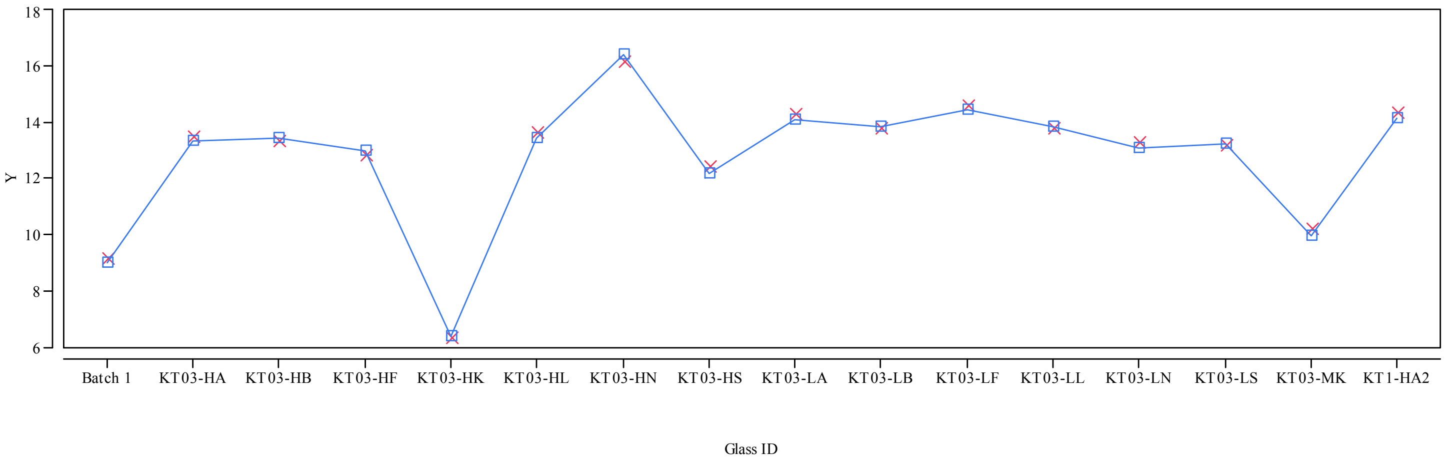
Y × Measured ▪ Targeted

Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=MnO (wt%)



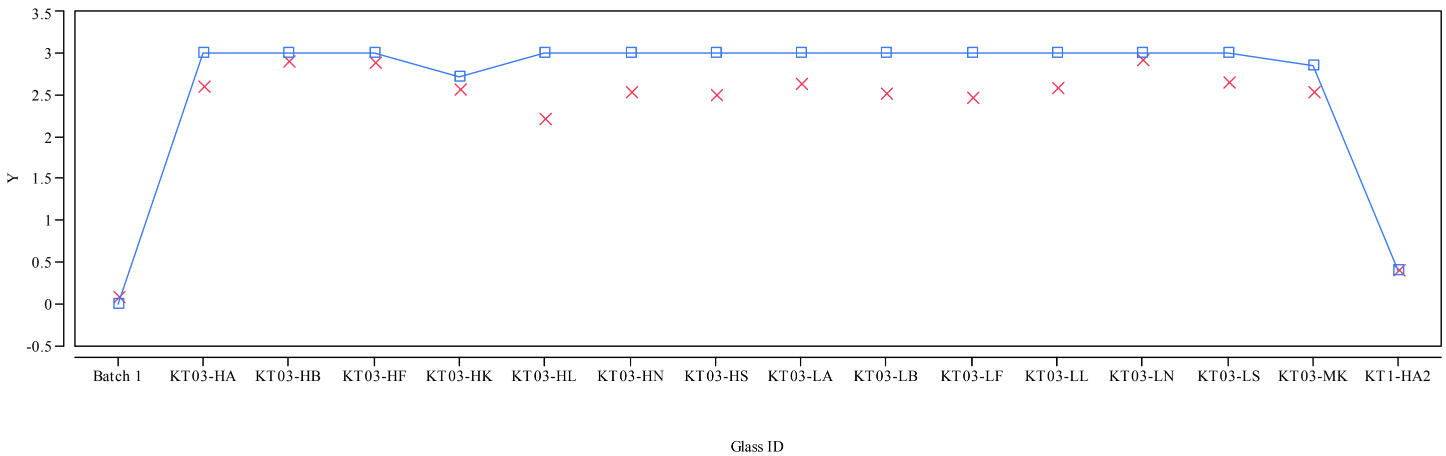
Oxide=Na2O (wt%)



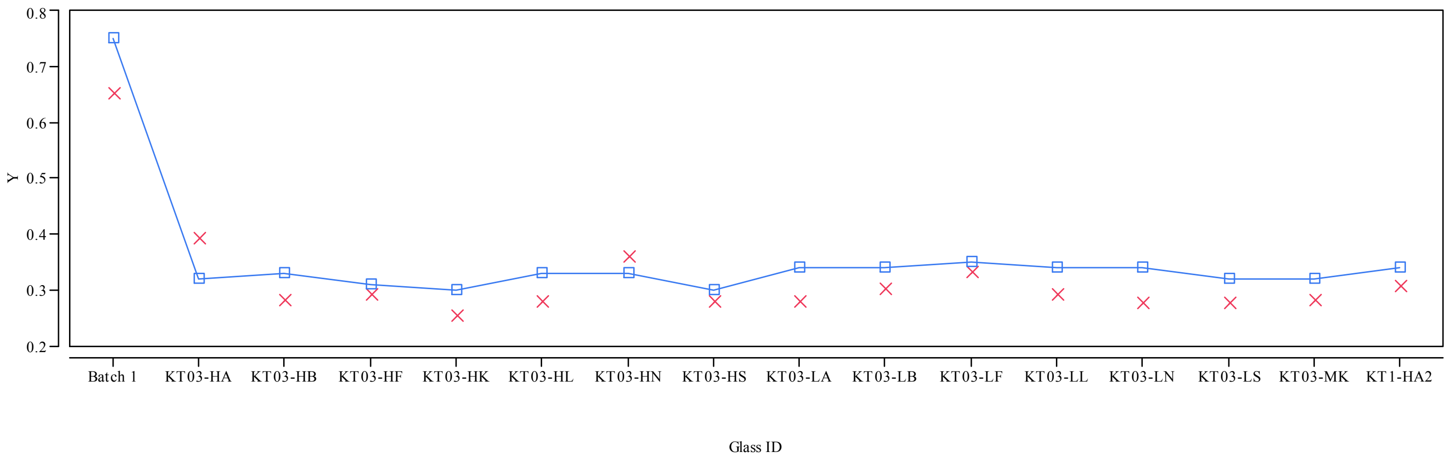
Y × Measured ▫ Targeted

Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=Nb2O5 (wt%)



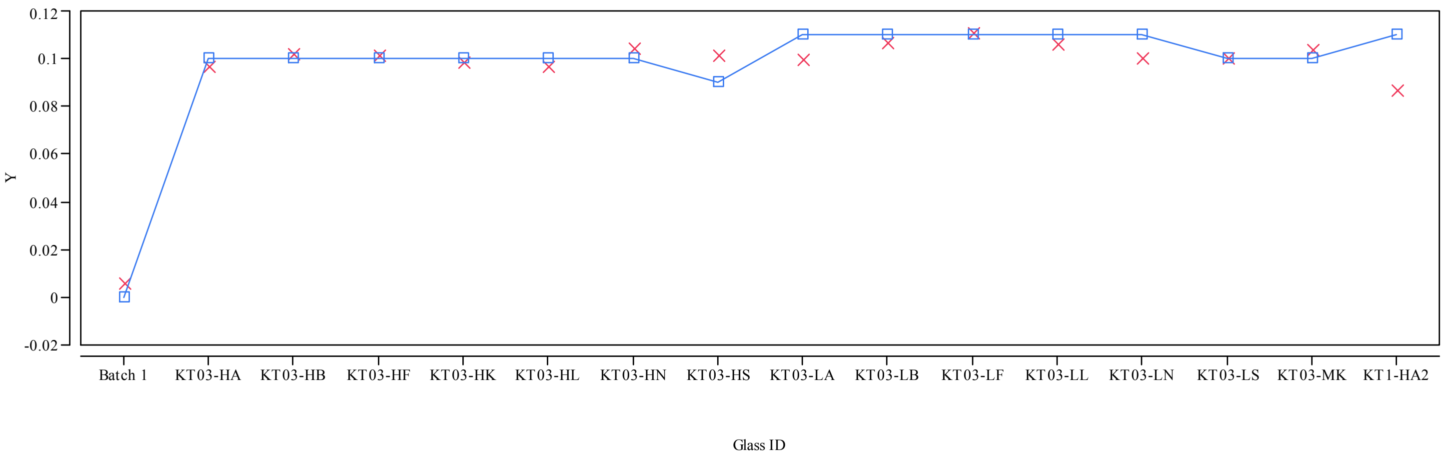
Oxide=NiO (wt%)



Y Measured Targeted

Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=PbO (wt%)



Oxide=SiO2 (wt%)

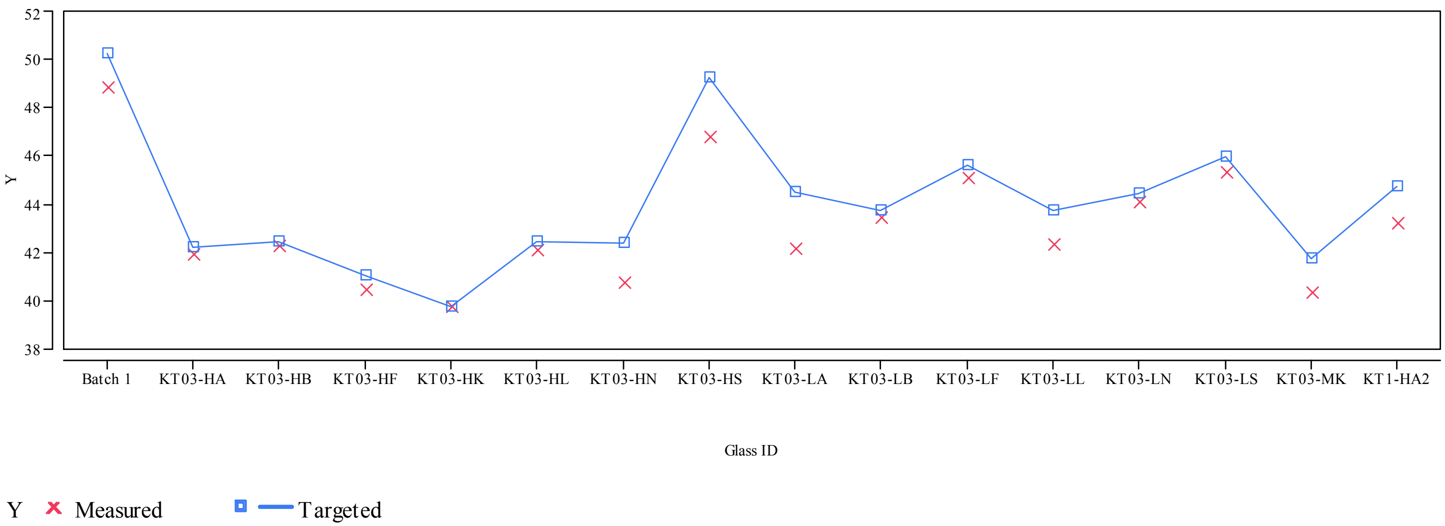
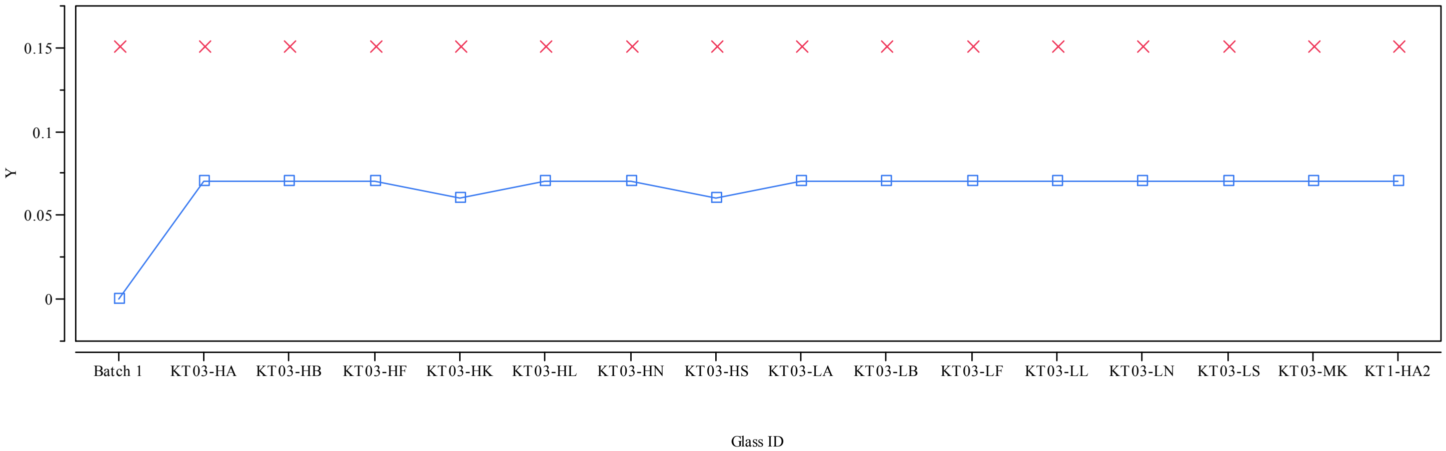


Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=SO4 (wt%)



Oxide=TiO2 (wt%)

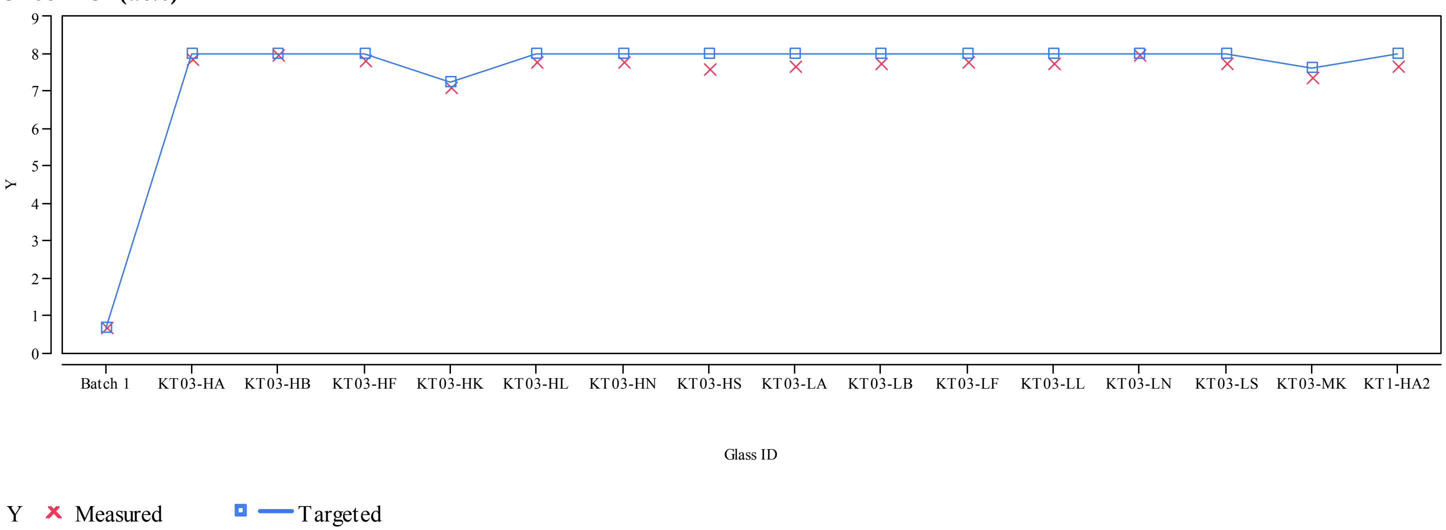
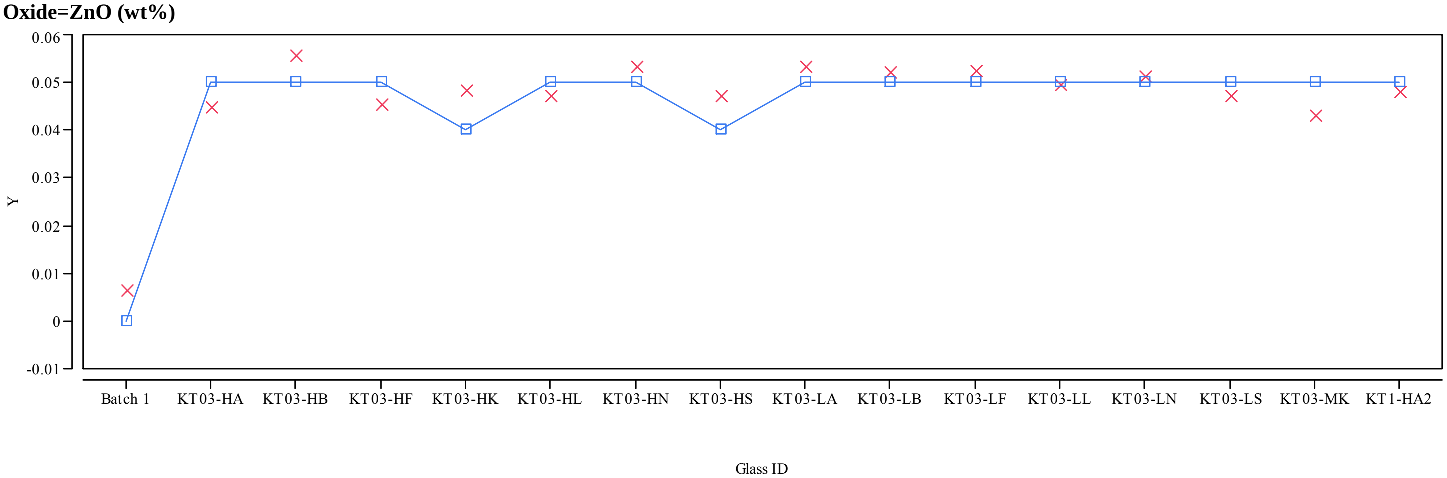
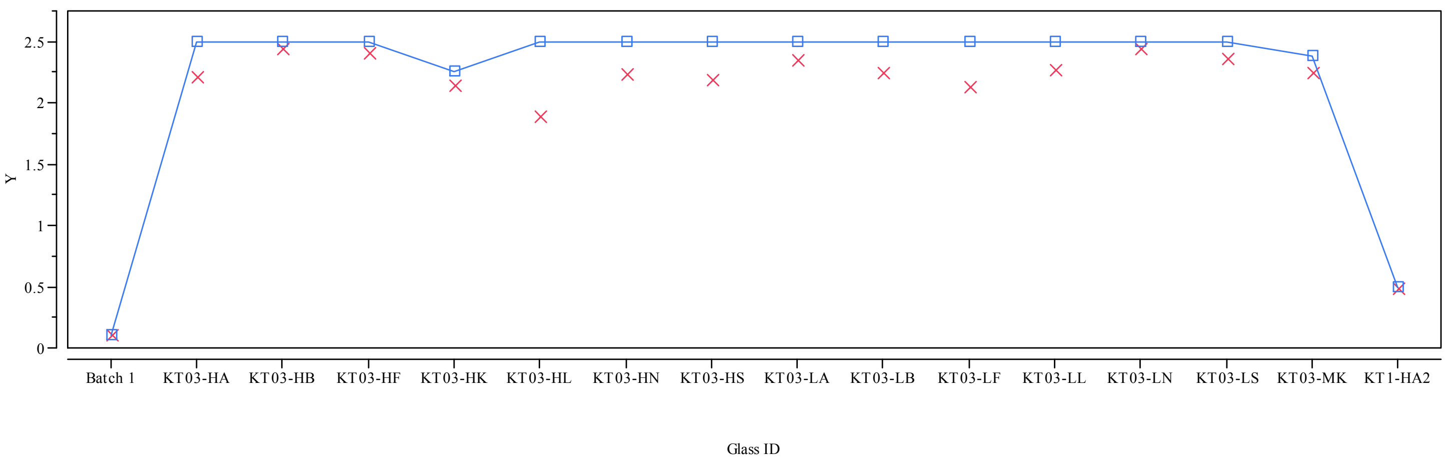


Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=ZnO (wt%)



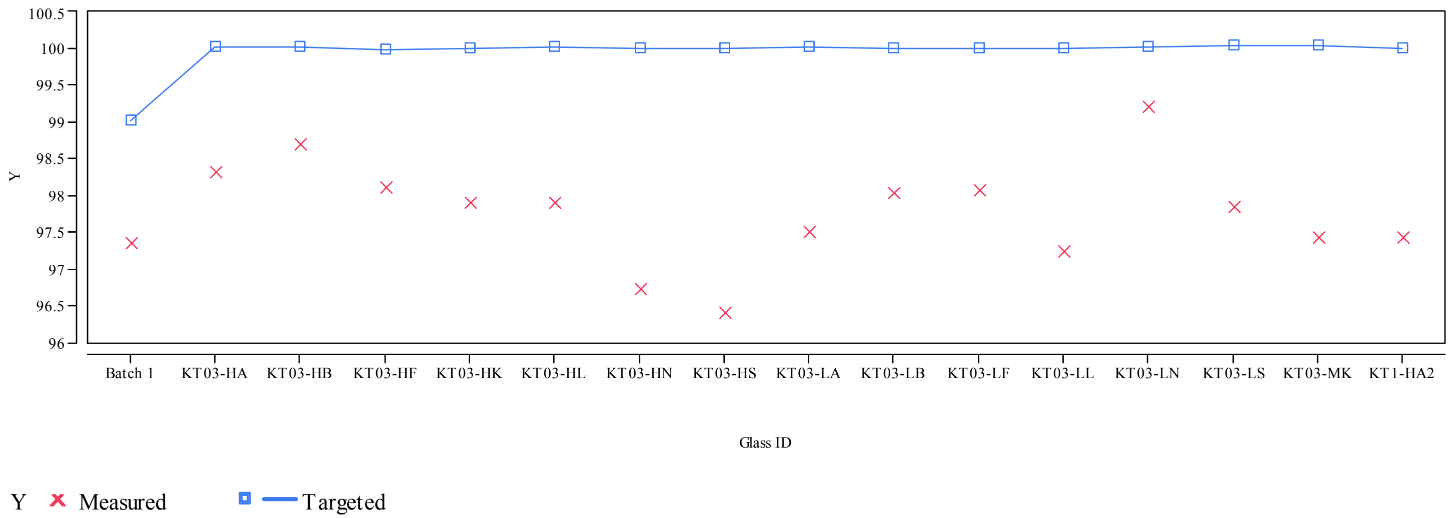
Oxide=ZrO2 (wt%)



Y × Measured ▫ Targeted

Exhibit B-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT03-Series. **(continued)**

Oxide=Sum of Oxides



Appendix C. Data Supporting the Chemical Composition Measurements of the KT04-Series Glasses

Table C-1. PSAL Chemical Composition Measurements of the KT04-Series of Glasses Using LM Preparation Method (Part 1).

Glass ID	Block	Sub-Blk	Seq	Lab ID	Al (wt%)	Ba (wt%)	Ca (wt%)	Ce (wt%)	Cr (wt%)	Cu (wt%)	Fe (wt%)	K (wt%)	La (wt%)	Mg (wt%)
Batch 1	1	1	1	BCHPF111	2.53	0.126	0.862	<0.010	0.076	0.312	8.78	2.29	<0.010	0.822
KT04-09	1	1	2	A10LM21	3.08	0.059	0.730	0.157	0.046	0.069	8.45	0.089	0.058	0.064
KT04-07	1	1	3	A04LM11	3.08	0.062	0.652	0.066	0.076	0.034	6.47	0.072	0.029	0.067
KT04-08	1	1	4	A02LM11	2.78	0.063	0.603	0.069	0.072	0.044	6.42	0.077	0.030	0.066
KT04-03	1	1	5	A03LM11	2.49	0.055	0.726	0.199	0.054	0.037	7.81	0.039	0.053	0.086
KT04-06	1	1	6	A06LM21	3.94	0.055	0.735	0.085	0.059	0.051	6.13	0.112	0.023	0.058
Batch 1	1	1	7	BCHPF112	2.50	0.127	0.855	<0.010	0.076	0.311	8.80	2.27	<0.010	0.816
KT04-07	1	1	8	A04LM21	3.09	0.063	0.651	0.066	0.076	0.036	6.40	0.074	0.028	0.066
KT04-06	1	1	9	A06LM11	3.94	0.056	0.738	0.087	0.060	0.056	6.12	0.115	0.024	0.058
KT04-08	1	1	10	A02LM21	2.76	0.064	0.604	0.068	0.073	0.039	6.30	0.081	0.029	0.064
KT04-09	1	1	11	A10LM11	3.06	0.060	0.727	0.159	0.049	0.046	8.42	0.090	0.058	0.064
KT04-03	1	1	12	A03LM21	2.44	0.057	0.708	0.206	0.057	0.037	8.13	0.034	0.054	0.090
Batch 1	1	1	13	BCHPF113	2.52	0.127	0.850	<0.010	0.077	0.310	8.82	2.26	<0.010	0.820
Batch 1	1	2	1	BCHPF121	2.54	0.123	0.859	<0.010	0.075	0.310	8.70	2.25	<0.010	0.816
KT04-06	1	2	2	A06LM22	4.03	0.054	0.728	0.087	0.059	0.050	6.08	0.111	0.022	0.057
KT04-06	1	2	3	A06LM12	4.01	0.054	0.742	0.086	0.058	0.055	6.15	0.115	0.022	0.056
KT04-03	1	2	4	A03LM12	2.52	0.054	0.734	0.199	0.054	0.037	7.73	0.040	0.051	0.083
KT04-07	1	2	5	A04LM12	3.12	0.060	0.655	0.067	0.075	0.034	6.37	0.074	0.027	0.064
KT04-08	1	2	6	A02LM12	2.84	0.061	0.611	0.070	0.071	0.045	6.28	0.079	0.028	0.063
Batch 1	1	2	7	BCHPF122	2.57	0.120	0.869	<0.010	0.073	0.313	8.58	2.29	<0.010	0.792
KT04-08	1	2	8	A02LM22	2.82	0.061	0.616	0.068	0.071	0.039	6.19	0.083	0.027	0.061
KT04-09	1	2	9	A10LM22	3.11	0.058	0.736	0.159	0.047	0.070	8.40	0.091	0.057	0.061
KT04-03	1	2	10	A03LM22	2.52	0.057	0.719	0.208	0.056	0.037	7.99	0.036	0.053	0.086
KT04-09	1	2	11	A10LM12	3.15	0.059	0.738	0.161	0.048	0.047	8.41	0.093	0.057	0.061
KT04-07	1	2	12	A04LM22	3.12	0.062	0.649	0.067	0.075	0.036	6.40	0.074	0.027	0.064
Batch 1	1	2	13	BCHPF123	2.57	0.127	0.853	<0.010	0.076	0.314	8.86	2.25	<0.010	0.818
Batch 1	2	1	1	BCHPF211	2.50	0.121	0.854	<0.010	0.073	0.304	8.68	2.31	<0.010	0.803
KT04-05	2	1	2	A01LM21	3.69	0.054	0.687	0.118	0.101	0.056	6.55	0.070	0.049	0.086
KT04-10	2	1	3	A05LM21	3.02	0.068	0.711	0.213	0.054	0.044	9.28	0.037	0.064	0.066
KT04-10	2	1	4	A05LM11	3.03	0.067	0.719	0.210	0.054	0.043	9.31	0.040	0.063	0.065
KT04-02	2	1	5	A07LM21	2.79	0.060	0.696	0.242	0.055	0.040	7.86	0.032	0.054	0.087
KT04-01	2	1	6	A08LM11	3.13	0.054	0.698	0.230	0.050	0.047	8.19	0.035	0.076	0.083
Batch 1	2	1	7	BCHPF212	2.48	0.122	0.861	<0.010	0.073	0.310	8.76	2.32	<0.010	0.783
KT04-01	2	1	8	A08LM21	3.07	0.054	0.688	0.232	0.050	0.043	8.24	0.033	0.077	0.083
KT04-05	2	1	9	A01LM11	3.69	0.052	0.681	0.116	0.098	0.046	6.62	0.067	0.049	0.086
KT04-04	2	1	10	A09LM11	2.67	0.051	0.655	0.168	0.053	0.042	8.25	0.040	0.048	0.082
KT04-02	2	1	11	A07LM11	2.78	0.057	0.709	0.233	0.052	0.035	7.96	0.034	0.052	0.084
KT04-04	2	1	12	A09LM21	2.65	0.050	0.659	0.164	0.052	0.056	8.27	0.043	0.047	0.080
Batch 1	2	1	13	BCHPF213	2.55	0.117	0.879	<0.010	0.072	0.311	9.46	2.36	<0.010	0.754
Batch 1	2	2	1	BCHPF221	2.52	0.128	0.843	<0.010	0.079	0.317	9.06	2.28	<0.010	0.811
KT04-01	2	2	2	A08LM22	3.11	0.059	0.674	0.235	0.054	0.041	8.12	0.027	0.079	0.088
KT04-05	2	2	3	A01LM22	3.74	0.058	0.671	0.118	0.106	0.045	6.51	0.063	0.051	0.090
KT04-01	2	2	4	A08LM12	3.17	0.058	0.694	0.231	0.053	0.045	8.03	0.029	0.078	0.087
KT04-10	2	2	5	A05LM12	3.10	0.071	0.704	0.209	0.057	0.040	9.24	0.034	0.065	0.069
KT04-02	2	2	6	A07LM22	2.85	0.063	0.683	0.242	0.057	0.037	7.83	0.026	0.055	0.091
Batch 1	2	2	7	BCHPF222	2.52	0.125	0.851	<0.010	0.077	0.309	8.75	2.28	<0.010	0.803
KT04-04	2	2	8	A09LM12	2.75	0.055	0.640	0.168	0.057	0.040	8.07	0.033	0.050	0.088
KT04-05	2	2	9	A01LM12	3.77	0.056	0.666	0.117	0.104	0.043	6.56	0.059	0.051	0.092
KT04-04	2	2	10	A09LM22	2.72	0.054	0.640	0.164	0.055	0.053	8.10	0.036	0.049	0.085
KT04-10	2	2	11	A05LM22	3.12	0.070	0.692	0.208	0.056	0.040	9.18	0.030	0.065	0.071
KT04-02	2	2	12	A07LM12	2.89	0.061	0.694	0.233	0.057	0.032	7.88	0.028	0.054	0.090
Batch 1	2	2	13	BCHPF223	2.57	0.125	0.847	<0.010	0.076	0.307	8.85	2.27	<0.010	0.804

Table C-2. PSAL Chemical Composition Measurements of the KT04-Series of Glasses Using LM Preparation Method (Part 2).

Glass ID	Block	Sub-Blk	Seq	Lab ID	Mn (wt%)	Na (wt%)	Nb (wt%)	Ni (wt%)	Pb (wt%)	Si (wt%)	Ti (wt%)	Zn (wt%)	Zr (wt%)
Batch 1	1	1	1	BCHPF111	1.32	6.63	<0.100	0.535	<0.010	23.2	0.393	<0.010	0.068
KT04-09	1	1	2	A10LM21	0.425	10.5	0.571	0.349	0.110	22.6	2.92	0.037	0.547
KT04-07	1	1	3	A04LM11	0.559	10.6	0.782	0.445	0.061	22.7	2.94	0.064	0.726
KT04-08	1	1	4	A02LM11	0.747	11.6	0.891	0.427	0.063	23.2	3.01	0.034	0.786
KT04-03	1	1	5	A03LM11	1.41	10.7	0.734	0.204	0.096	22.8	2.63	0.029	0.676
KT04-06	1	1	6	A06LM21	0.907	10.2	0.657	0.106	0.051	22.9	2.63	0.065	0.646
Batch 1	1	1	7	BCHPF112	1.31	6.63	<0.100	0.536	<0.010	23.3	0.392	<0.010	0.069
KT04-07	1	1	8	A04LM21	0.548	10.7	0.800	0.441	0.061	23.0	2.93	0.065	0.741
KT04-06	1	1	9	A06LM11	0.907	10.3	0.675	0.105	0.054	23.0	2.62	0.068	0.658
KT04-08	1	1	10	A02LM21	0.731	11.3	0.878	0.410	0.061	23.0	2.97	0.035	0.778
KT04-09	1	1	11	A10LM11	0.427	10.7	0.575	0.337	0.111	22.6	2.94	0.039	0.550
KT04-03	1	1	12	A03LM21	1.40	11.1	0.720	0.215	0.104	22.9	2.53	0.030	0.695
Batch 1	1	1	13	BCHPF113	1.32	6.95	<0.100	0.534	<0.010	23.7	0.394	<0.010	0.068
Batch 1	1	2	1	BCHPF121	1.31	6.73	<0.100	0.531	<0.010	23.0	0.395	<0.010	0.067
KT04-06	1	2	2	A06LM22	0.901	10.4	0.657	0.105	0.050	22.6	2.62	0.063	0.646
KT04-06	1	2	3	A06LM12	0.898	10.5	0.669	0.103	0.052	22.8	2.61	0.065	0.653
KT04-03	1	2	4	A03LM12	1.40	10.8	0.728	0.200	0.093	22.5	2.62	0.027	0.670
KT04-07	1	2	5	A04LM12	0.537	10.8	0.775	0.438	0.059	22.4	2.92	0.061	0.721
KT04-08	1	2	6	A02LM12	0.724	12.0	0.883	0.419	0.059	22.9	2.98	0.032	0.784
Batch 1	1	2	7	BCHPF122	1.30	6.80	<0.100	0.518	<0.010	22.9	0.388	<0.010	0.067
KT04-08	1	2	8	A02LM22	0.719	11.8	0.878	0.402	0.057	22.6	2.95	0.033	0.767
KT04-09	1	2	9	A10LM22	0.410	10.7	0.563	0.342	0.108	22.0	2.90	0.036	0.547
KT04-03	1	2	10	A03LM22	1.40	11.1	0.722	0.211	0.104	22.1	2.60	0.029	0.698
KT04-09	1	2	11	A10LM12	0.416	11.1	0.576	0.332	0.109	22.0	2.92	0.037	0.551
KT04-07	1	2	12	A04LM22	0.535	11.1	0.785	0.433	0.059	22.9	2.83	0.063	0.738
Batch 1	1	2	13	BCHPF123	1.33	7.12	<0.100	0.530	<0.010	23.0	0.397	<0.010	0.068
Batch 1	2	1	1	BCHPF211	1.30	6.70	<0.100	0.537	<0.010	23.3	0.392	<0.010	0.067
KT04-05	2	1	2	A01LM21	0.768	10.0	0.702	0.081	0.051	23.5	2.64	0.030	0.693
KT04-10	2	1	3	A05LM21	0.268	9.62	0.534	0.333	0.119	22.5	2.73	0.032	0.545
KT04-10	2	1	4	A05LM11	0.266	9.98	0.533	0.331	0.117	22.6	2.74	0.033	0.540
KT04-02	2	1	5	A07LM21	1.33	10.4	0.733	0.134	0.103	22.9	2.67	0.029	0.708
KT04-01	2	1	6	A08LM11	1.50	9.58	0.643	0.232	0.116	22.5	2.59	<0.010	0.608
Batch 1	2	1	7	BCHPF212	1.31	6.59	<0.100	0.522	<0.010	23.4	0.384	<0.010	0.067
KT04-01	2	1	8	A08LM21	1.49	9.54	0.669	0.233	0.120	22.5	2.58	<0.010	0.623
KT04-05	2	1	9	A01LM11	0.768	9.85	0.708	0.081	0.051	23.5	2.65	0.028	0.690
KT04-04	2	1	10	A09LM11	0.803	9.81	0.674	0.100	0.071	23.2	2.62	0.056	0.620
KT04-02	2	1	11	A07LM11	1.34	10.3	0.717	0.132	0.096	22.9	2.67	0.026	0.682
KT04-04	2	1	12	A09LM21	0.799	10.2	0.663	0.110	0.068	23.4	2.63	0.054	0.605
Batch 1	2	1	13	BCHPF213	1.41	6.96	<0.100	0.512	<0.010	24.5	0.387	<0.010	0.067
Batch 1	2	2	1	BCHPF221	1.33	6.72	<0.100	0.537	<0.010	23.1	0.385	<0.010	0.066
KT04-01	2	2	2	A08LM22	1.49	9.96	0.681	0.239	0.126	22.1	2.56	<0.010	0.624
KT04-05	2	2	3	A01LM22	0.772	10.2	0.712	0.083	0.054	23.1	2.63	0.031	0.695
KT04-01	2	2	4	A08LM12	1.49	10.0	0.652	0.236	0.121	22.1	2.56	<0.010	0.609
KT04-10	2	2	5	A05LM12	0.281	10.3	0.533	0.338	0.121	22.2	2.72	0.035	0.538
KT04-02	2	2	6	A07LM22	1.34	10.6	0.743	0.137	0.106	22.5	2.63	0.031	0.704
Batch 1	2	2	7	BCHPF222	1.32	6.64	<0.100	0.531	<0.010	23.1	0.394	<0.010	0.066
KT04-04	2	2	8	A09LM12	0.800	10.3	0.687	0.105	0.075	22.8	2.59	0.060	0.624
KT04-05	2	2	9	A01LM12	0.778	10.2	0.721	0.086	0.054	23.0	2.60	0.031	0.693
KT04-04	2	2	10	A09LM22	0.800	10.8	0.676	0.115	0.071	22.8	2.56	0.058	0.606
KT04-10	2	2	11	A05LM22	0.280	10.2	0.546	0.343	0.121	22.0	2.69	0.034	0.538
KT04-02	2	2	12	A07LM12	1.35	10.9	0.743	0.136	0.100	22.3	2.62	0.028	0.679
Batch 1	2	2	13	BCHPF223	1.34	6.89	<0.100	0.532	<0.010	22.9	0.389	<0.010	0.066

Table C-3. PSAL Chemical Composition Measurements of the KT04-Series of Glasses Using PF Preparation Method.

Glass ID	Block	Sub-Blk	Sequence	Lab ID	B (wt%)	Li (wt%)
Batch 1	1	1	1	BCHPF111	2.47	2.08
KT04-10	1	1	2	A05PF21	1.88	1.68
KT04-01	1	1	3	A08PF21	1.86	1.68
KT04-02	1	1	4	A07PF21	1.81	1.70
KT04-02	1	1	5	A07PF11	1.84	1.70
KT04-04	1	1	6	A09PF21	1.82	1.68
Batch 1	1	1	7	BCHPF112	2.41	2.12
KT04-10	1	1	8	A05PF11	1.84	1.67
KT04-01	1	1	9	A08PF11	1.87	1.67
KT04-03	1	1	10	A03PF11	1.86	1.69
KT04-03	1	1	11	A03PF21	1.84	1.71
KT04-04	1	1	12	A09PF11	1.85	1.69
Batch 1	1	1	13	BCHPF113	2.39	2.11
Batch 1	1	2	1	BCHPF121	2.45	2.09
KT04-03	1	2	2	A03PF12	1.83	1.68
KT04-10	1	2	3	A05PF12	1.80	1.69
KT04-04	1	2	4	A09PF22	1.82	1.67
KT04-04	1	2	5	A09PF12	1.77	1.67
KT04-01	1	2	6	A08PF22	1.80	1.68
Batch 1	1	2	7	BCHPF122	2.34	2.11
KT04-02	1	2	8	A07PF22	1.82	1.70
KT04-03	1	2	9	A03PF22	1.81	1.67
KT04-02	1	2	10	A07PF12	1.79	1.69
KT04-10	1	2	11	A05PF22	1.79	1.67
KT04-01	1	2	12	A08PF12	1.78	1.66
Batch 1	1	2	13	BCHPF123	2.37	2.11
Batch 1	2	1	1	BCHPF211	2.42	2.11
KT04-09	2	1	2	A10PF21	1.79	1.68
KT04-05	2	1	3	A01PF21	1.79	1.67
KT04-06	2	1	4	A06PF11	1.79	1.68
KT04-07	2	1	5	A04PF21	1.76	1.69
KT04-07	2	1	6	A04PF11	1.76	1.68
Batch 1	2	1	7	BCHPF212	2.28	2.10
KT04-08	2	1	8	A02PF11	1.77	1.66
KT04-05	2	1	9	A01PF11	1.79	1.66
KT04-08	2	1	10	A02PF21	1.77	1.68
KT04-09	2	1	11	A10PF11	1.78	1.66
KT04-06	2	1	12	A06PF21	1.77	1.68
Batch 1	2	1	13	BCHPF213	2.31	2.09
Batch 1	2	2	1	BCHPF221	2.43	2.16
KT04-08	2	2	2	A02PF12	1.86	1.72
KT04-05	2	2	3	A01PF12	1.87	1.73
KT04-09	2	2	4	A10PF22	1.86	1.71
KT04-07	2	2	5	A04PF12	1.87	1.72
KT04-06	2	2	6	A06PF12	1.88	1.71
Batch 1	2	2	7	BCHPF222	2.39	2.13
KT04-05	2	2	8	A01PF22	1.89	1.73
KT04-08	2	2	9	A02PF22	1.88	1.74
KT04-09	2	2	10	A10PF12	1.89	1.72
KT04-07	2	2	11	A04PF22	1.86	1.73
KT04-06	2	2	12	A06PF22	1.88	1.74
Batch 1	2	2	13	BCHPF223	2.43	2.17

Table C-4. Comparison of Measured versus Targeted Composition for KT04 Glasses.

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
Batch 1	Al_2O_3	4.7820	4.8770	-0.0950	-1.9%
Batch 1	B_2O_3	7.6982	7.7770	-0.0788	-1.0%
Batch 1	BaO	0.1384	0.1510	-0.0126	-8.3%
Batch 1	CaO	1.1990	1.2200	-0.0210	-1.7%
Batch 1	Ce_2O_3	0.0059	0.0000	0.0059	
Batch 1	Cr_2O_3	0.1100	0.1070	0.0030	2.8%
Batch 1	CuO	0.3889	0.3990	-0.0101	-2.5%
Batch 1	Fe_2O_3	12.6409	12.8390	-0.1981	-1.5%
Batch 1	K_2O	2.7535	3.3270	-0.5735	-17.2%
Batch 1	La_2O_3	0.0059	0.0000	0.0059	
Batch 1	Li_2O	4.5534	4.4290	0.1244	2.8%
Batch 1	MgO	1.3324	1.4190	-0.0866	-6.1%
Batch 1	MnO	1.7108	1.7260	-0.0152	-0.9%
Batch 1	Na_2O	9.1394	9.0030	0.1364	1.5%
Batch 1	Nb_2O_5	0.0715	0.0000	0.0715	
Batch 1	NiO	0.6739	0.7510	-0.0771	-10.3%
Batch 1	PbO	0.0054	0.0000	0.0054	
Batch 1	SiO_2	49.8100	50.2200	-0.4100	-0.8%
Batch 1	TiO_2	0.6519	0.6770	-0.0251	-3.7%
Batch 1	ZnO	0.0062	0.0000	0.0062	
Batch 1	ZrO_2	0.0907	0.0980	-0.0073	-7.4%
Batch 1	Sum	97.7686	99.0200	-1.2514	-1.3%
KT04-01	Al_2O_3	5.8952	5.8000	0.0952	1.6%
KT04-01	B_2O_3	5.8844	6.0000	-0.1156	-1.9%
KT04-01	BaO	0.0628	0.0700	-0.0072	-10.3%
KT04-01	CaO	0.9633	0.9400	0.0233	2.5%
KT04-01	Ce_2O_3	0.2717	0.2900	-0.0183	-6.3%
KT04-01	Cr_2O_3	0.0756	0.0900	-0.0144	-16.0%
KT04-01	CuO	0.0551	0.0400	0.0151	37.7%
KT04-01	Fe_2O_3	11.6449	12.1100	-0.4651	-3.8%
KT04-01	K_2O	0.0373	0.0400	-0.0027	-6.6%
KT04-01	La_2O_3	0.0909	0.1100	-0.0191	-17.4%
KT04-01	Li_2O	3.6007	3.6000	0.0007	0.0%
KT04-01	MgO	0.1414	0.1500	-0.0086	-5.8%
KT04-01	MnO	1.9271	1.9300	-0.0029	-0.1%
KT04-01	Na_2O	13.1700	13.2200	-0.0500	-0.4%
KT04-01	Nb_2O_5	0.9459	1.0400	-0.0941	-9.0%
KT04-01	NiO	0.2990	0.3500	-0.0510	-14.6%
KT04-01	PbO	0.1301	0.1600	-0.0299	-18.7%
KT04-01	SiO_2	47.7064	48.8000	-1.0936	-2.2%
KT04-01	TiO_2	4.2909	4.3500	-0.0591	-1.4%
KT04-01	ZnO	0.0062	0.0000	0.0062	
KT04-01	ZrO_2	0.8321	0.9200	-0.0879	-9.6%
KT04-01	Sum	98.0312	100.0100	-1.9788	-2.0%
KT04-02	Al_2O_3	5.3426	5.1900	0.1526	2.9%
KT04-02	B_2O_3	5.8441	6.0000	-0.1559	-2.6%
KT04-02	BaO	0.0673	0.0700	-0.0027	-3.9%
KT04-02	CaO	0.9731	0.9500	0.0231	2.4%
KT04-02	Ce_2O_3	0.2782	0.2900	-0.0118	-4.1%
KT04-02	Cr_2O_3	0.0808	0.0900	-0.0092	-10.3%
KT04-02	CuO	0.0451	0.0400	0.0051	12.7%
KT04-02	Fe_2O_3	11.2696	11.5600	-0.2904	-2.5%
KT04-02	K_2O	0.0361	0.0400	-0.0039	-9.7%
KT04-02	La_2O_3	0.0630	0.0700	-0.0070	-9.9%
KT04-02	Li_2O	3.6545	3.6000	0.0545	1.5%
KT04-02	MgO	0.1459	0.1500	-0.0041	-2.7%
KT04-02	MnO	1.7302	1.7100	0.0202	1.2%
KT04-02	Na_2O	14.2214	14.0800	0.1414	1.0%
KT04-02	Nb_2O_5	1.0500	1.1000	-0.0500	-4.5%

Table C-4. Comparison of Measured versus Targeted Composition for KT04 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT04-02	NiO	0.1715	0.2000	-0.0285	-14.3%
KT04-02	PbO	0.1091	0.1300	-0.0209	-16.1%
KT04-02	SiO_2	48.4551	49.3200	-0.8649	-1.8%
KT04-02	TiO_2	4.4160	4.3800	0.0360	0.8%
KT04-02	ZnO	0.0355	0.0400	-0.0045	-11.3%
KT04-02	ZrO_2	0.9364	1.0100	-0.0736	-7.3%
KT04-02	Sum	98.9256	100.0200	-1.0944	-1.1%
KT04-03	Al_2O_3	4.7096	4.4900	0.2196	4.9%
KT04-03	B_2O_3	5.9085	6.0000	-0.0915	-1.5%
KT04-03	BaO	0.0622	0.0700	-0.0078	-11.1%
KT04-03	CaO	1.0099	0.9600	0.0499	5.2%
KT04-03	Ce_2O_3	0.2378	0.2600	-0.0222	-8.5%
KT04-03	Cr_2O_3	0.0808	0.0900	-0.0092	-10.3%
KT04-03	CuO	0.0463	0.0400	0.0063	15.8%
KT04-03	Fe_2O_3	11.3161	11.5300	-0.2139	-1.9%
KT04-03	K_2O	0.0449	0.0400	0.0049	12.2%
KT04-03	La_2O_3	0.0619	0.0700	-0.0081	-11.6%
KT04-03	Li_2O	3.6330	3.6000	0.0330	0.9%
KT04-03	MgO	0.1430	0.1500	-0.0070	-4.6%
KT04-03	MnO	1.8109	1.8100	0.0009	0.1%
KT04-03	Na_2O	14.7269	14.3600	0.3669	2.6%
KT04-03	Nb_2O_5	1.0385	1.1000	-0.0615	-5.6%
KT04-03	NiO	0.2640	0.3200	-0.0560	-17.5%
KT04-03	PbO	0.1069	0.1300	-0.0231	-17.8%
KT04-03	SiO_2	48.2947	49.5300	-1.2353	-2.5%
KT04-03	TiO_2	4.3285	4.4000	-0.0715	-1.6%
KT04-03	ZnO	0.0358	0.0400	-0.0042	-10.5%
KT04-03	ZrO_2	0.9250	1.0200	-0.0950	-9.3%
KT04-03	Sum	98.7851	100.0100	-1.2249	-1.2%
KT04-04	Al_2O_3	5.0969	4.9700	0.1269	2.6%
KT04-04	B_2O_3	5.8441	6.0000	-0.1559	-2.6%
KT04-04	BaO	0.0586	0.0700	-0.0114	-16.3%
KT04-04	CaO	0.9074	0.8600	0.0474	5.5%
KT04-04	Ce_2O_3	0.1944	0.2200	-0.0256	-11.6%
KT04-04	Cr_2O_3	0.0793	0.0900	-0.0107	-11.9%
KT04-04	CuO	0.0598	0.0400	0.0198	49.4%
KT04-04	Fe_2O_3	11.6842	12.1700	-0.4858	-4.0%
KT04-04	K_2O	0.0458	0.0400	0.0058	14.4%
KT04-04	La_2O_3	0.0569	0.0700	-0.0131	-18.7%
KT04-04	Li_2O	3.6115	3.6000	0.0115	0.3%
KT04-04	MgO	0.1389	0.1500	-0.0111	-7.4%
KT04-04	MnO	1.0336	1.0700	-0.0364	-3.4%
KT04-04	Na_2O	13.8541	13.8000	0.0541	0.4%
KT04-04	Nb_2O_5	0.9656	1.0600	-0.0944	-8.9%
KT04-04	NiO	0.1368	0.1600	-0.0232	-14.5%
KT04-04	PbO	0.0768	0.1000	-0.0232	-23.2%
KT04-04	SiO_2	49.3109	50.1300	-0.8191	-1.6%
KT04-04	TiO_2	4.3368	4.4100	-0.0732	-1.7%
KT04-04	ZnO	0.0710	0.0800	-0.0090	-11.3%
KT04-04	ZrO_2	0.8291	0.9400	-0.1109	-11.8%
KT04-04	Sum	98.3923	100.0300	-1.6377	-1.6%
KT04-05	Al_2O_3	7.0337	6.8900	0.1437	2.1%
KT04-05	B_2O_3	5.9085	6.0000	-0.0915	-1.5%
KT04-05	BaO	0.0614	0.0700	-0.0086	-12.3%
KT04-05	CaO	0.9462	0.9400	0.0062	0.7%
KT04-05	Ce_2O_3	0.1373	0.1400	-0.0027	-1.9%
KT04-05	Cr_2O_3	0.1494	0.1300	0.0194	15.0%
KT04-05	CuO	0.0595	0.0400	0.0195	48.7%

Table C-4. Comparison of Measured versus Targeted Composition for KT04 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT04-05	Fe_2O_3	9.3788	9.6700	-0.2912	-3.0%
KT04-05	K_2O	0.0780	0.0700	0.0080	11.4%
KT04-05	La_2O_3	0.0586	0.0700	-0.0114	-16.2%
KT04-05	Li_2O	3.6545	3.6000	0.0545	1.5%
KT04-05	MgO	0.1468	0.1500	-0.0032	-2.2%
KT04-05	MnO	0.9962	1.0300	-0.0338	-3.3%
KT04-05	Na_2O	13.5643	13.7600	-0.1958	-1.4%
KT04-05	Nb_2O_5	1.0167	1.0800	-0.0633	-5.9%
KT04-05	NiO	0.1053	0.1200	-0.0147	-12.3%
KT04-05	PbO	0.0566	0.0700	-0.0134	-19.2%
KT04-05	SiO_2	49.7922	50.6700	-0.8778	-1.7%
KT04-05	TiO_2	4.3868	4.4700	-0.0832	-1.9%
KT04-05	ZnO	0.0373	0.0400	-0.0027	-6.6%
KT04-05	ZrO_2	0.9358	1.0000	-0.0642	-6.4%
KT04-05	Sum	98.5040	100.0100	-1.5060	-1.5%
KT04-06	Al_2O_3	7.5202	7.3100	0.2102	2.9%
KT04-06	B_2O_3	5.8924	6.0000	-0.1076	-1.8%
KT04-06	BaO	0.0611	0.0700	-0.0089	-12.7%
KT04-06	CaO	1.0295	1.0000	0.0295	2.9%
KT04-06	Ce_2O_3	0.1010	0.1100	-0.0090	-8.2%
KT04-06	Cr_2O_3	0.0862	0.1400	-0.0538	-38.4%
KT04-06	CuO	0.0663	0.0400	0.0263	65.9%
KT04-06	Fe_2O_3	8.7498	9.1200	-0.3702	-4.1%
KT04-06	K_2O	0.1364	0.1100	0.0264	24.0%
KT04-06	La_2O_3	0.0267	0.0400	-0.0133	-33.3%
KT04-06	Li_2O	3.6653	3.6000	0.0653	1.8%
KT04-06	MgO	0.0949	0.1000	-0.0051	-5.1%
KT04-06	MnO	1.1663	1.2000	-0.0337	-2.8%
KT04-06	Na_2O	13.9518	13.7700	0.1818	1.3%
KT04-06	Nb_2O_5	0.9506	1.0300	-0.0794	-7.7%
KT04-06	NiO	0.1333	0.1600	-0.0267	-16.7%
KT04-06	PbO	0.0557	0.0700	-0.0143	-20.4%
KT04-06	SiO_2	48.8295	50.6600	-1.8305	-3.6%
KT04-06	TiO_2	4.3702	4.4200	-0.0498	-1.1%
KT04-06	ZnO	0.0812	0.0800	0.0012	1.5%
KT04-06	ZrO_2	0.8790	0.9700	-0.0910	-9.4%
KT04-06	Sum	97.8476	100.0000	-2.1524	-2.2%
KT04-07	Al_2O_3	5.8622	5.6900	0.1722	3.0%
KT04-07	B_2O_3	5.8361	6.0000	-0.1639	-2.7%
KT04-07	BaO	0.0689	0.0800	-0.0111	-13.8%
KT04-07	CaO	0.9119	0.9000	0.0119	1.3%
KT04-07	Ce_2O_3	0.0779	0.0800	-0.0021	-2.6%
KT04-07	Cr_2O_3	0.1104	0.1500	-0.0396	-26.4%
KT04-07	CuO	0.0438	0.0400	0.0038	9.5%
KT04-07	Fe_2O_3	9.1644	9.4900	-0.3256	-3.4%
KT04-07	K_2O	0.0885	0.0800	0.0085	10.7%
KT04-07	La_2O_3	0.0325	0.0400	-0.0075	-18.6%
KT04-07	Li_2O	3.6707	3.6000	0.0707	2.0%
KT04-07	MgO	0.1082	0.1100	-0.0018	-1.6%
KT04-07	MnO	0.7034	0.7400	-0.0366	-4.9%
KT04-07	Na_2O	14.5584	14.6400	-0.0816	-0.6%
KT04-07	Nb_2O_5	1.1237	1.2100	-0.0863	-7.1%
KT04-07	NiO	0.5589	0.6500	-0.0911	-14.0%
KT04-07	PbO	0.0646	0.0700	-0.0054	-7.7%
KT04-07	SiO_2	48.6691	50.3800	-1.7109	-3.4%
KT04-07	TiO_2	4.8455	4.9000	-0.0545	-1.1%
KT04-07	ZnO	0.0787	0.0800	-0.0013	-1.6%
KT04-07	ZrO_2	0.9881	1.0700	-0.0819	-7.7%

Table C-4. Comparison of Measured versus Targeted Composition for KT04 Glasses. (continued)

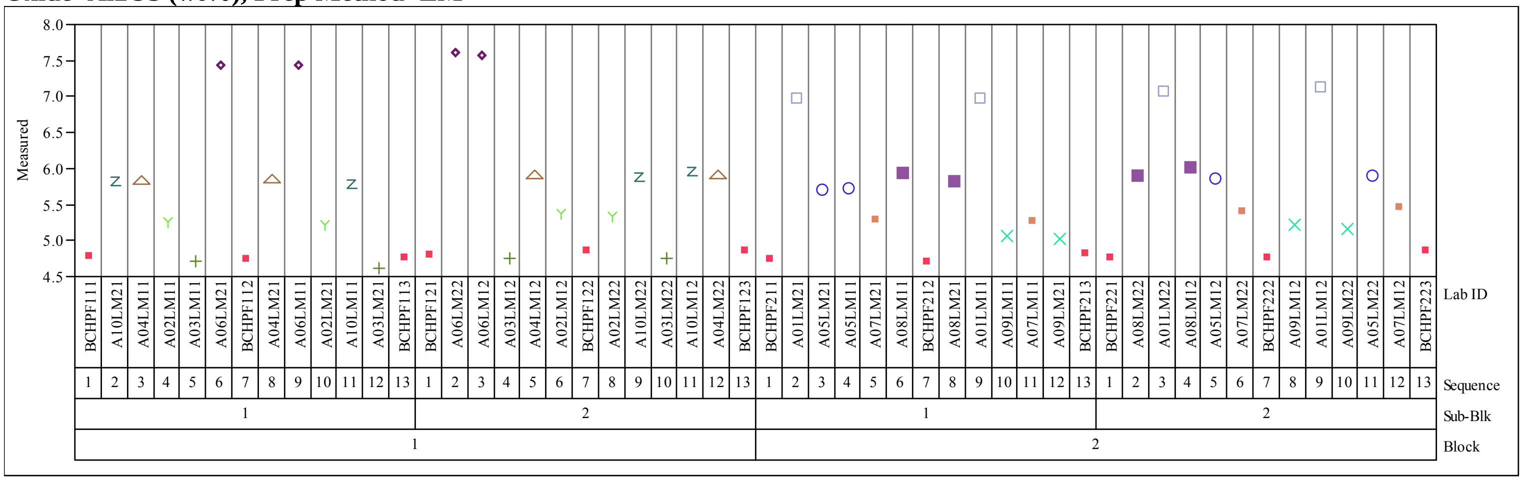
Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT04-07	Sum	97.5660	100.0000	-2.4340	-2.4%
KT04-08	Al_2O_3	5.2906	5.0700	0.2206	4.4%
KT04-08	B_2O_3	5.8602	6.0000	-0.1398	-2.3%
KT04-08	BaO	0.0695	0.0800	-0.0105	-13.1%
KT04-08	CaO	0.8514	0.8100	0.0414	5.1%
KT04-08	Ce_2O_3	0.0805	0.0800	0.0005	0.7%
KT04-08	Cr_2O_3	0.1049	0.1000	0.0049	4.9%
KT04-08	CuO	0.0523	0.0400	0.0123	30.7%
KT04-08	Fe_2O_3	9.0035	9.2400	-0.2365	-2.6%
KT04-08	K_2O	0.0964	0.0800	0.0164	20.5%
KT04-08	La_2O_3	0.0334	0.0400	-0.0066	-16.4%
KT04-08	Li_2O	3.6599	3.6000	0.0599	1.7%
KT04-08	MgO	0.1053	0.1100	-0.0047	-4.3%
KT04-08	MnO	0.9429	0.9700	-0.0271	-2.8%
KT04-08	Na_2O	15.7379	15.5600	0.1779	1.1%
KT04-08	Nb_2O_5	1.2624	1.3100	-0.0476	-3.6%
KT04-08	NiO	0.5275	0.6100	-0.0825	-13.5%
KT04-08	PbO	0.0646	0.0700	-0.0054	-7.7%
KT04-08	SiO_2	49.0435	50.0400	-0.9965	-2.0%
KT04-08	TiO_2	4.9665	4.9900	-0.0235	-0.5%
KT04-08	ZnO	0.0417	0.0400	0.0017	4.3%
KT04-08	ZrO_2	1.0519	1.1400	-0.0881	-7.7%
KT04-08	Sum	98.8468	99.9800	-1.1332	-1.1%
KT04-09	Al_2O_3	5.8575	5.5300	0.3275	5.9%
KT04-09	B_2O_3	5.8924	6.0000	-0.1076	-1.8%
KT04-09	BaO	0.0659	0.0800	-0.0141	-17.7%
KT04-09	CaO	1.0253	0.9600	0.0653	6.8%
KT04-09	Ce_2O_3	0.1862	0.2000	-0.0138	-6.9%
KT04-09	Cr_2O_3	0.0694	0.1000	-0.0306	-30.6%
KT04-09	CuO	0.0726	0.0400	0.0326	81.5%
KT04-09	Fe_2O_3	12.0381	12.4300	-0.3919	-3.2%
KT04-09	K_2O	0.1093	0.0800	0.0293	36.6%
KT04-09	La_2O_3	0.0674	0.0800	-0.0126	-15.7%
KT04-09	Li_2O	3.6438	3.6000	0.0438	1.2%
KT04-09	MgO	0.1036	0.1100	-0.0064	-5.8%
KT04-09	MnO	0.5417	0.5800	-0.0383	-6.6%
KT04-09	Na_2O	14.4910	14.1500	0.3410	2.4%
KT04-09	Nb_2O_5	0.8172	0.8500	-0.0328	-3.9%
KT04-09	NiO	0.4327	0.5200	-0.0874	-16.8%
KT04-09	PbO	0.1180	0.1500	-0.0320	-21.4%
KT04-09	SiO_2	47.7064	48.7900	-1.0836	-2.2%
KT04-09	TiO_2	4.8706	4.8800	-0.0094	-0.2%
KT04-09	ZnO	0.0464	0.0400	0.0064	15.9%
KT04-09	ZrO_2	0.7413	0.8100	-0.0687	-8.5%
KT04-09	Sum	98.8965	99.9800	-1.0835	-1.1%
KT04-10	Al_2O_3	5.7960	5.6800	0.1160	2.0%
KT04-10	B_2O_3	5.8844	6.0000	-0.1156	-1.9%
KT04-10	BaO	0.0770	0.0800	-0.0030	-3.7%
KT04-10	CaO	0.9885	0.9800	0.0085	0.9%
KT04-10	Ce_2O_3	0.2460	0.2500	-0.0040	-1.6%
KT04-10	Cr_2O_3	0.0808	0.1000	-0.0192	-19.2%
KT04-10	CuO	0.0523	0.0400	0.0123	30.7%
KT04-10	Fe_2O_3	13.2283	13.7400	-0.5117	-3.7%
KT04-10	K_2O	0.0425	0.0400	0.0025	6.2%
KT04-10	La_2O_3	0.0754	0.0800	-0.0046	-5.8%
KT04-10	Li_2O	3.6115	3.6000	0.0115	0.3%
KT04-10	MgO	0.1123	0.1200	-0.0077	-6.4%
KT04-10	MnO	0.3535	0.4100	-0.0565	-13.8%

Table C-4. Comparison of Measured versus Targeted Composition for KT04 Glasses. (continued)

Glass ID	Oxide	Measured (wt%)	Targeted (wt%)	Difference of Measured versus Targeted	% Difference of Measured versus Targeted
KT04-10	Na_2O	13.5137	13.6300	-0.1163	-0.9%
KT04-10	Nb_2O_5	0.7675	0.7900	-0.0225	-2.9%
KT04-10	NiO	0.4279	0.4900	-0.0621	-12.7%
KT04-10	PbO	0.1287	0.1500	-0.0213	-14.2%
KT04-10	SiO_2	47.7599	48.4500	-0.6901	-1.4%
KT04-10	TiO_2	4.5370	4.5600	-0.0230	-0.5%
KT04-10	ZnO	0.0417	0.0400	0.0017	4.3%
KT04-10	ZrO_2	0.7298	0.7700	-0.0402	-5.2%
KT04-10	Sum	98.4545	100.0000	-1.5455	-1.5%

Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide.

Oxide=Al2O3 (wt%), Prep Method=LM



Oxide=B2O3 (wt%), Prep Method=PF

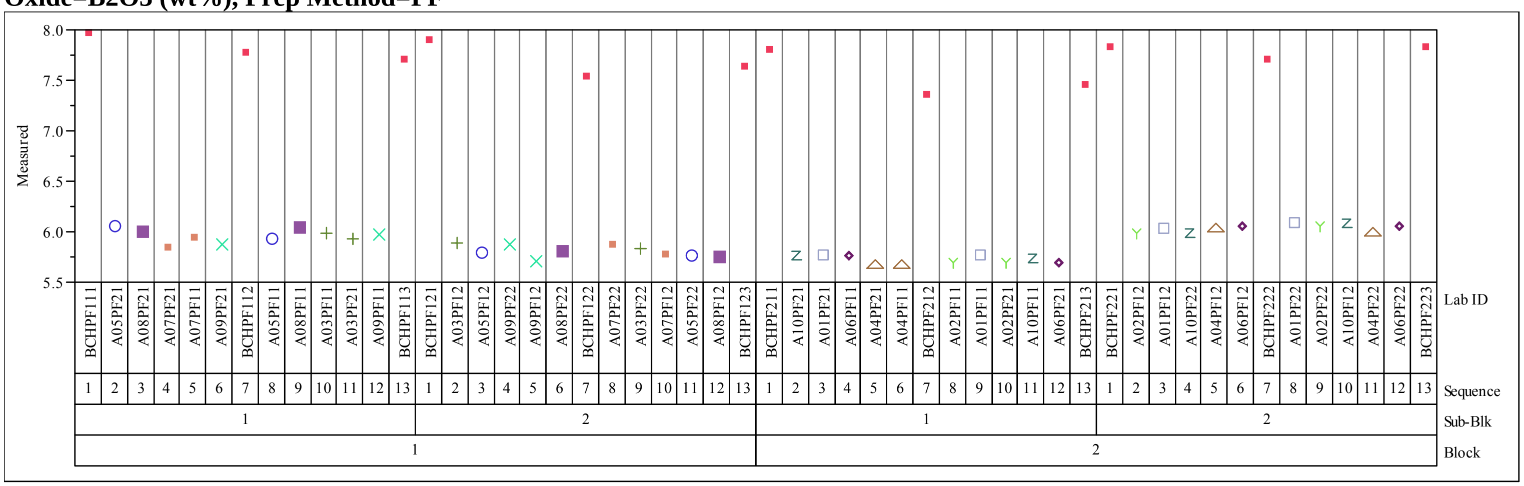
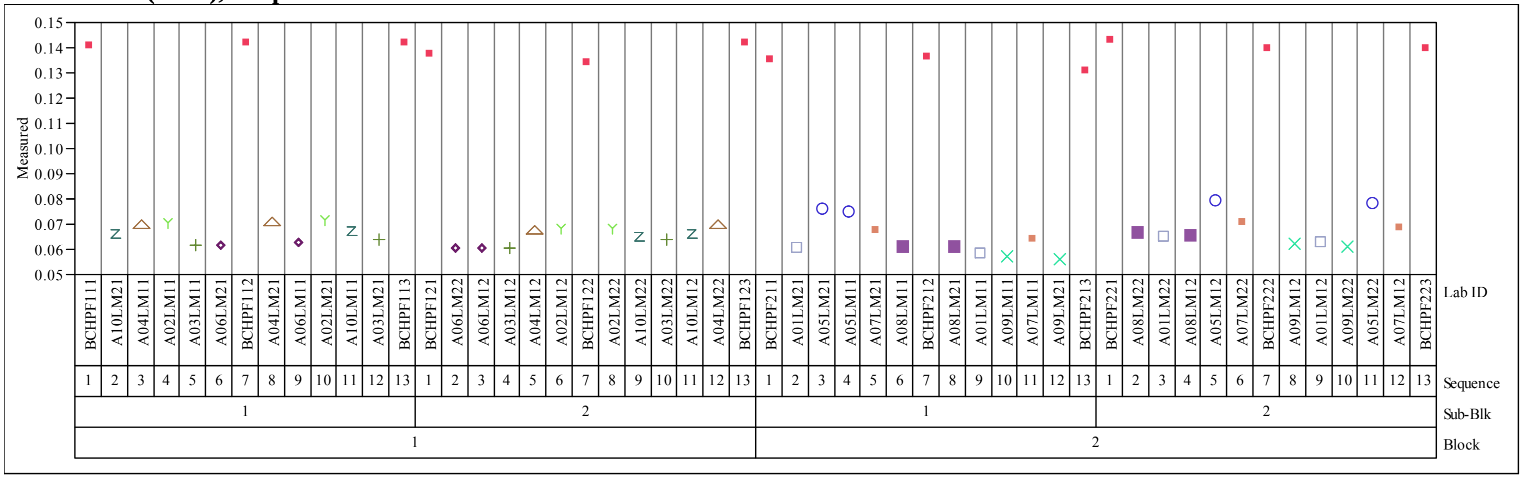


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=BaO (wt%), Prep Method=LM



Oxide=CaO (wt%), Prep Method=LM

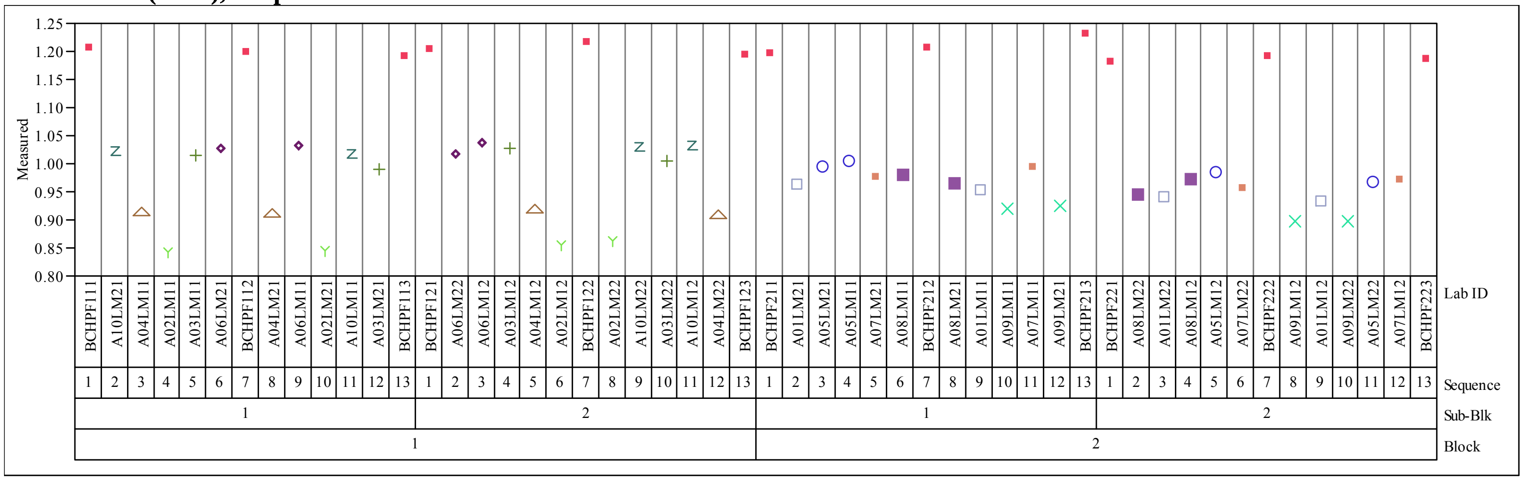
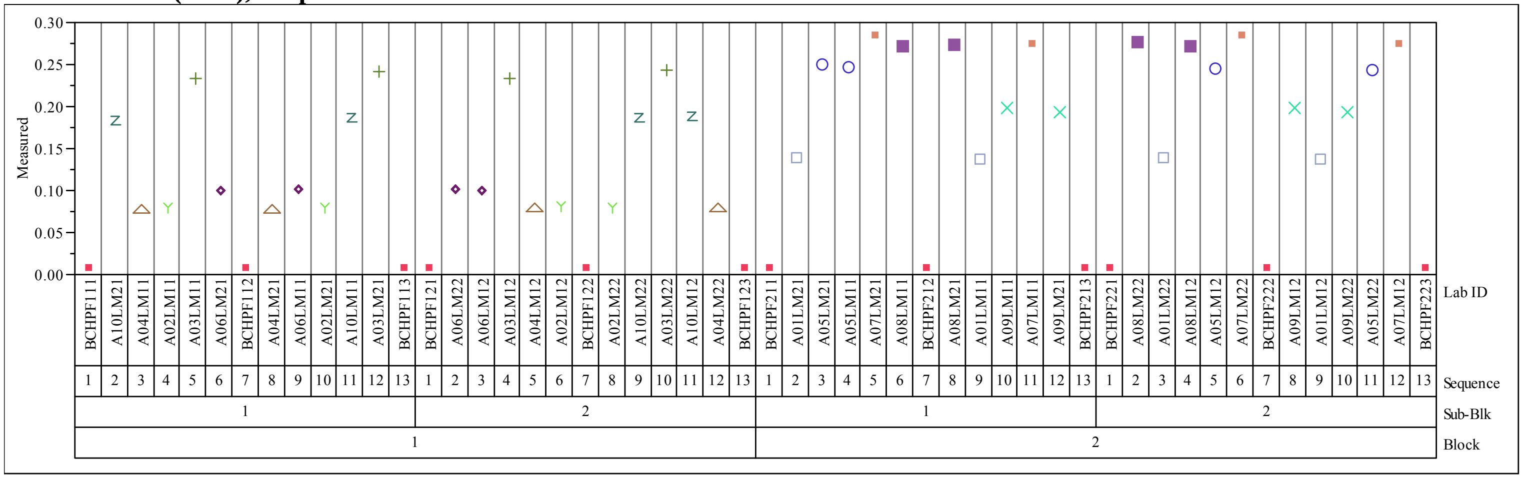


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=Ce2O3 (wt%), Prep Method=LM



Oxide=Cr2O3 (wt%), Prep Method=LM

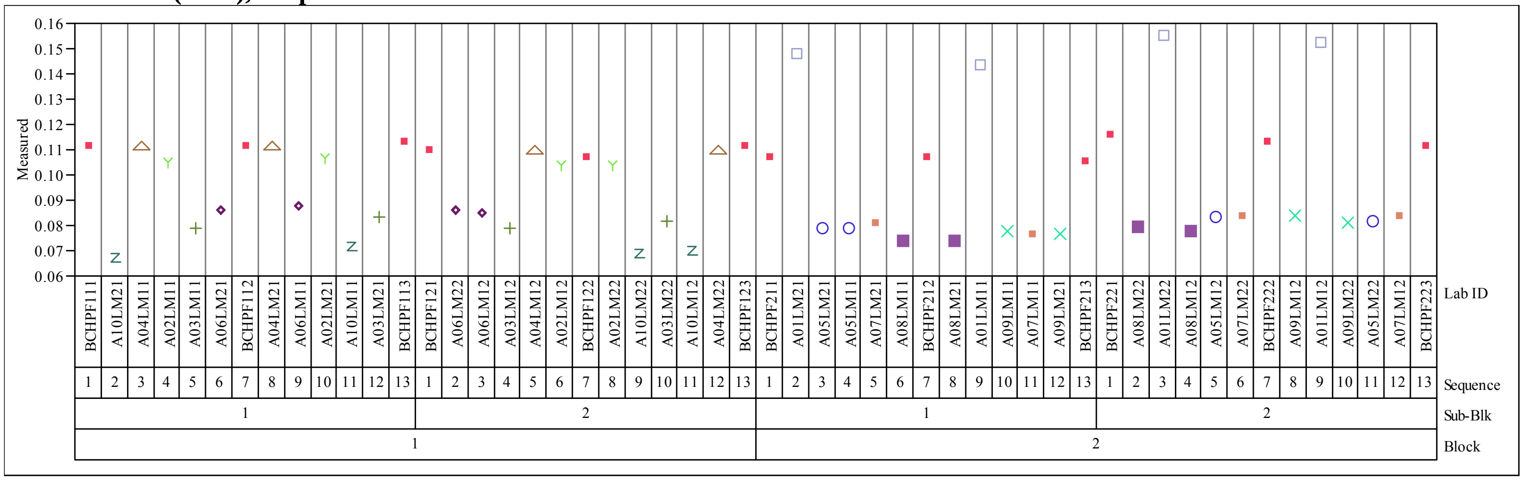
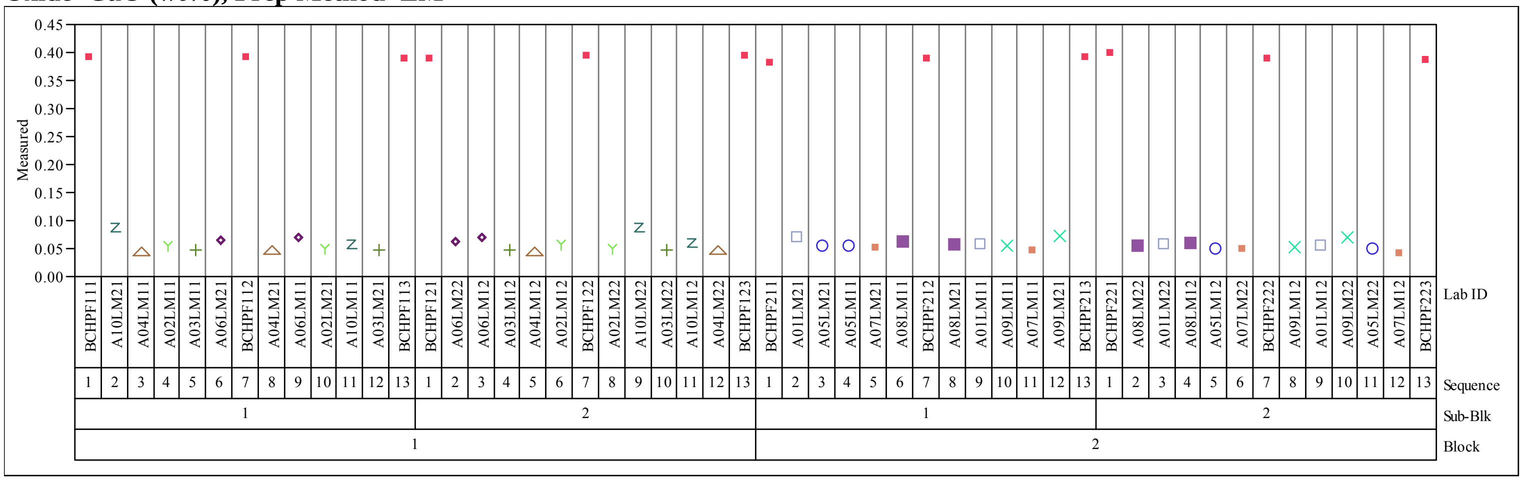


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=CuO (wt%), Prep Method=LM



Oxide=Fe2O3 (wt%), Prep Method=LM

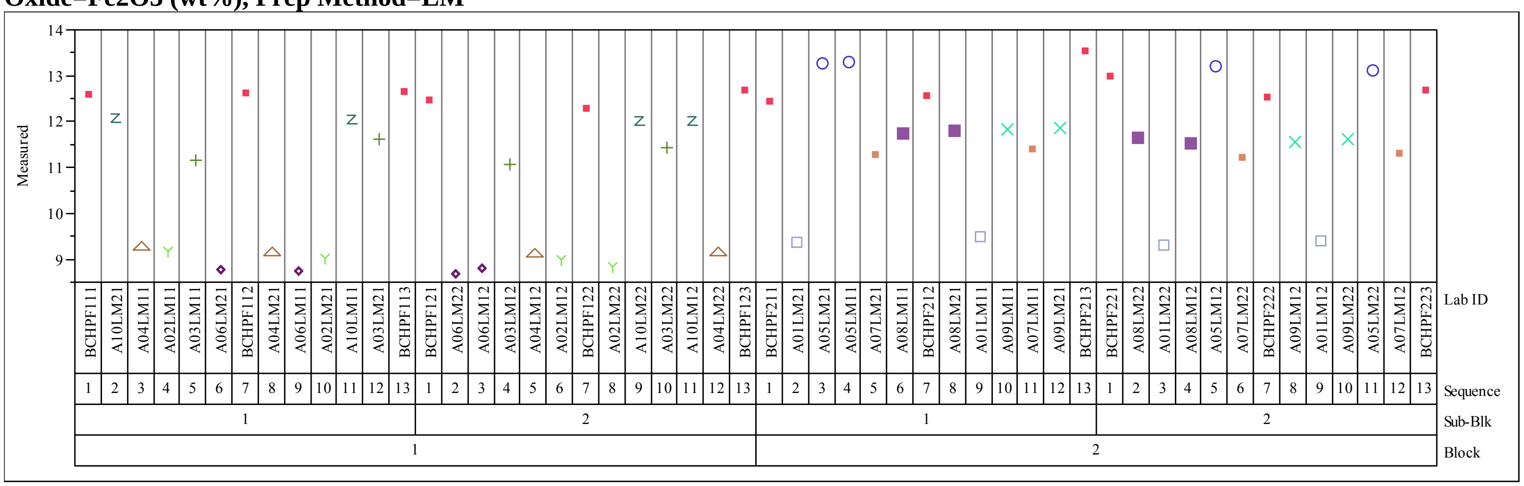
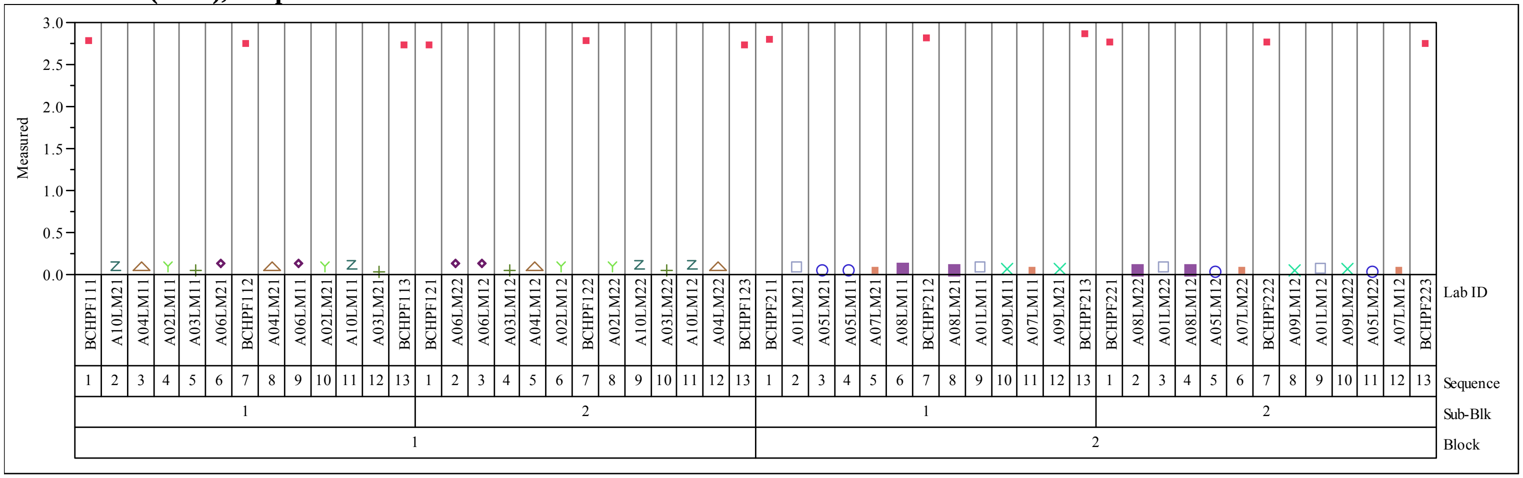


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=K2O (wt%), Prep Method=LM



Oxide=La2O3 (wt%), Prep Method=LM

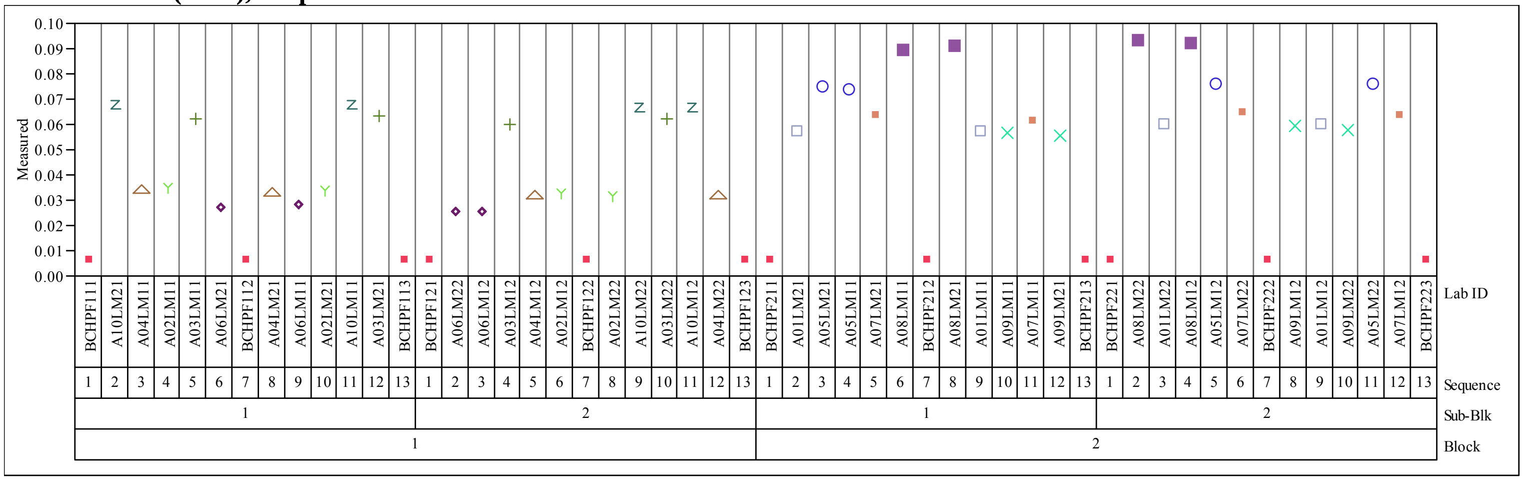
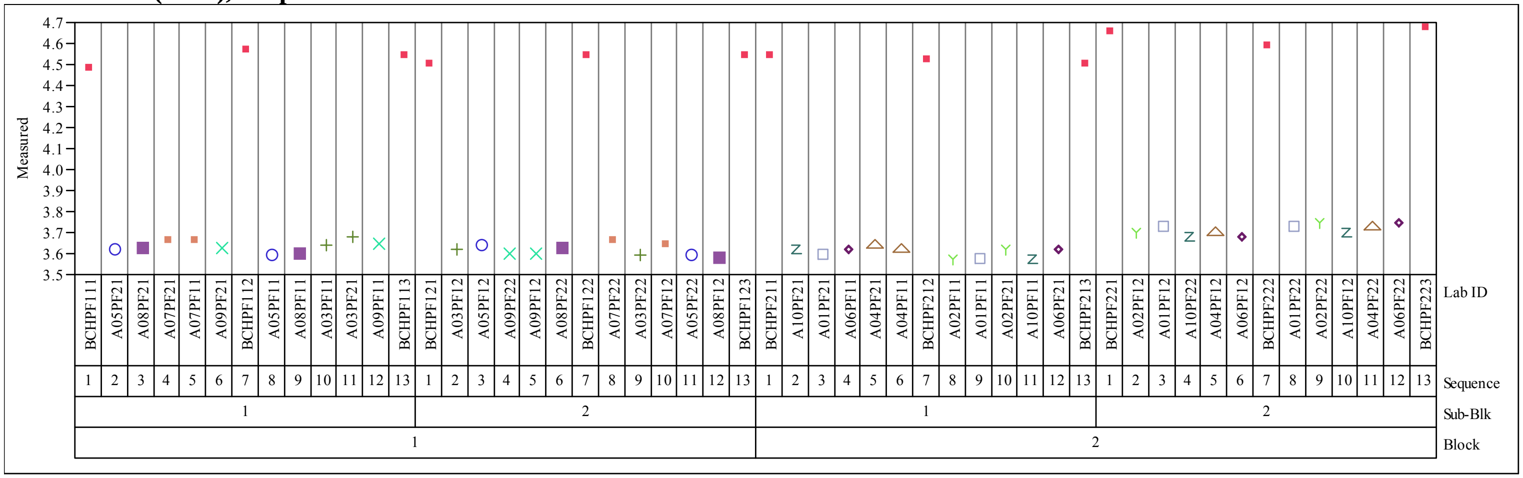


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=Li2O (wt%), Prep Method=PF



Oxide=MgO (wt%), Prep Method=LM

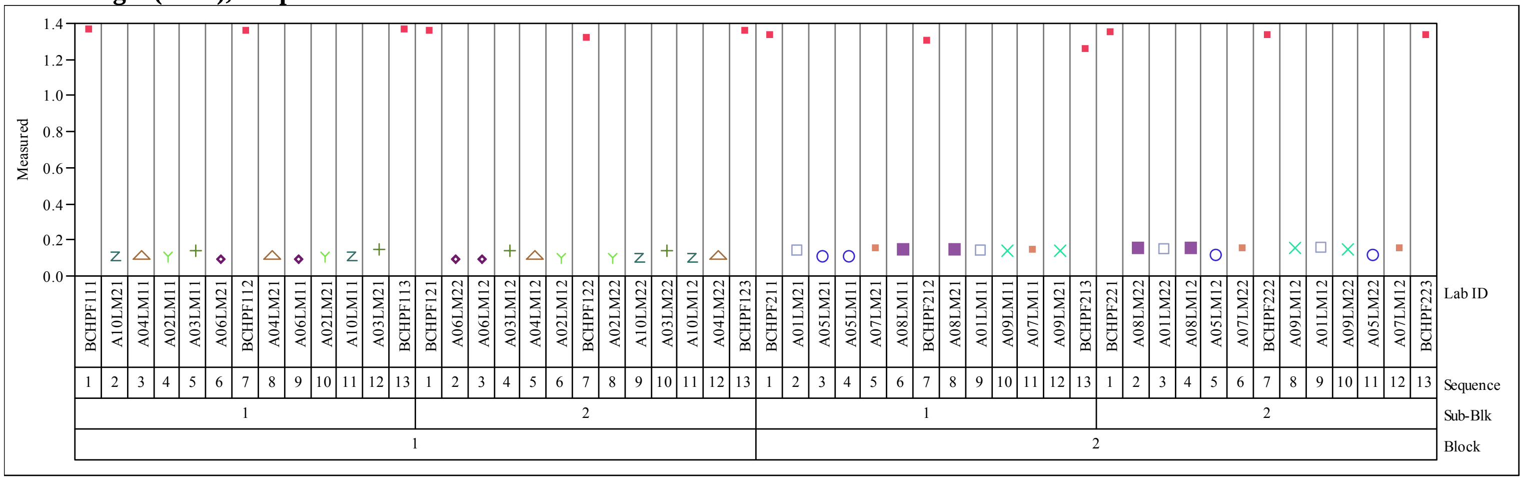
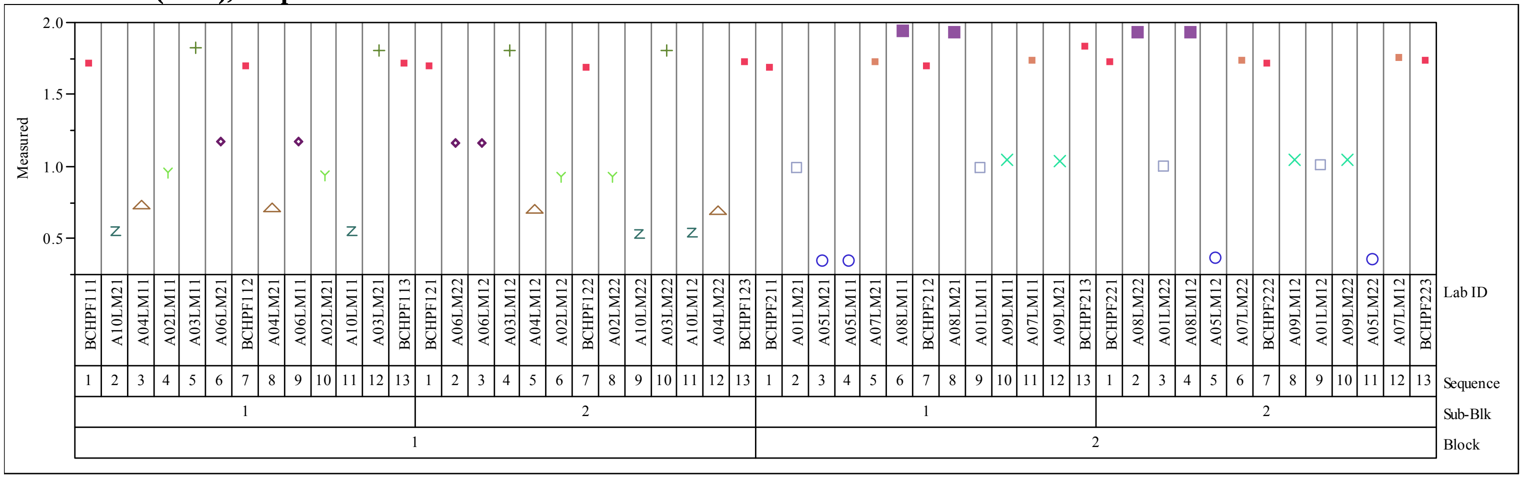


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=MnO (wt%), Prep Method=LM



Oxide=Na2O (wt%), Prep Method=LM

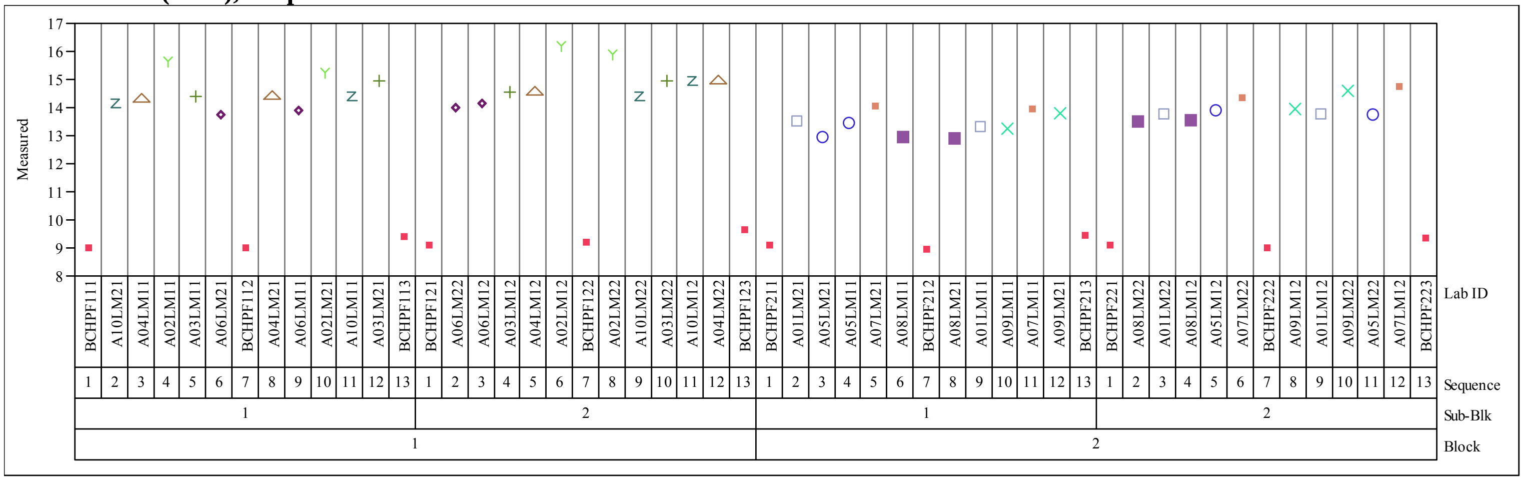
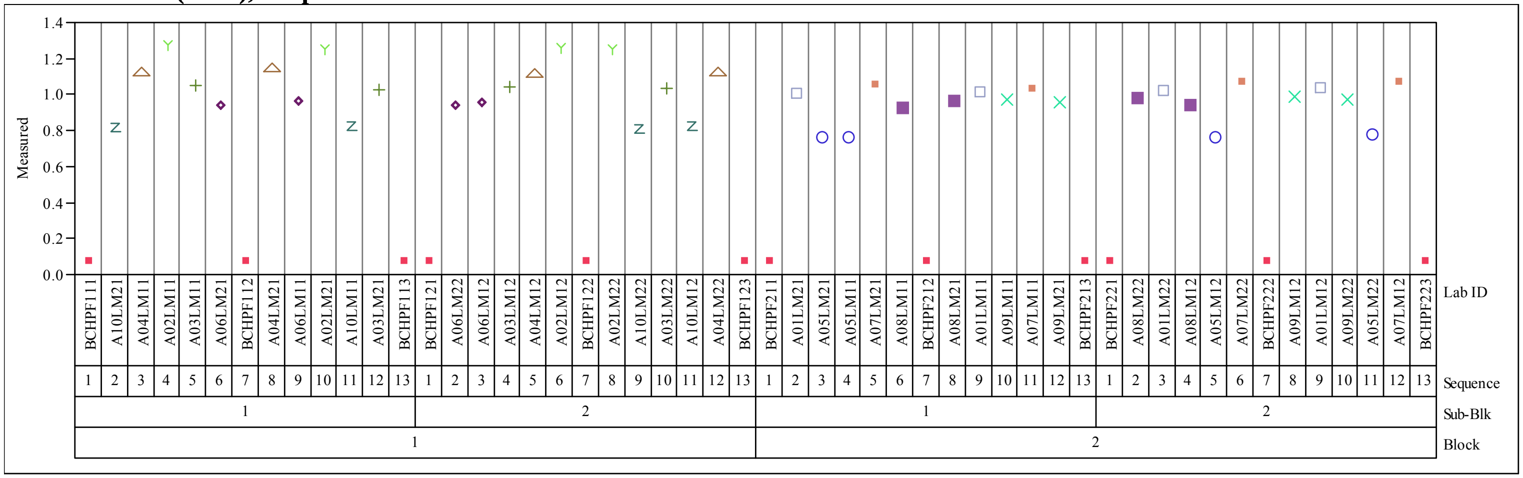


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=Nb2O5 (wt%), Prep Method=LM



Oxide=NiO (wt%), Prep Method=LM

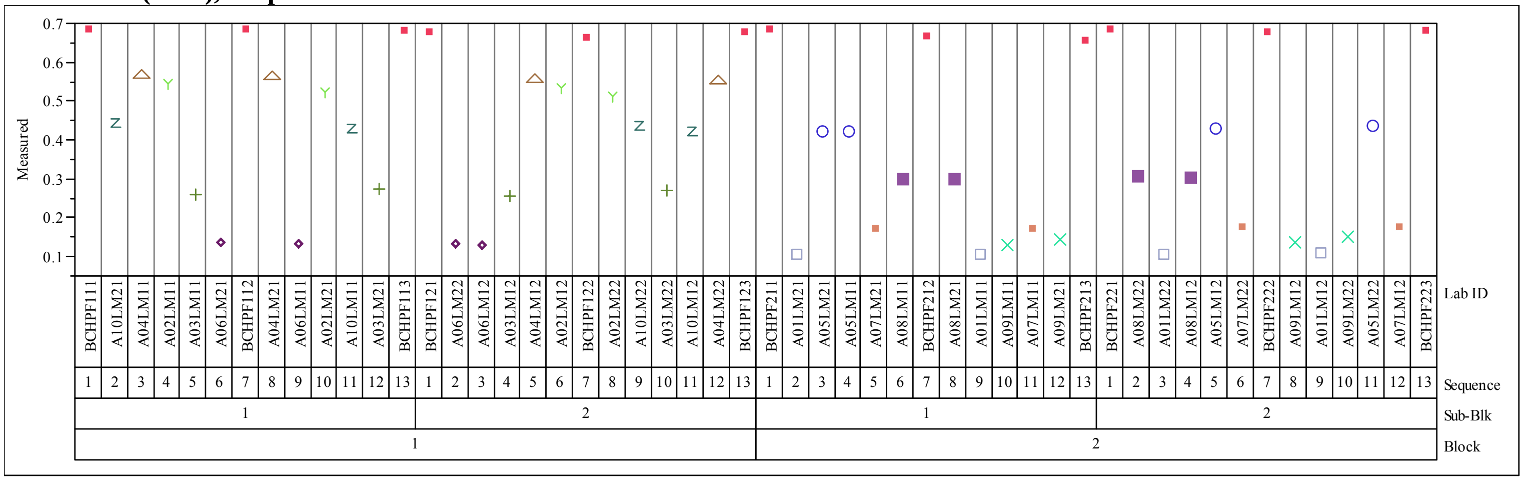
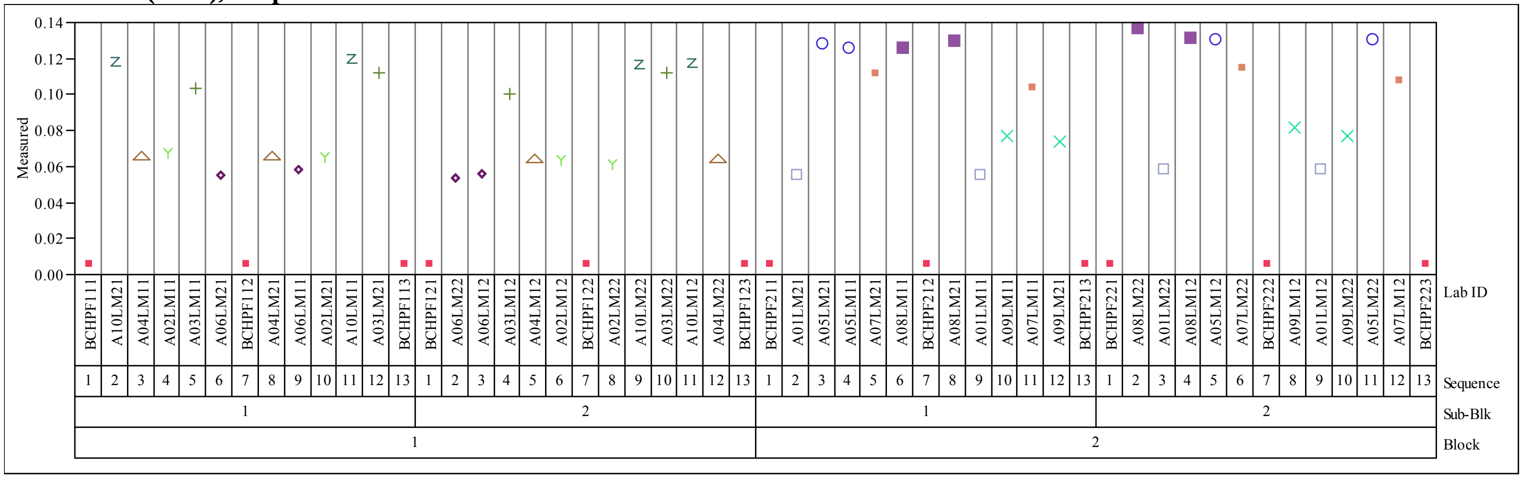


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=PbO (wt%), Prep Method=LM



Oxide=SiO2 (wt%), Prep Method=LM

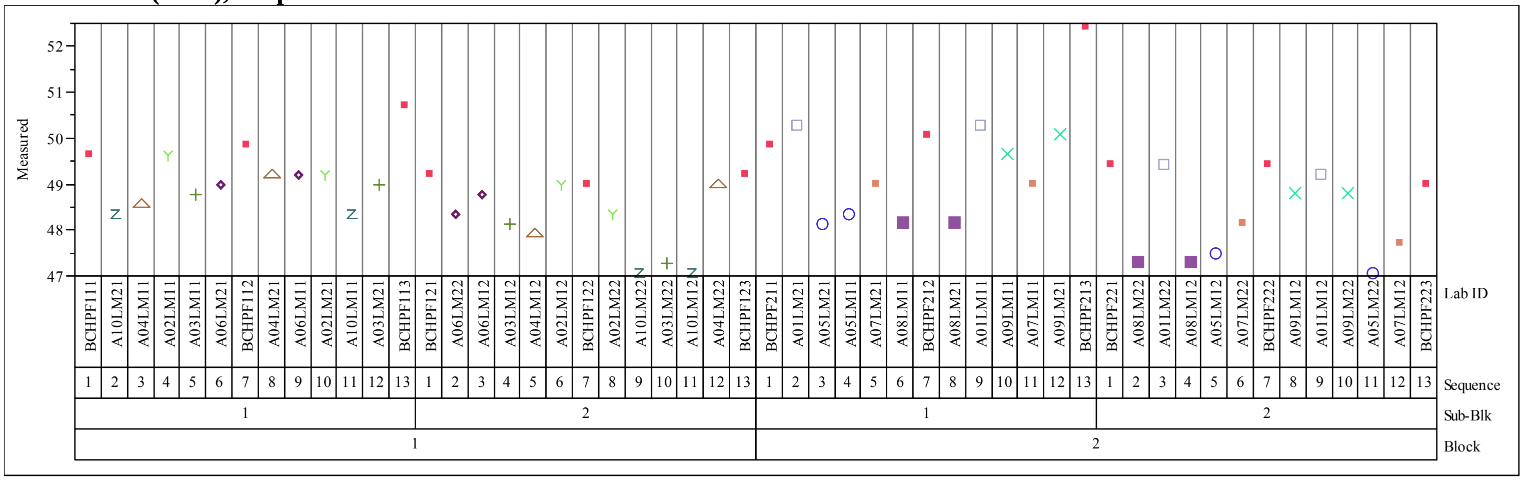
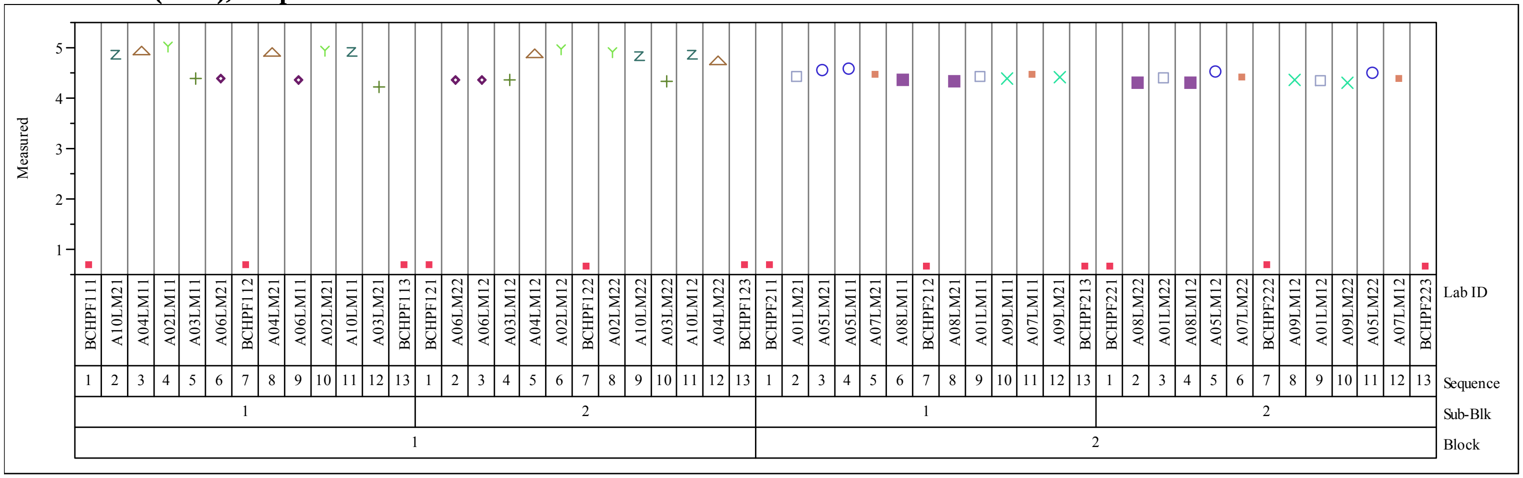


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=TiO2 (wt%), Prep Method=LM



Oxide=ZnO (wt%), Prep Method=LM

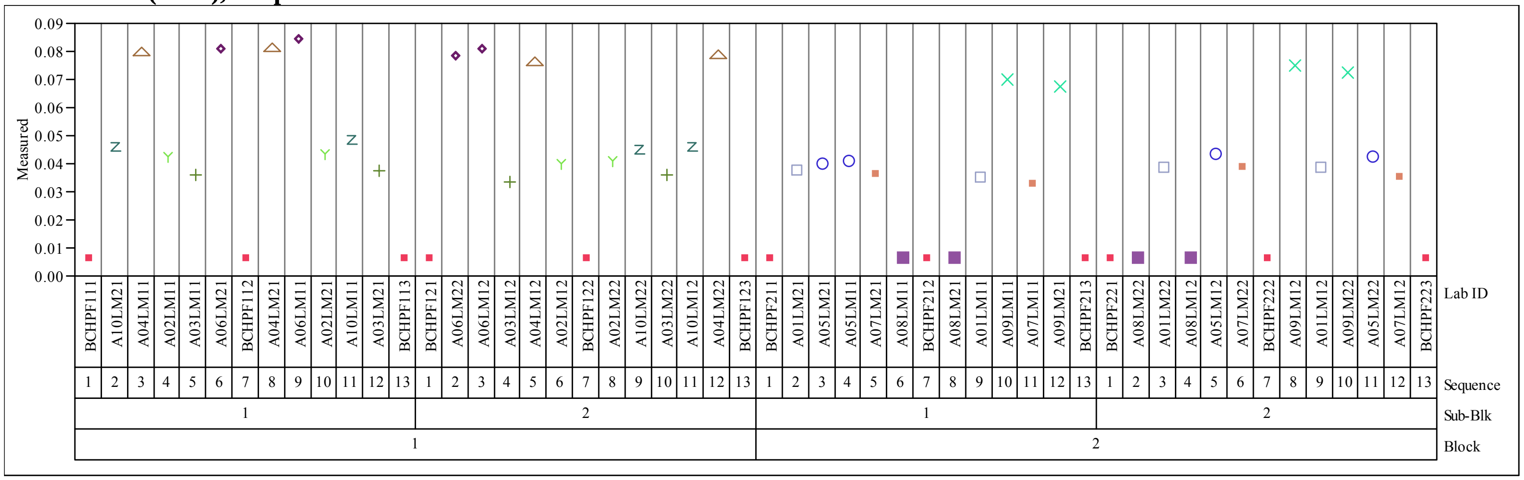


Exhibit C-1 Measurements in Analytical Sequence for KT04-Series by Preparation Method by Oxide. (continued)

Oxide=ZrO2 (wt%), Prep Method=LM

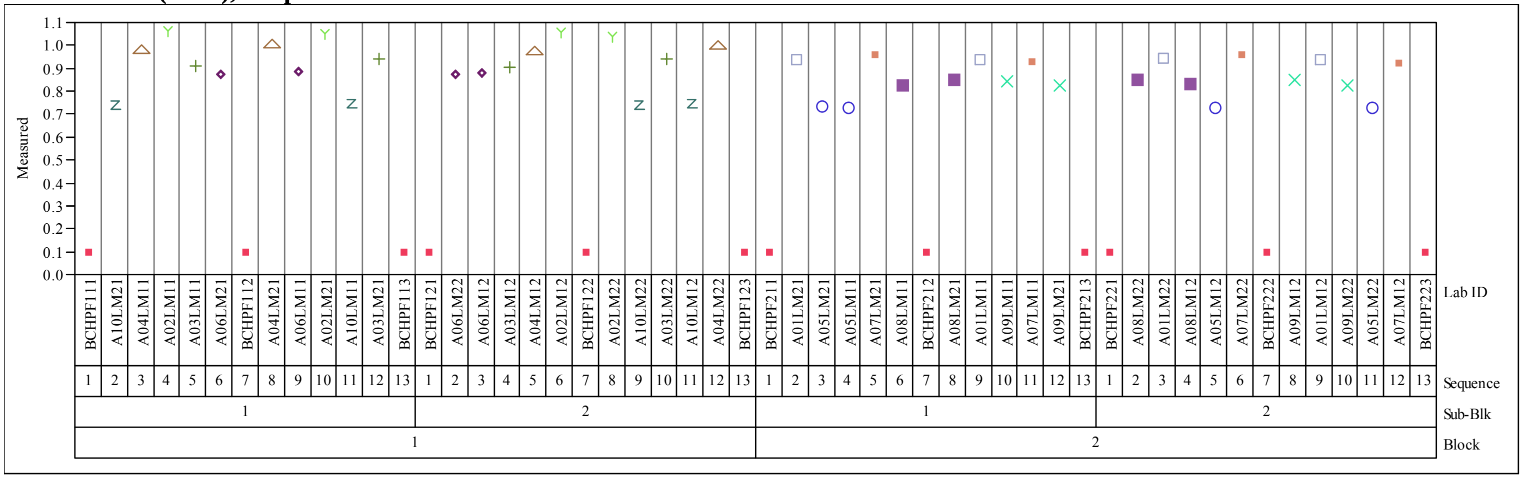
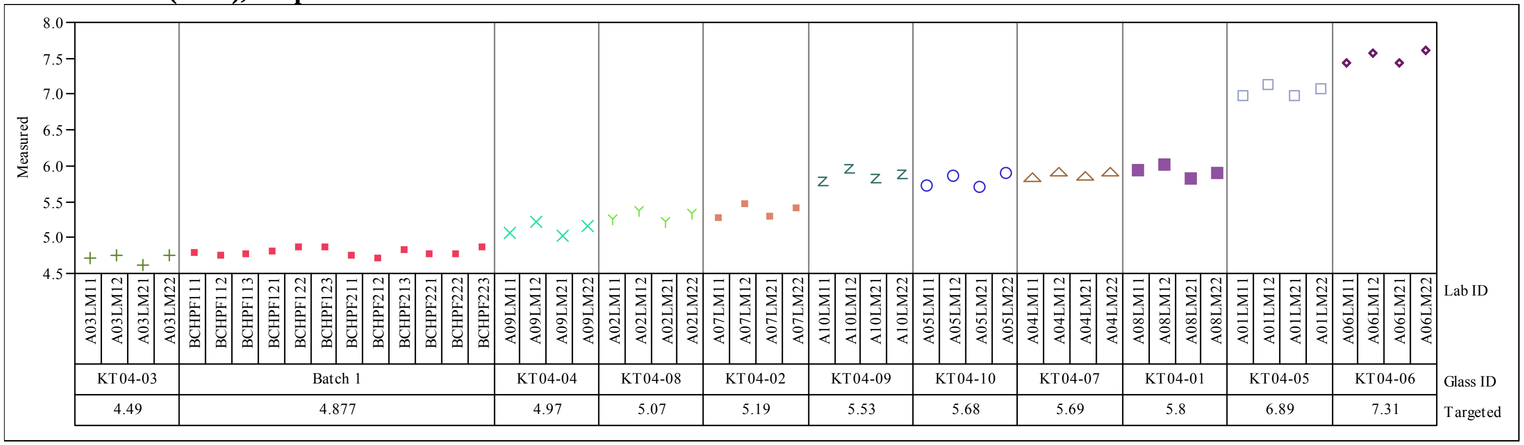


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide.

Oxide=Al2O3 (wt%), Prep Method=LM



Oxide=B2O3 (wt%), Prep Method=PF

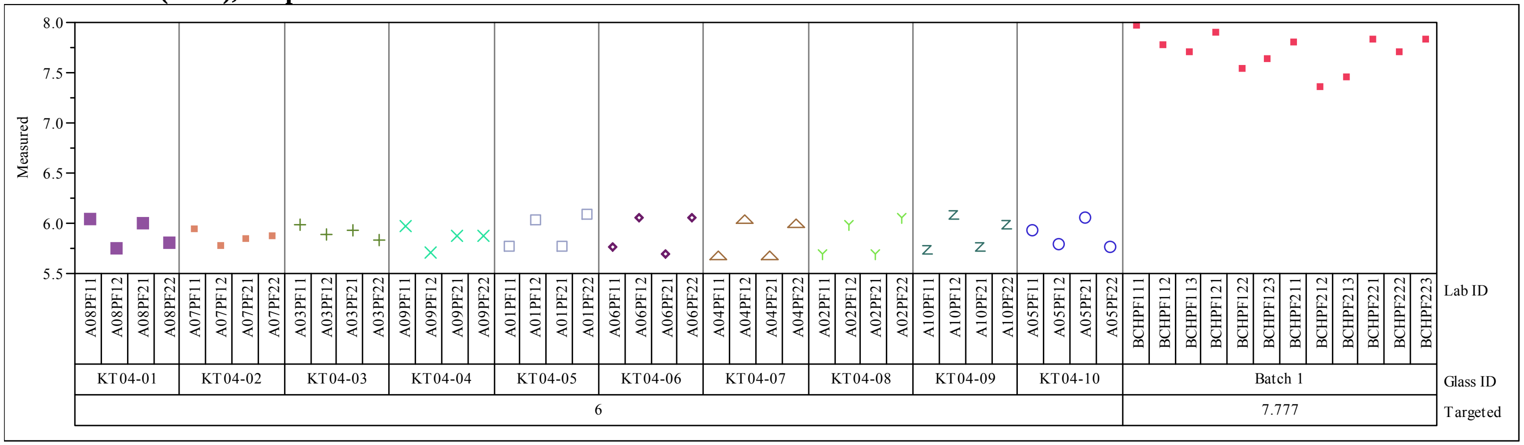
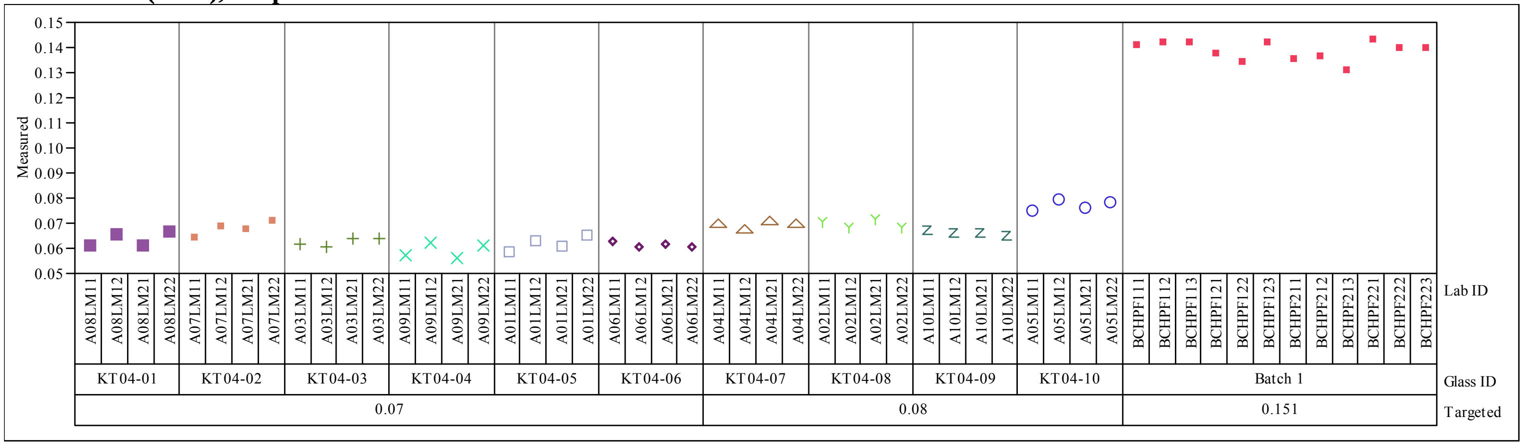


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=BaO (wt%), Prep Method=LM



Oxide=CaO (wt%), Prep Method=LM

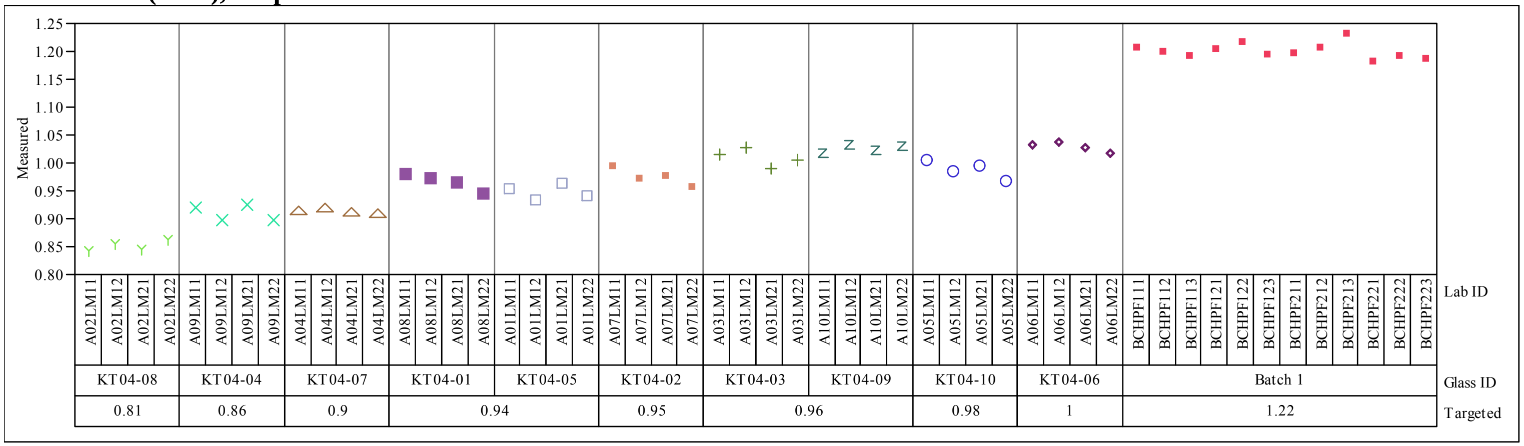
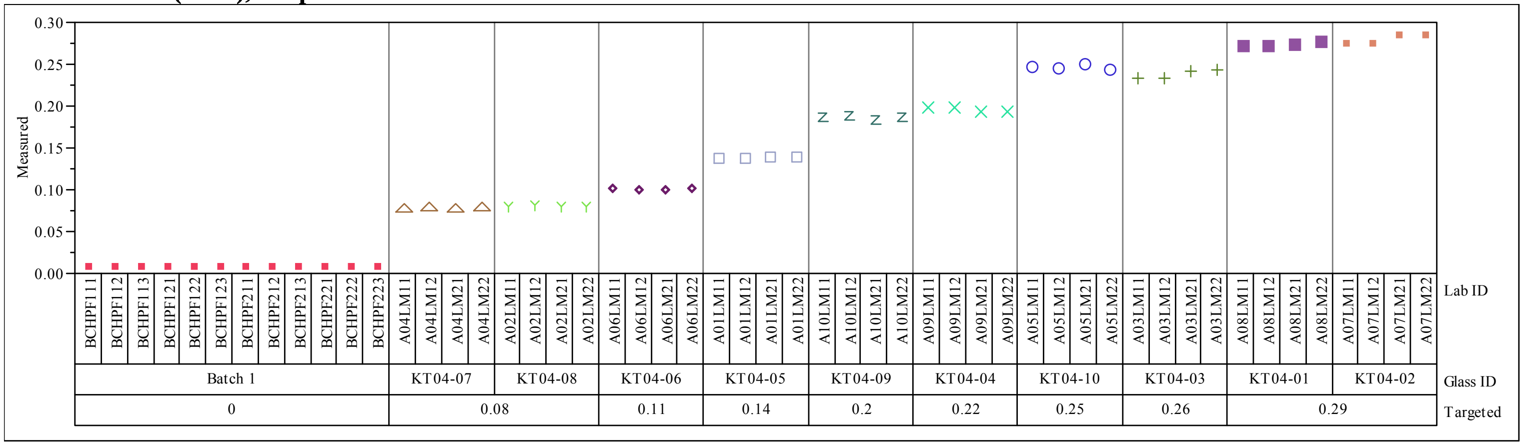


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=Ce2O3 (wt%), Prep Method=LM



Oxide=Cr2O3 (wt%), Prep Method=LM

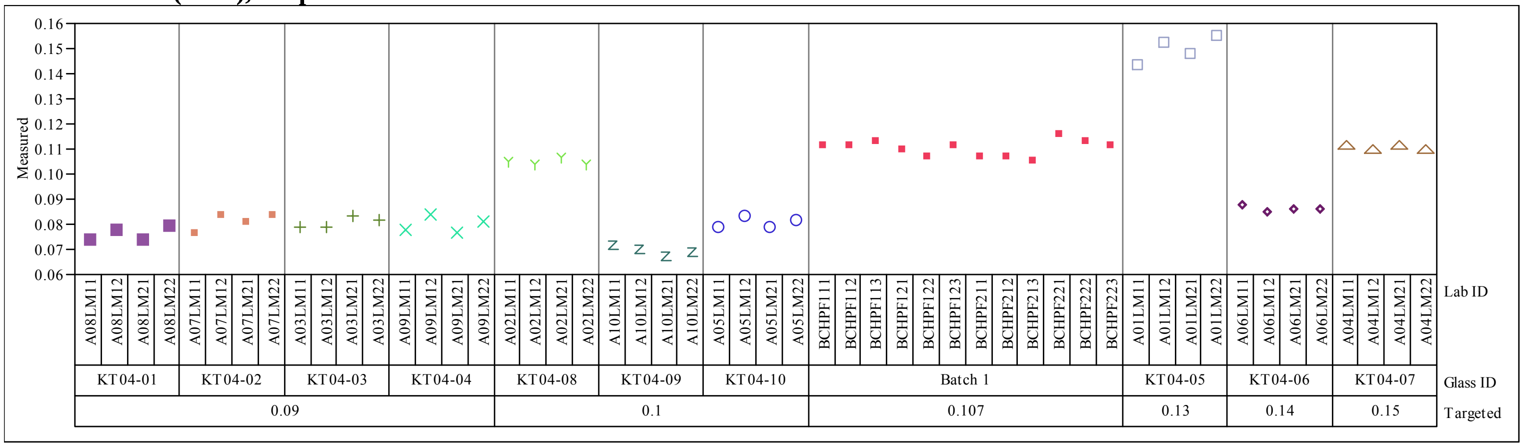
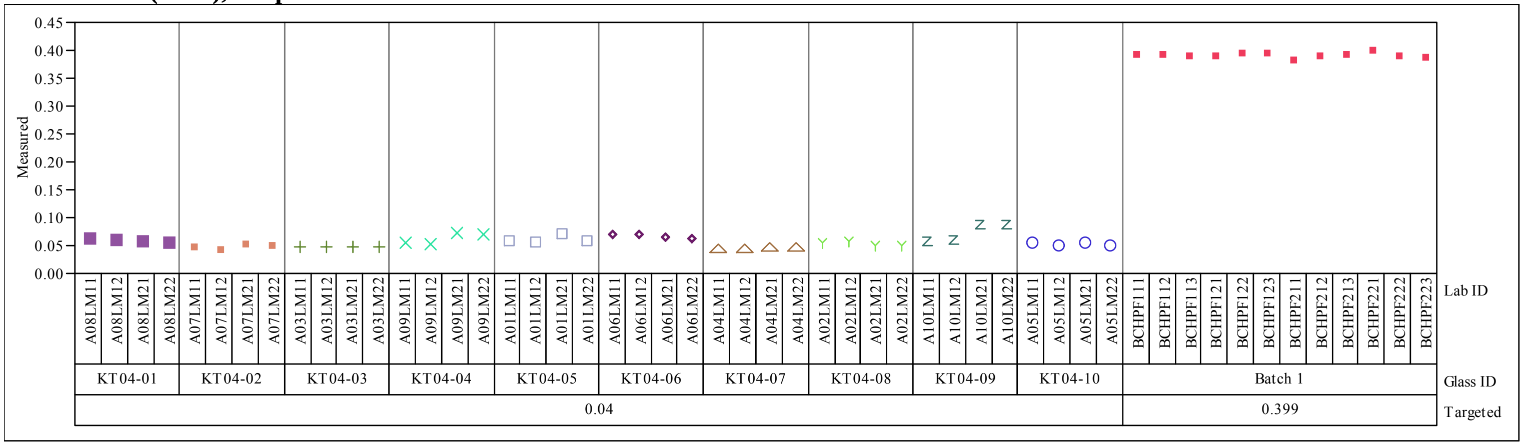


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=CuO (wt%), Prep Method=LM



Oxide=Fe2O3 (wt%), Prep Method=LM

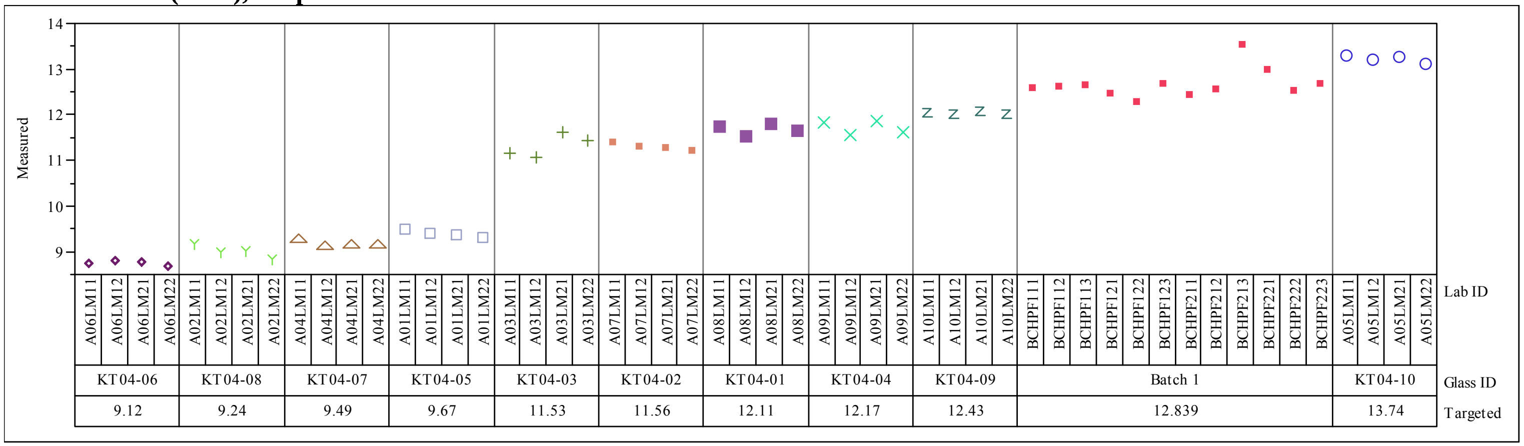
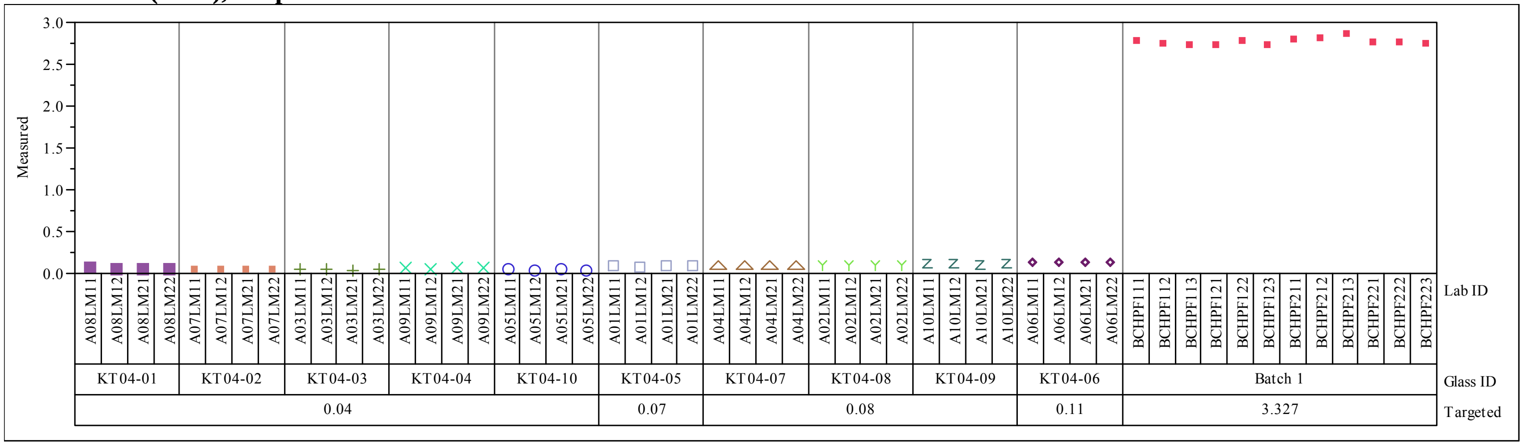


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=K2O (wt%), Prep Method=LM



Oxide=La2O3 (wt%), Prep Method=LM

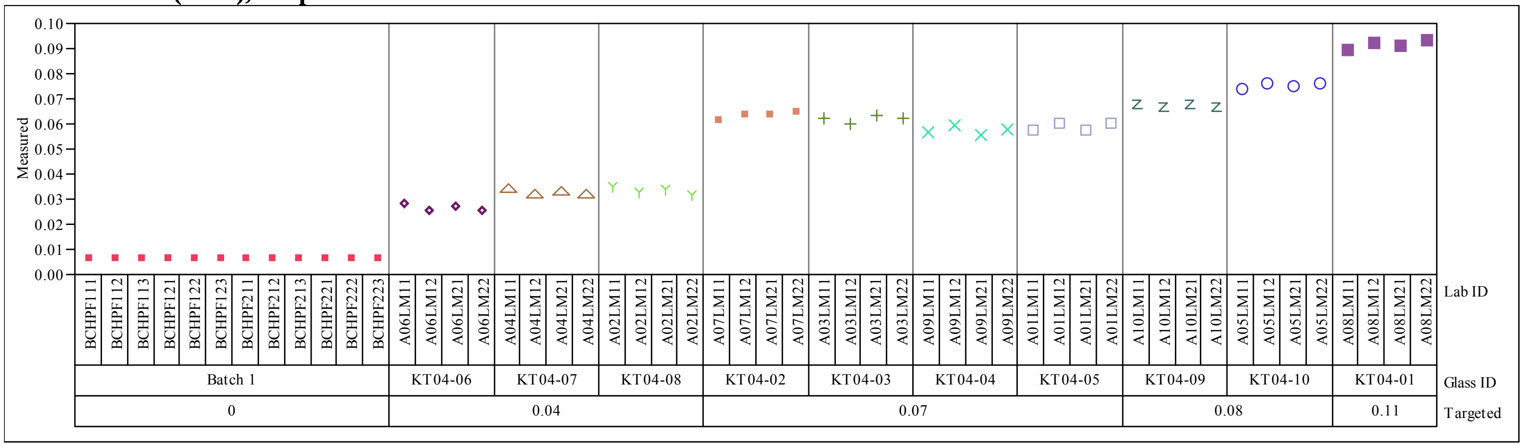
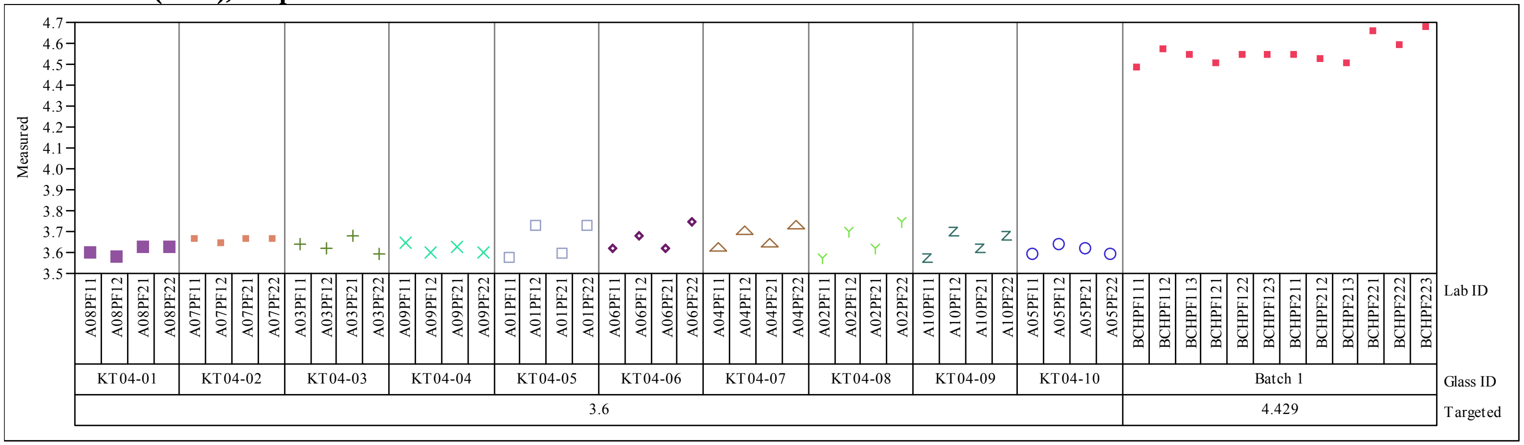


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=Li2O (wt%), Prep Method=PF



Oxide=MgO (wt%), Prep Method=LM

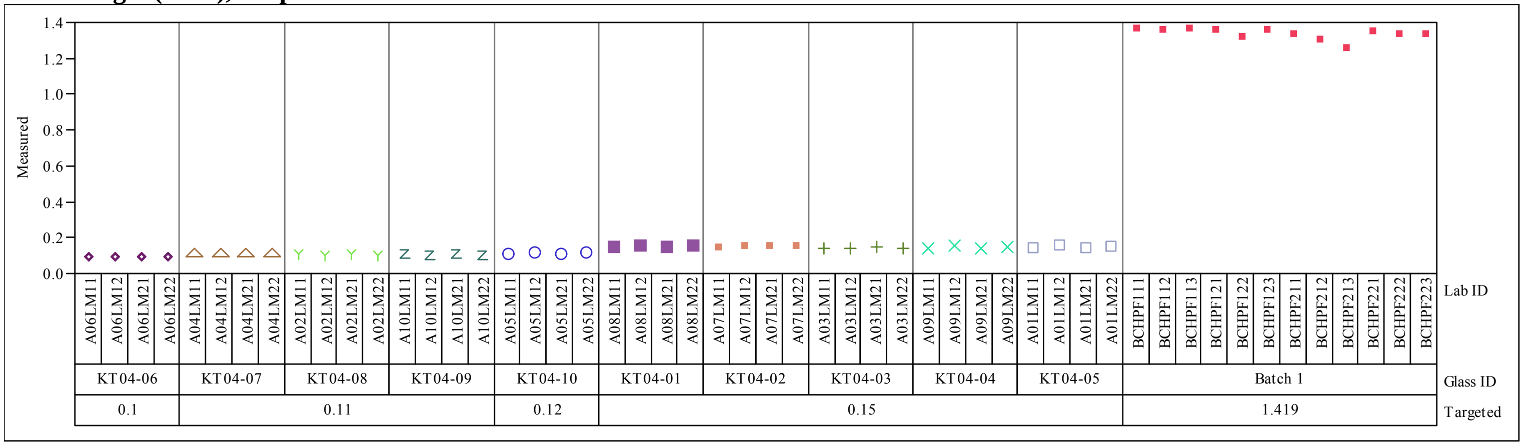
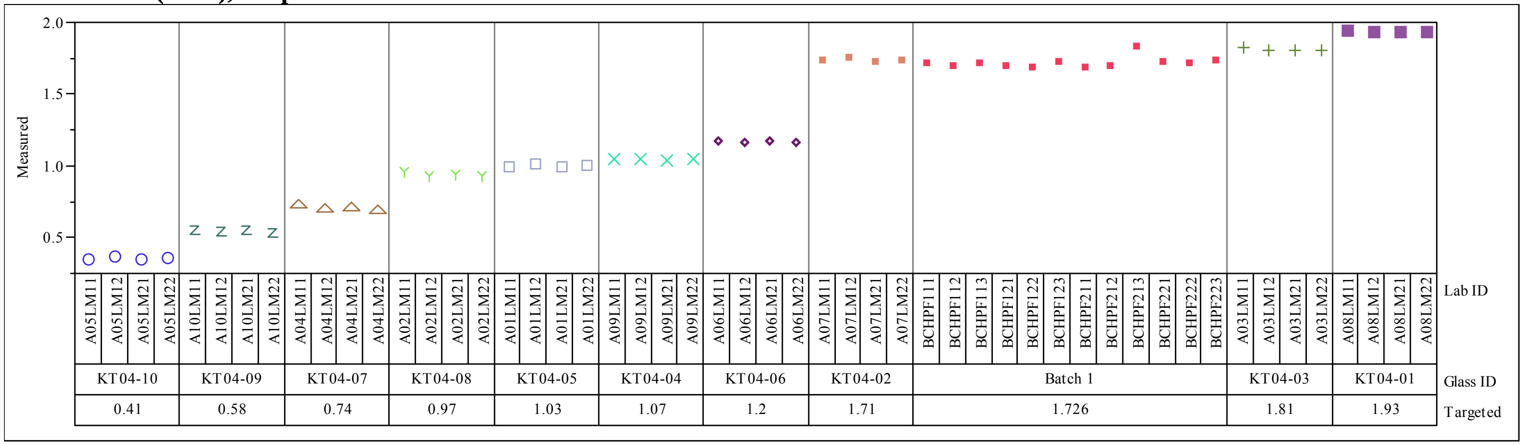


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=MnO (wt%), Prep Method=LM



Oxide=Na2O (wt%), Prep Method=LM

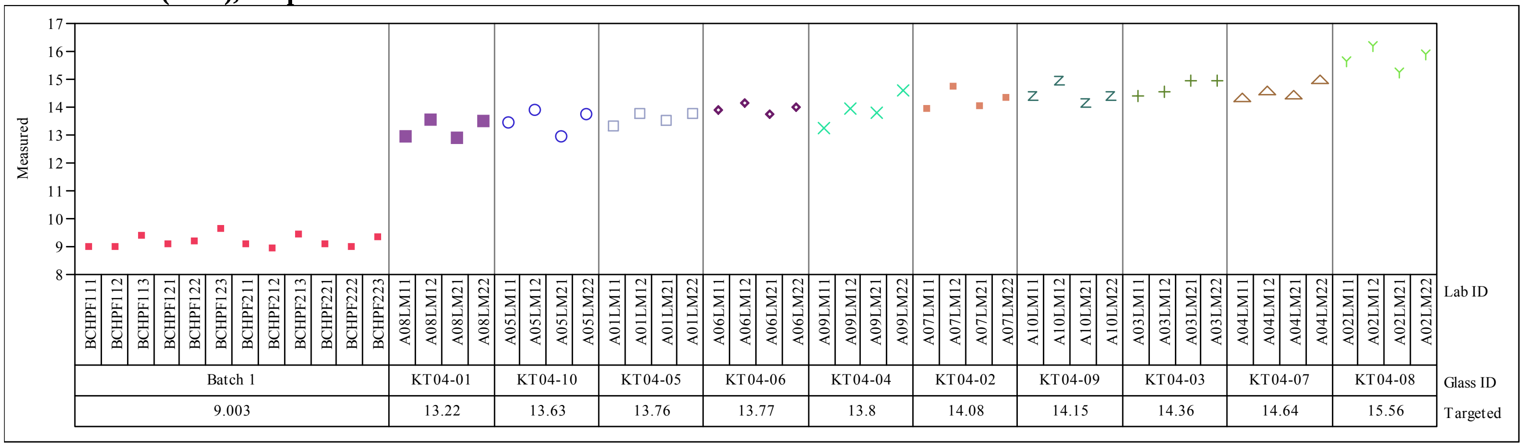
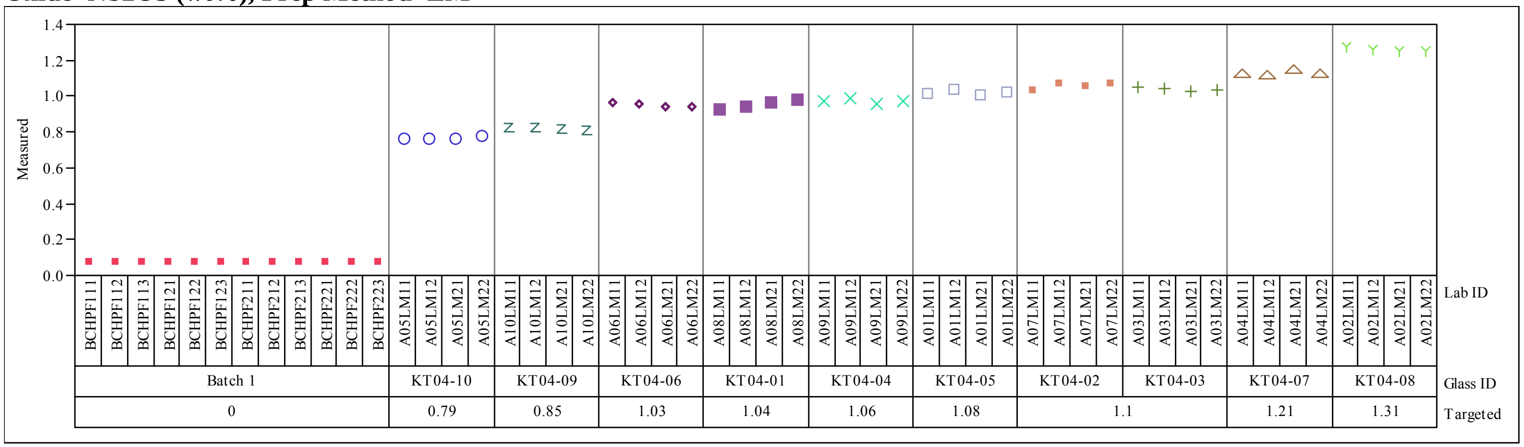


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=Nb2O5 (wt%), Prep Method=LM



Oxide=NiO (wt%), Prep Method=LM

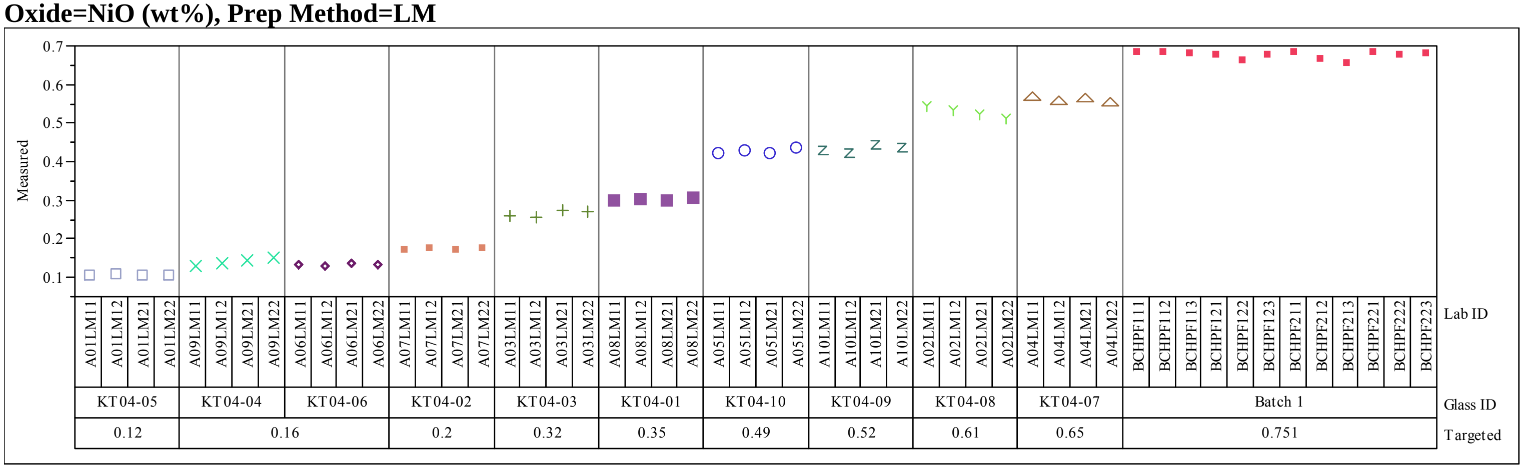
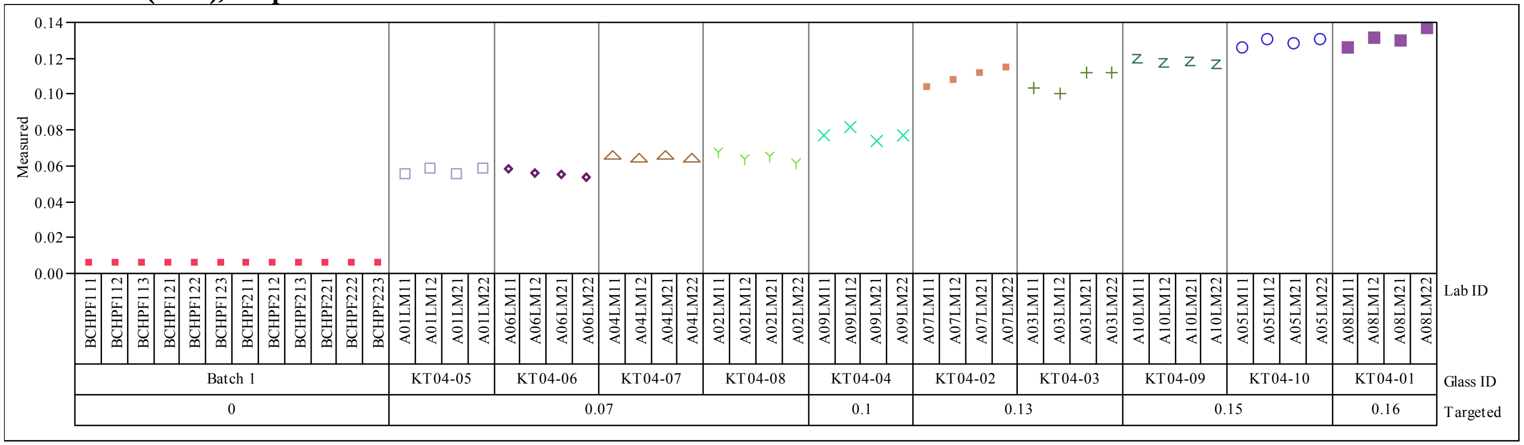


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=PbO (wt%), Prep Method=LM



Oxide=SiO2 (wt%), Prep Method=LM

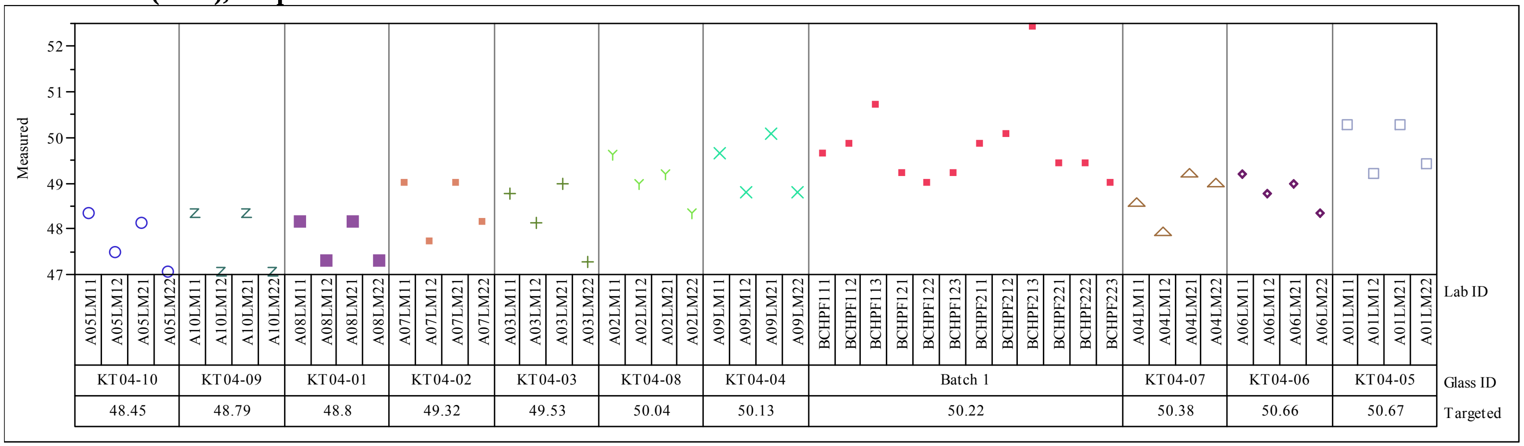
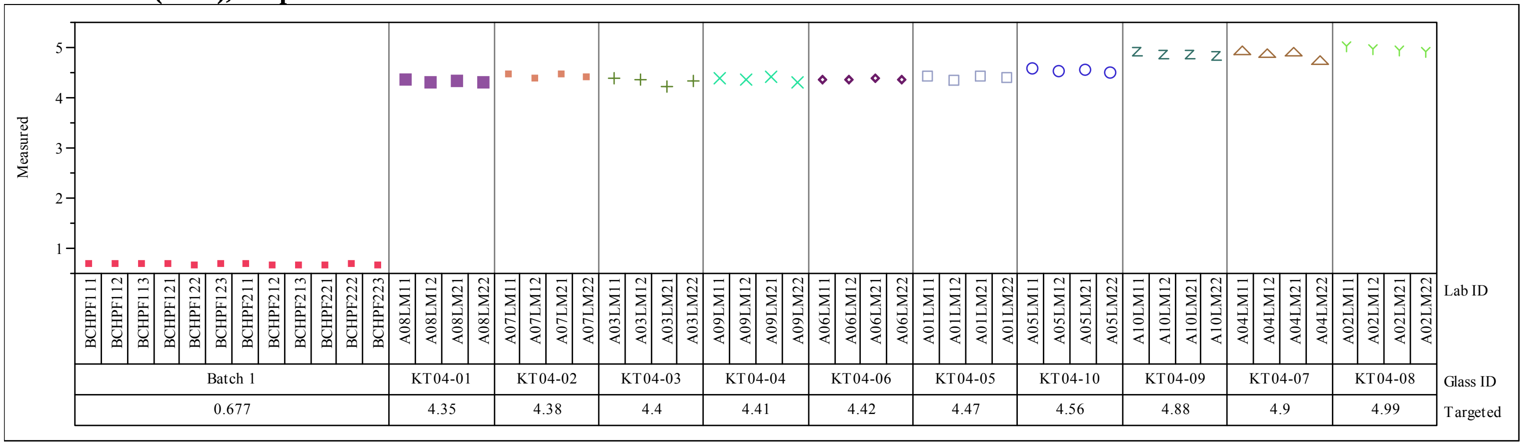


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=TiO2 (wt%), Prep Method=LM



Oxide=ZnO (wt%), Prep Method=LM

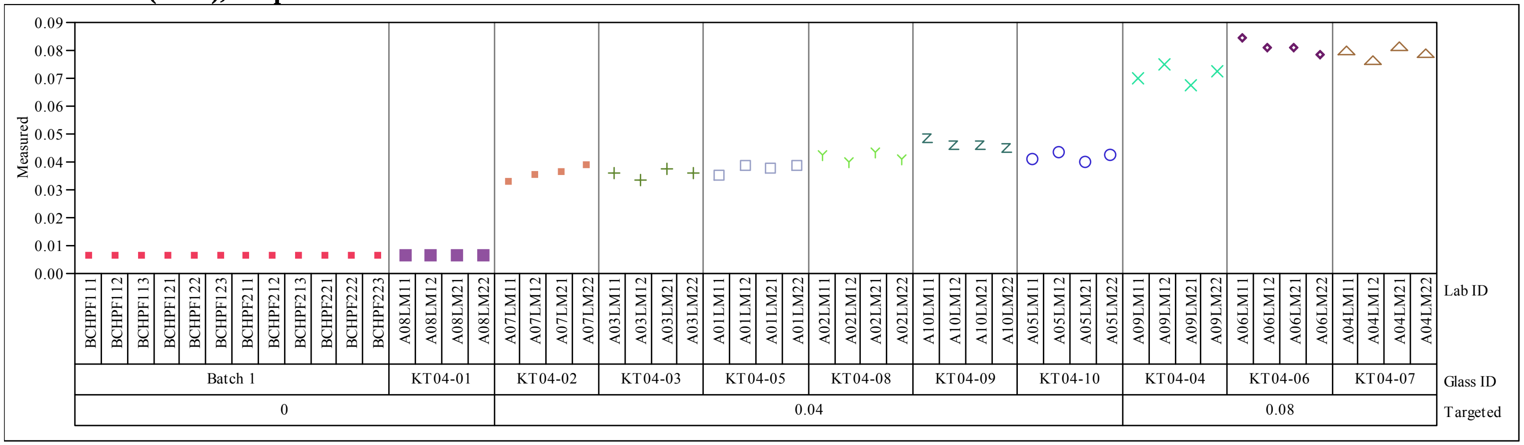


Exhibit C-2. Measurements for Each KT01-Series Glass ID by Preparation Method by Oxide. (continued)

Oxide=ZrO2 (wt%), Prep Method=LM

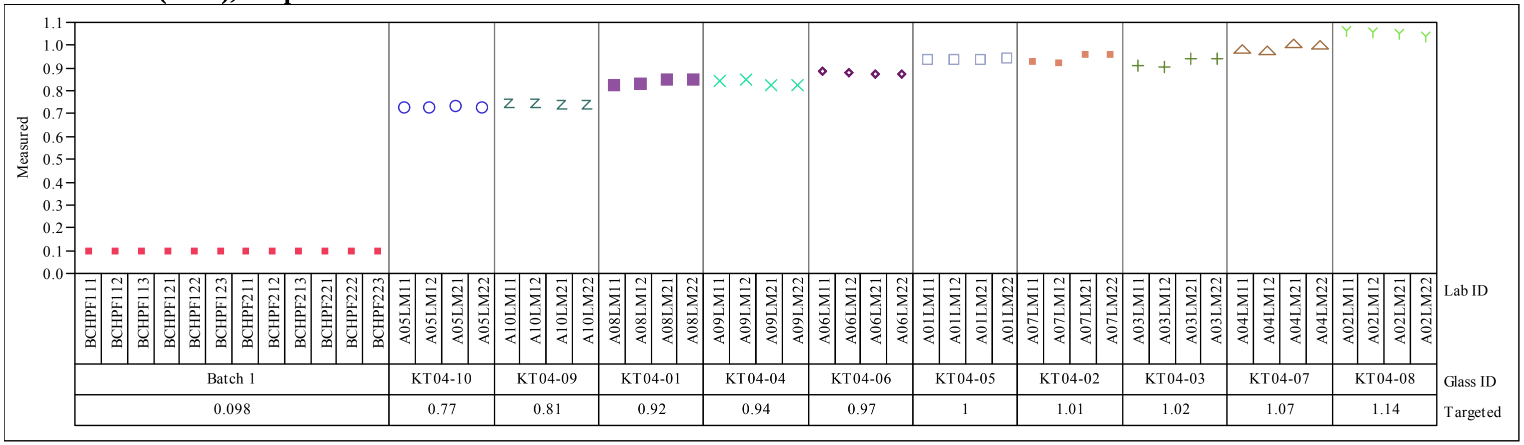
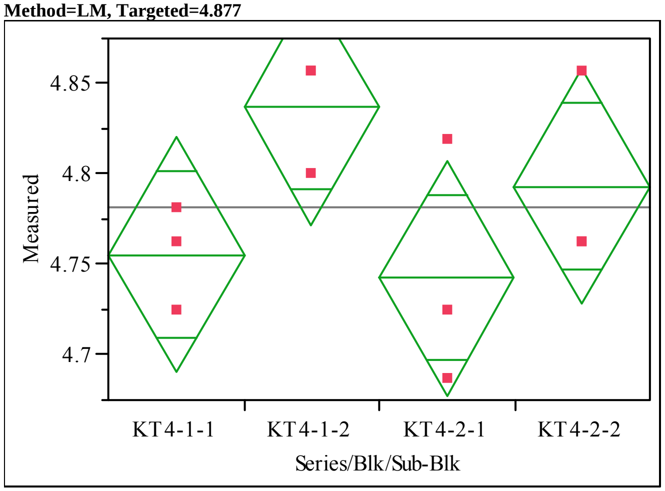


Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide.

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=Al2O3 (wt%), Prep Method=LM, Targeted=4.877



Oneway Anova
Summary of Fit

Rsquare	0.460826
Adj Rsquare	0.258635
Root Mean Square Error	0.048787
Mean of Response	4.78201
Observations (or Sum Wgts)	12

Analysis of Variance

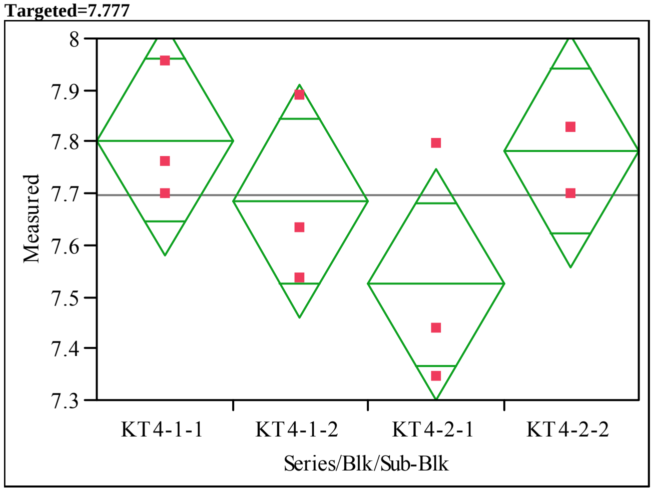
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01627421	0.005425	2.2792	0.1564
Error	8	0.01904112	0.002380		
C. Total	11	0.03531533			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	4.75524	0.02817	4.6903	4.8202
KT4-1-2	3	4.83712	0.02817	4.7722	4.9021
KT4-2-1	3	4.74265	0.02817	4.6777	4.8076
KT4-2-2	3	4.79303	0.02817	4.7281	4.8580

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=B2O3 (wt%), Prep Method=PF, Targeted=7.777



Oneway Anova
Summary of Fit

Rsquare	0.390759
Adj Rsquare	0.162294
Root Mean Square Error	0.168341
Mean of Response	7.698244
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.14540778	0.048469	1.7104	0.2417
Error	8	0.22670826	0.028339		
C. Total	11	0.37211604			

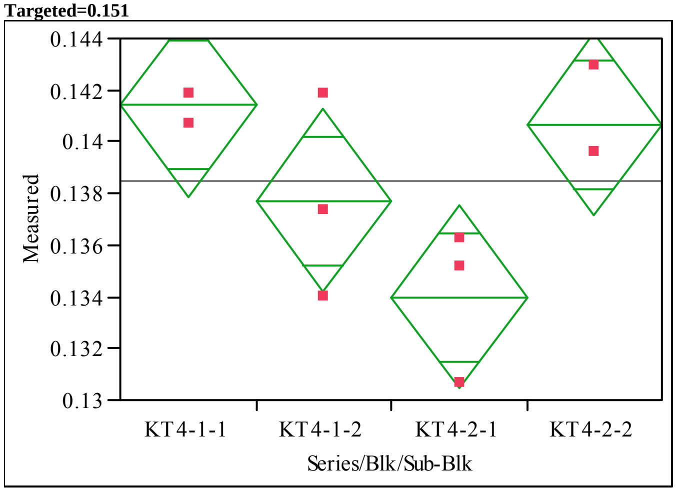
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	7.80289	0.09719	7.5788	8.0270
KT4-1-2	3	7.68483	0.09719	7.4607	7.9090
KT4-2-1	3	7.52383	0.09719	7.2997	7.7480
KT4-2-2	3	7.78143	0.09719	7.5573	8.0055

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=BaO (wt%), Prep Method=LM, Targeted=0.151



Oneway Anova
Summary of Fit

Rsquare	0.645833
Adj Rsquare	0.513021
Root Mean Square Error	0.002658
Mean of Response	0.138446
Observations (or Sum Wgts)	12

Analysis of Variance

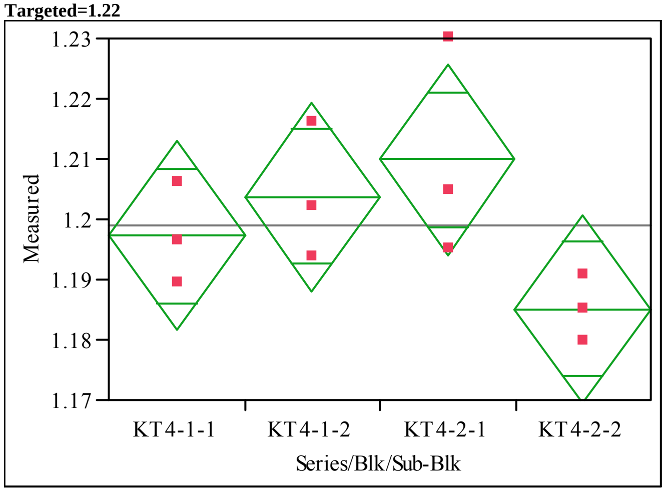
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00010305	0.000034	4.8627	0.0328
Error	8	0.00005651	7.064e-6		
C. Total	11	0.00015956			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.141423	0.00153	0.13788	0.14496
KT4-1-2	3	0.137702	0.00153	0.13416	0.14124
KT4-2-1	3	0.133980	0.00153	0.13044	0.13752
KT4-2-2	3	0.140679	0.00153	0.13714	0.14422

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=CaO (wt%), Prep Method=LM, Targeted=1.22



Oneway Anova
Summary of Fit

Rsquare	0.475491
Adj Rsquare	0.2788
Root Mean Square Error	0.01179
Mean of Response	1.198998
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00100808	0.000336	2.4174	0.1415
Error	8	0.00111201	0.000139		
C. Total	11	0.00212009			

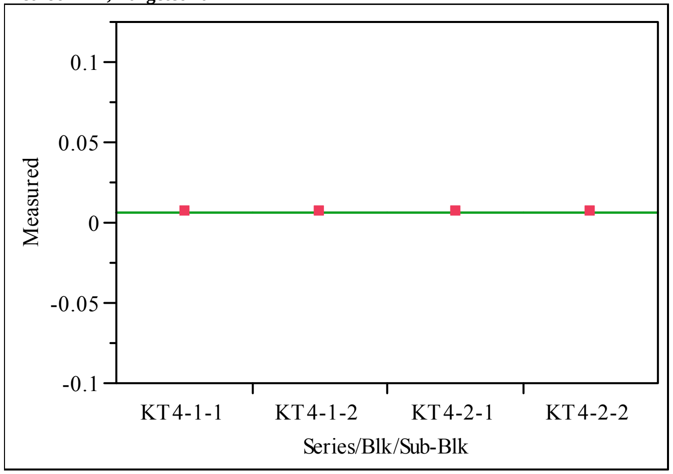
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	1.19725	0.00681	1.1816	1.2129
KT4-1-2	3	1.20378	0.00681	1.1881	1.2195
KT4-2-1	3	1.20984	0.00681	1.1941	1.2255
KT4-2-2	3	1.18512	0.00681	1.1694	1.2008

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=Ce2O3 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005857
Observations (or Sum Wgts)	12

Analysis of Variance

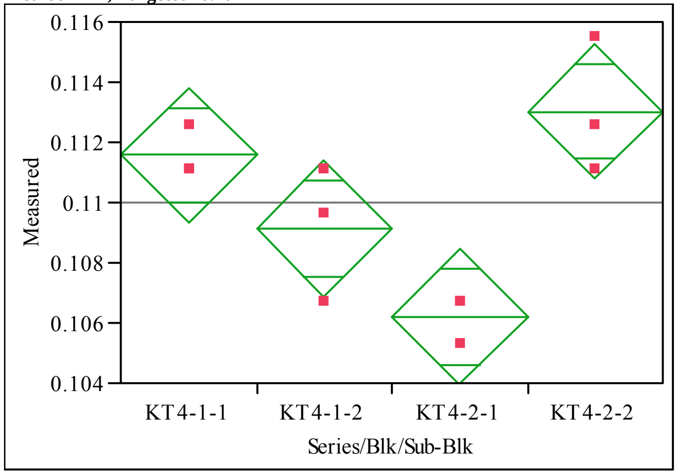
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.005857	0	0.00586	0.00586
KT4-1-2	3	0.005857	0	0.00586	0.00586
KT4-2-1	3	0.005857	0	0.00586	0.00586
KT4-2-2	3	0.005857	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=Cr2O3 (wt%), Prep Method=LM, Targeted=0.107



Oneway Anova
Summary of Fit

Rsquare	0.778929
Adj Rsquare	0.696028
Root Mean Square Error	0.001688
Mean of Response	0.109985
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00008029	0.000027	9.3958	0.0053
Error	8	0.00002279	2.848e-6		
C. Total	11	0.00010308			

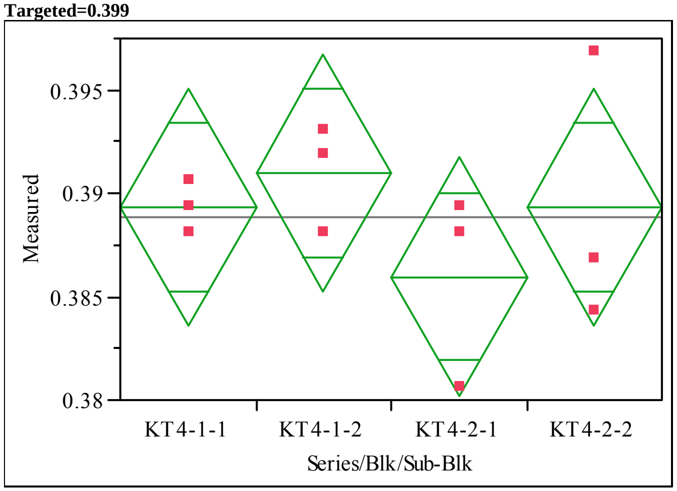
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.111569	0.00097	0.10932	0.11382
KT4-1-2	3	0.109133	0.00097	0.10689	0.11138
KT4-2-1	3	0.106210	0.00097	0.10396	0.10846
KT4-2-2	3	0.113030	0.00097	0.11078	0.11528

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=CuO (wt%), Prep Method=LM, Targeted=0.399



Oneway Anova
Summary of Fit

Rsquare	0.209945
Adj Rsquare	-0.08633
Root Mean Square Error	0.004321
Mean of Response	0.388893
Observations (or Sum Wgts)	12

Analysis of Variance

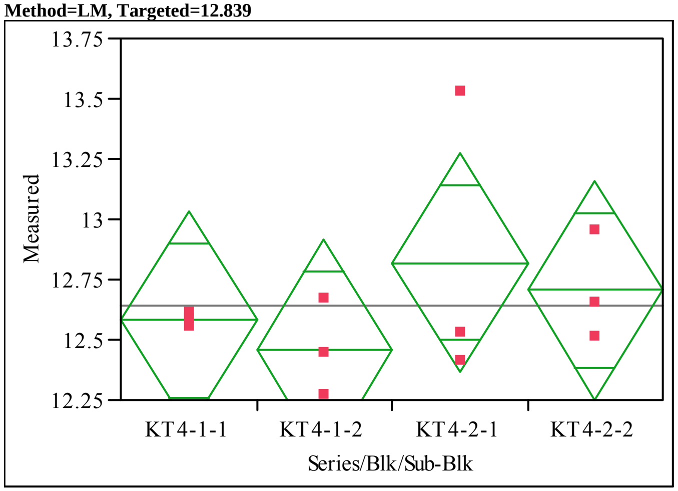
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00003970	0.000013	0.7086	0.5734
Error	8	0.00014939	0.000019		
C. Total	11	0.00018909			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.389310	0.00249	0.38356	0.39506
KT4-1-2	3	0.390979	0.00249	0.38523	0.39673
KT4-2-1	3	0.385972	0.00249	0.38022	0.39172
KT4-2-2	3	0.389310	0.00249	0.38356	0.39506

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=Fe2O3 (wt%), Prep Method=LM, Targeted=12.839



Oneway Anova
Summary of Fit

Rsquare	0.189991
Adj Rsquare	-0.11376
Root Mean Square Error	0.342308
Mean of Response	12.64093
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.2198708	0.073290	0.6255	0.6184
Error	8	0.9373977	0.117175		
C. Total	11	1.1572685			

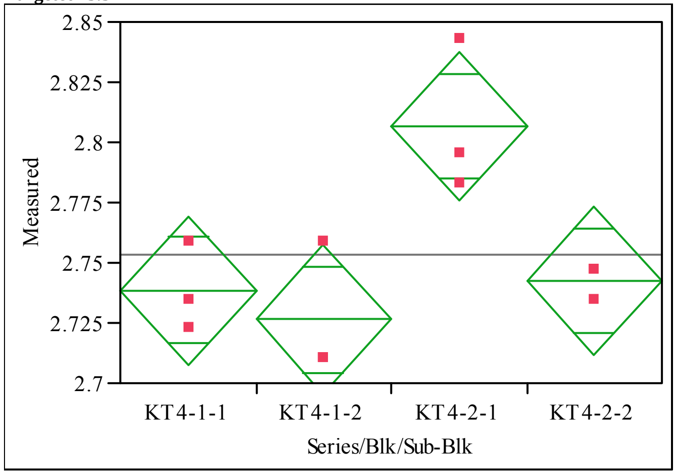
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	12.5814	0.19763	12.126	13.037
KT4-1-2	3	12.4575	0.19763	12.002	12.913
KT4-2-1	3	12.8196	0.19763	12.364	13.275
KT4-2-2	3	12.7053	0.19763	12.250	13.161

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=K2O (wt%), Prep Method=LM, Targeted=3.327



Oneway Anova
Summary of Fit

Rsquare	0.729527
Adj Rsquare	0.628099
Root Mean Square Error	0.023327
Mean of Response	2.753515
Observations (or Sum Wgts)	12

Analysis of Variance

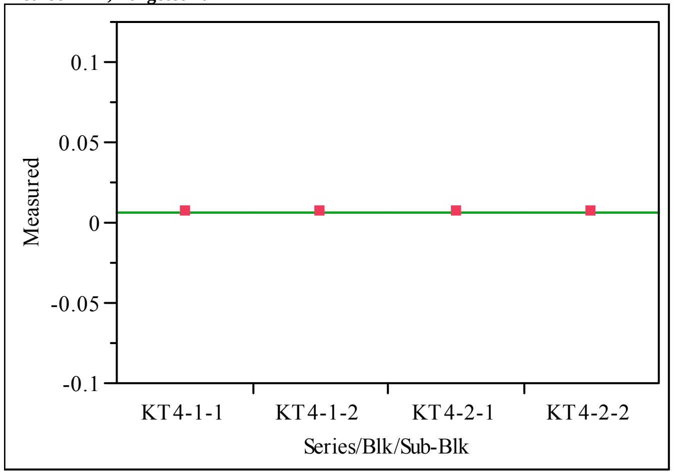
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01174150	0.003914	7.1926	0.0117
Error	8	0.00435318	0.000544		
C. Total	11	0.01609469			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	2.73846	0.01347	2.7074	2.7695
KT4-1-2	3	2.72641	0.01347	2.6954	2.7575
KT4-2-1	3	2.80672	0.01347	2.7757	2.8378
KT4-2-2	3	2.74247	0.01347	2.7114	2.7735

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=La2O3 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005864
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

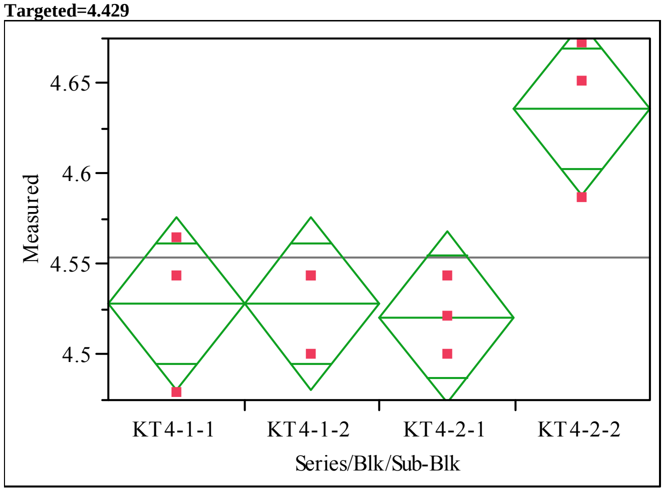
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.005864	0	0.00586	0.00586
KT4-1-2	3	0.005864	0	0.00586	0.00586
KT4-2-1	3	0.005864	0	0.00586	0.00586
KT4-2-2	3	0.005864	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=Li2O (wt%), Prep Method=PF, Targeted=4.429



Oneway Anova
Summary of Fit

Rsquare	0.728395
Adj Rsquare	0.626543
Root Mean Square Error	0.035702
Mean of Response	4.553384
Observations (or Sum Wgts)	12

Analysis of Variance

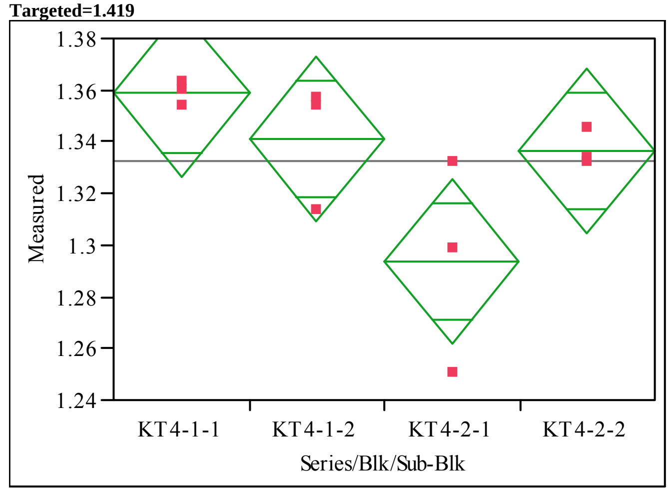
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.02734637	0.009115	7.1515	0.0118
Error	8	0.01019695	0.001275		
C. Total	11	0.03754333			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	4.52827	0.02061	4.4807	4.5758
KT4-1-2	3	4.52827	0.02061	4.4807	4.5758
KT4-2-1	3	4.52109	0.02061	4.4736	4.5686
KT4-2-2	3	4.63591	0.02061	4.5884	4.6834

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=MgO (wt%), Prep Method=LM, Targeted=1.419



Oneway Anova
Summary of Fit

Rsquare	0.59749
Adj Rsquare	0.446549
Root Mean Square Error	0.024098
Mean of Response	1.332444
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00689598	0.002299	3.9584	0.0531
Error	8	0.00464560	0.000581		
C. Total	11	0.01154158			

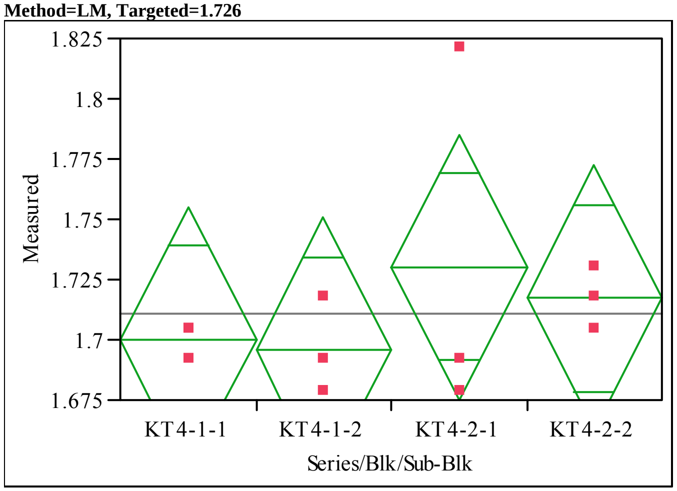
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	1.35870	0.01391	1.3266	1.3908
KT4-1-2	3	1.34101	0.01391	1.3089	1.3731
KT4-2-1	3	1.29347	0.01391	1.2614	1.3256
KT4-2-2	3	1.33659	0.01391	1.3045	1.3687

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=MnO (wt%), Prep Method=LM, Targeted=1.726



Oneway Anova
Summary of Fit

Rsquare	0.14386
Adj Rsquare	-0.17719
Root Mean Square Error	0.04117
Mean of Response	1.71084
Observations (or Sum Wgts)	12

Analysis of Variance

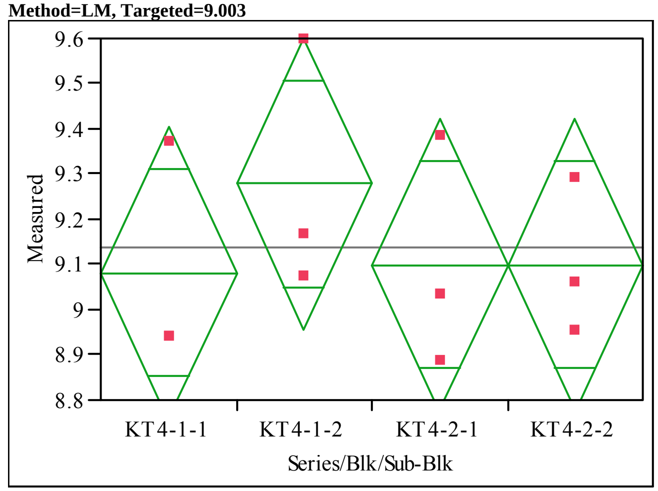
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00227850	0.000760	0.4481	0.7255
Error	8	0.01355987	0.001695		
C. Total	11	0.01583838			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	1.70008	0.02377	1.6453	1.7549
KT4-1-2	3	1.69578	0.02377	1.6410	1.7506
KT4-2-1	3	1.73021	0.02377	1.6754	1.7850
KT4-2-2	3	1.71730	0.02377	1.6625	1.7721

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=Na2O (wt%), Prep Method=LM, Targeted=9.003



Oneway Anova
Summary of Fit

Rsquare	0.142322
Adj Rsquare	-0.17931
Root Mean Square Error	0.242796
Mean of Response	9.13944
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.07825661	0.026086	0.4425	0.7291
Error	8	0.47159906	0.058950		
C. Total	11	0.54985567			

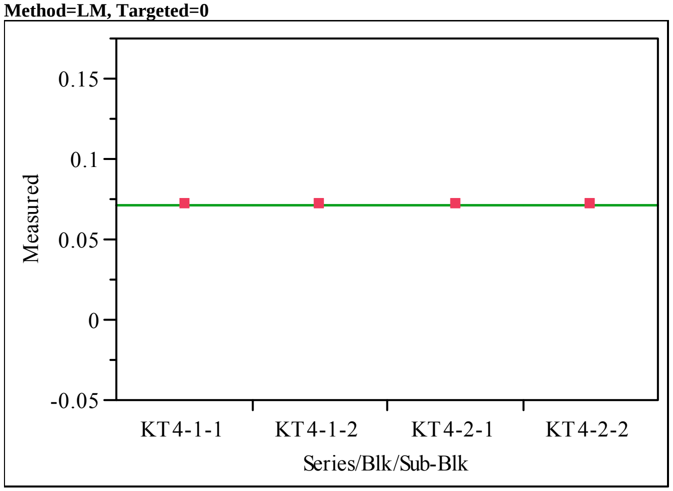
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	9.08103	0.14018	8.7578	9.4043
KT4-1-2	3	9.27873	0.14018	8.9555	9.6020
KT4-2-1	3	9.09900	0.14018	8.7757	9.4223
KT4-2-2	3	9.09900	0.14018	8.7757	9.4223

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=Nb2O5 (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.071525
Observations (or Sum Wgts)	12

Analysis of Variance

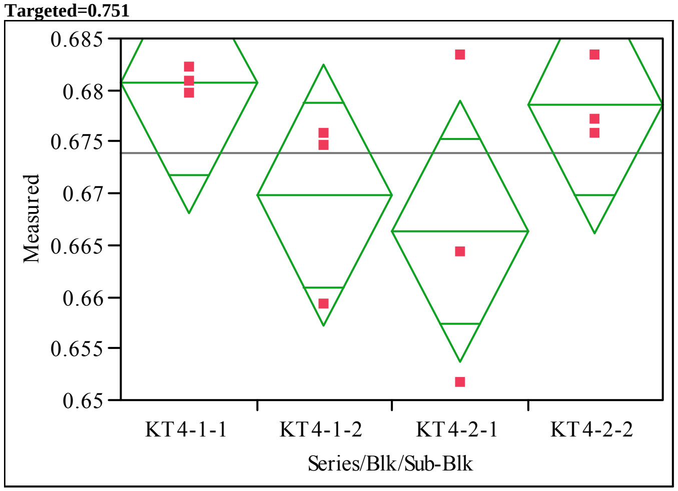
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.071525	0	0.07153	0.07153
KT4-1-2	3	0.071525	0	0.07153	0.07153
KT4-2-1	3	0.071525	0	0.07153	0.07153
KT4-2-2	3	0.071525	0	0.07153	0.07153

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=NiO (wt%), Prep Method=LM, Targeted=0.751



Oneway Anova
Summary of Fit

Rsquare	0.375454
Adj Rsquare	0.14125
Root Mean Square Error	0.00948
Mean of Response	0.673895
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00043221	0.000144	1.6031	0.2636
Error	8	0.00071895	0.000090		
C. Total	11	0.00115116			

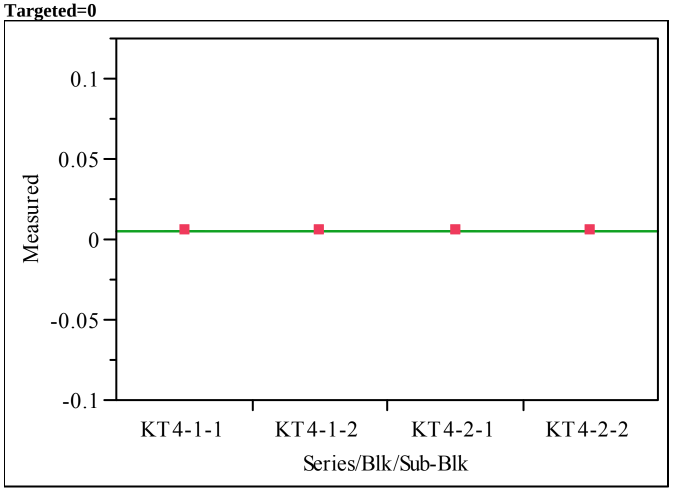
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.680788	0.00547	0.66817	0.69341
KT4-1-2	3	0.669759	0.00547	0.65714	0.68238
KT4-2-1	3	0.666366	0.00547	0.65374	0.67899
KT4-2-2	3	0.678667	0.00547	0.66605	0.69129

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=PbO (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.375
Root Mean Square Error	1.06e-18
Mean of Response	0.005386
Observations (or Sum Wgts)	12

Analysis of Variance

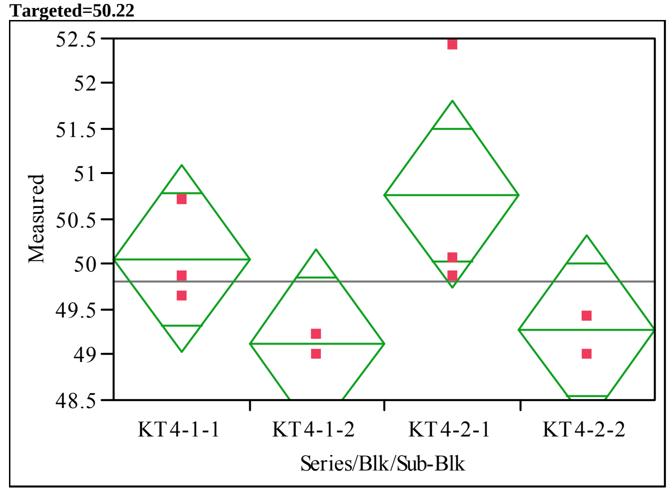
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	9.0278e-36	1.128e-36		
C. Total	11	9.0278e-36			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.005386	6.133e-19	0.00539	0.00539
KT4-1-2	3	0.005386	6.133e-19	0.00539	0.00539
KT4-2-1	3	0.005386	6.133e-19	0.00539	0.00539
KT4-2-2	3	0.005386	6.133e-19	0.00539	0.00539

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=SiO2 (wt%), Prep Method=LM, Targeted=50.22



Oneway Anova
Summary of Fit

Rsquare	0.517451
Adj Rsquare	0.336495
Root Mean Square Error	0.778717
Mean of Response	49.81004
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	5.202074	1.73402	2.8595	0.1043
Error	8	4.851201	0.60640		
C. Total	11	10.053275			

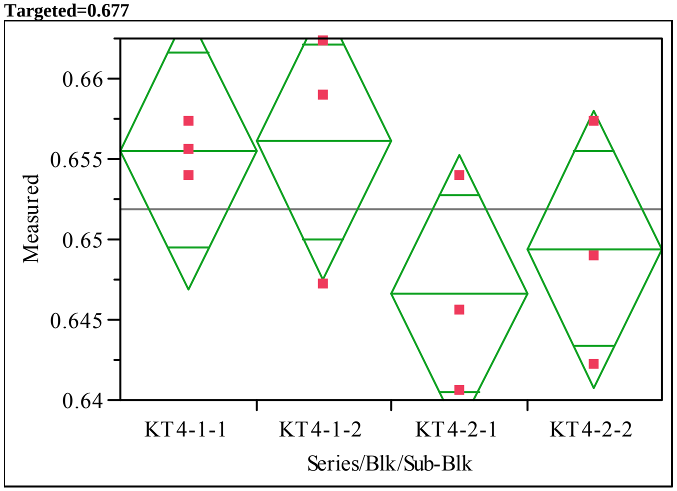
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	50.0596	0.44959	49.023	51.096
KT4-1-2	3	49.1326	0.44959	48.096	50.169
KT4-2-1	3	50.7727	0.44959	49.736	51.809
KT4-2-2	3	49.2752	0.44959	48.238	50.312

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=TiO2 (wt%), Prep Method=LM, Targeted=0.677



Oneway Anova
Summary of Fit

Rsquare	0.367311
Adj Rsquare	0.130053
Root Mean Square Error	0.00646
Mean of Response	0.65191
Observations (or Sum Wgts)	12

Analysis of Variance

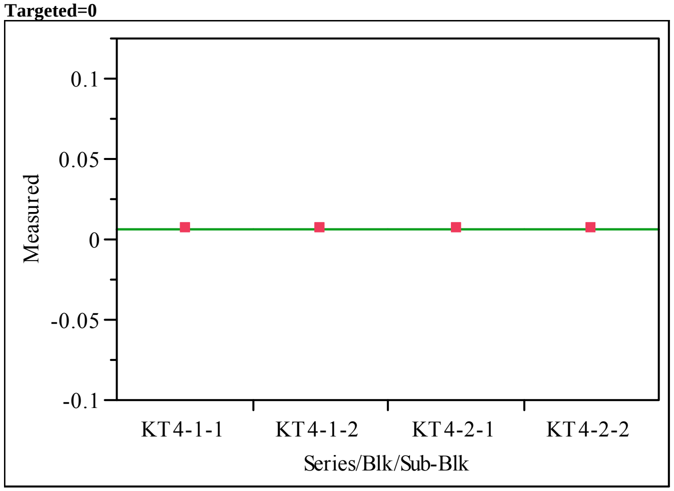
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00019383	0.000065	1.5481	0.2757
Error	8	0.00033387	0.000042		
C. Total	11	0.00052770			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.655524	0.00373	0.64692	0.66412
KT4-1-2	3	0.656080	0.00373	0.64748	0.66468
KT4-2-1	3	0.646628	0.00373	0.63803	0.65523
KT4-2-2	3	0.649408	0.00373	0.64081	0.65801

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=ZnO (wt%), Prep Method=LM, Targeted=0



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006224
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

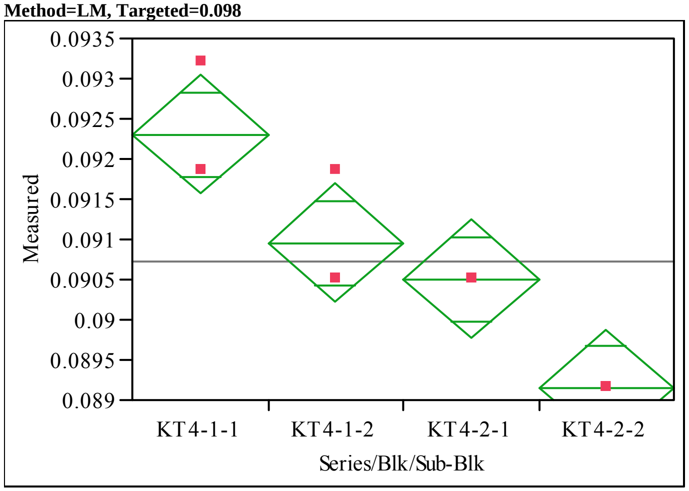
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.006224	0	0.00622	0.00622
KT4-1-2	3	0.006224	0	0.00622	0.00622
KT4-2-1	3	0.006224	0	0.00622	0.00622
KT4-2-2	3	0.006224	0	0.00622	0.00622

Std Error uses a pooled estimate of error variance

Exhibit C-3. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Batch 1 Results by Oxide. (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Series=KT4, Oxide=ZrO2 (wt%), Prep Method=LM, Targeted=0.098



Oneway Anova
Summary of Fit

Rsquare	0.862069
Adj Rsquare	0.810345
Root Mean Square Error	0.000551
Mean of Response	0.090729
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001521	5.0685e-6	16.6667	0.0008
Error	8	0.00000243	3.0411e-7		
C. Total	11	0.00001764			

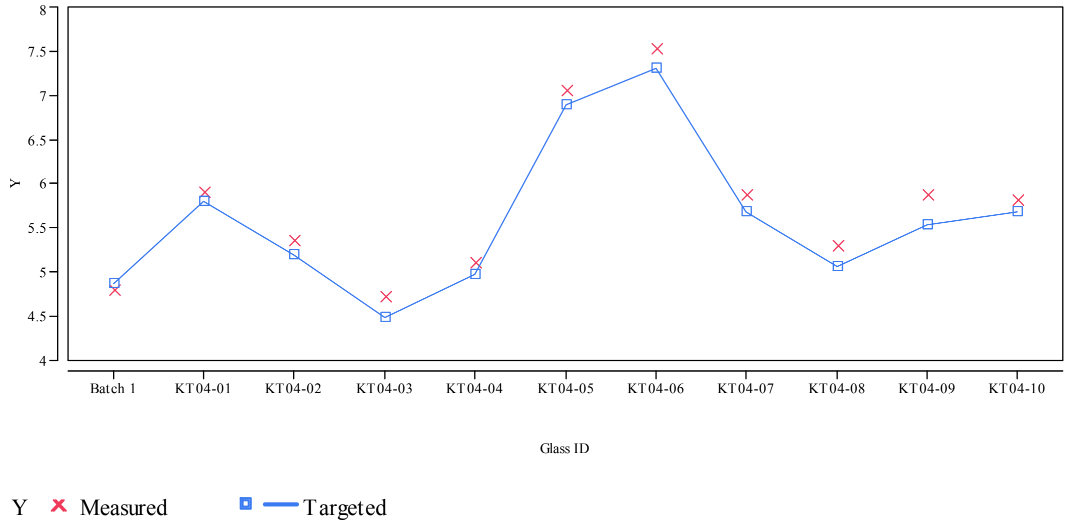
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
KT4-1-1	3	0.092305	0.00032	0.09157	0.09304
KT4-1-2	3	0.090954	0.00032	0.09022	0.09169
KT4-2-1	3	0.090504	0.00032	0.08977	0.09124
KT4-2-2	3	0.089153	0.00032	0.08842	0.08989

Std Error uses a pooled estimate of error variance

Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series.

Oxide=Al2O3 (wt%)



Oxide=B2O3 (wt%)

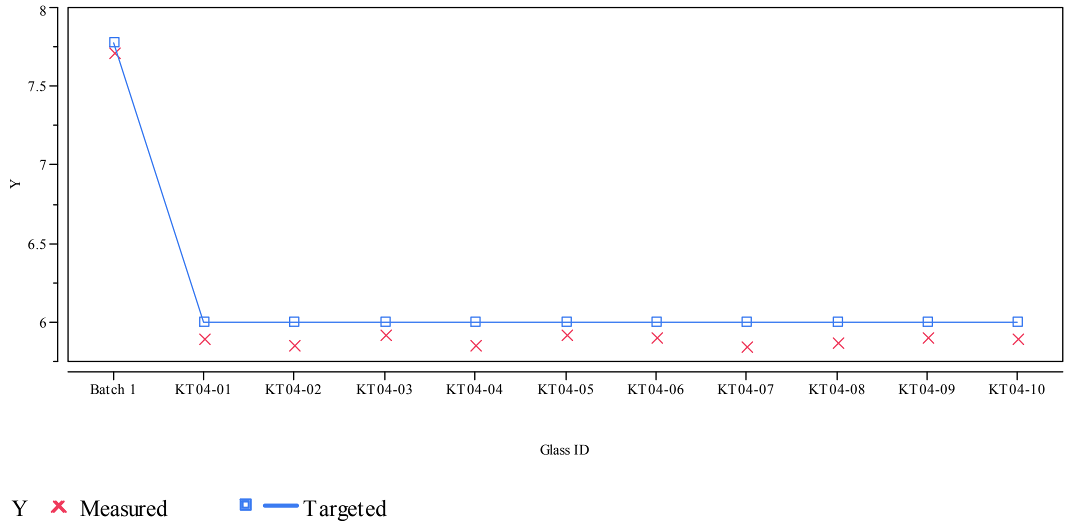
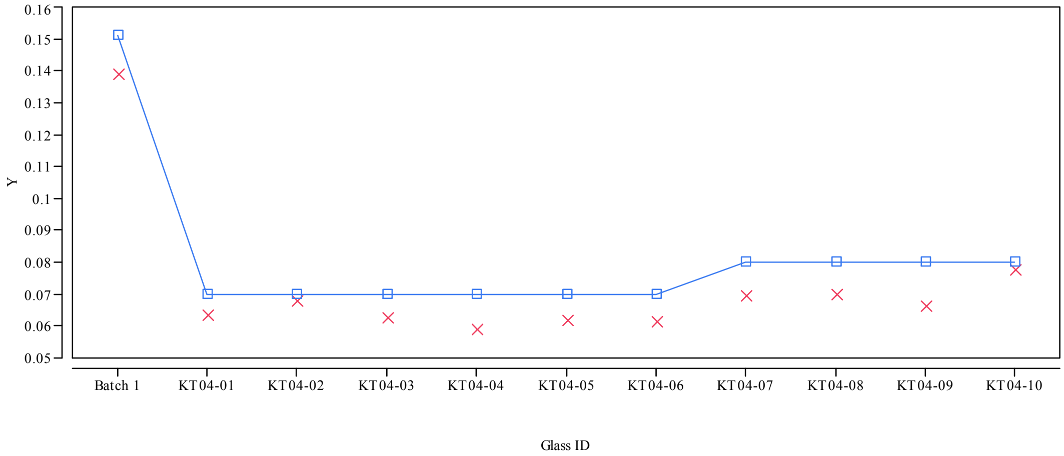


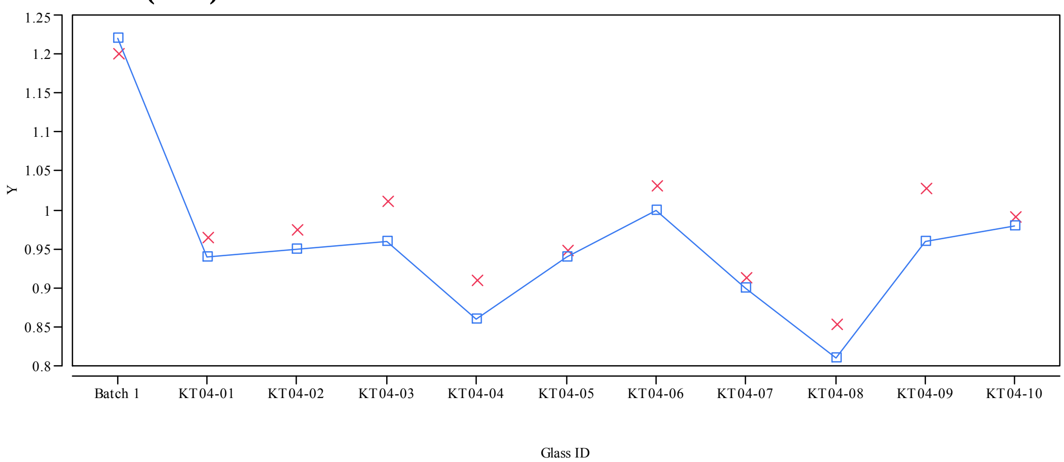
Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=BaO (wt%)



Y Measured Targeted

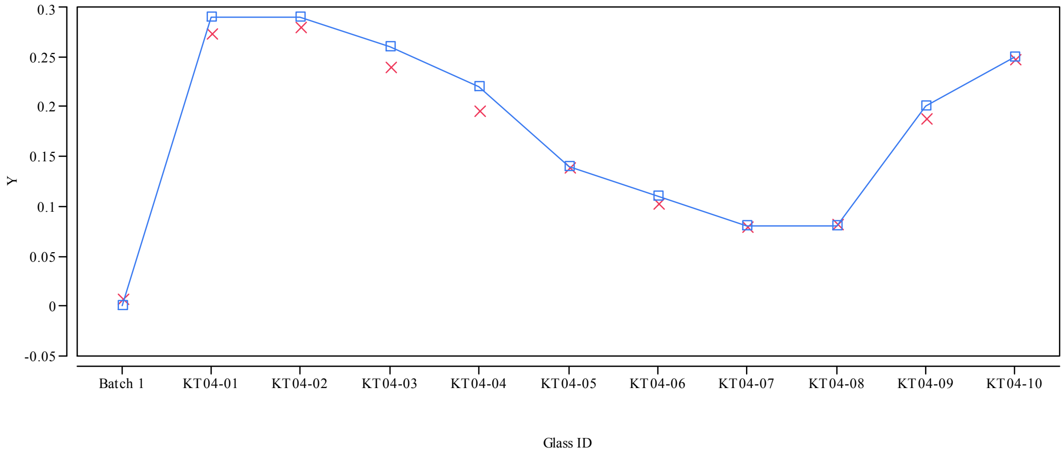
Oxide=CaO (wt%)



Y Measured Targeted

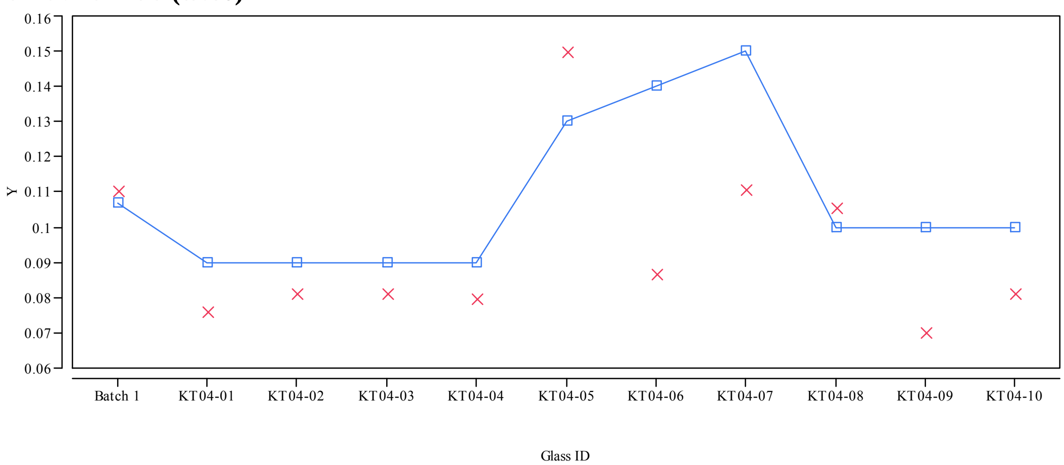
Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=Ce2O3 (wt%)



Y × Measured ▪ — Targeted

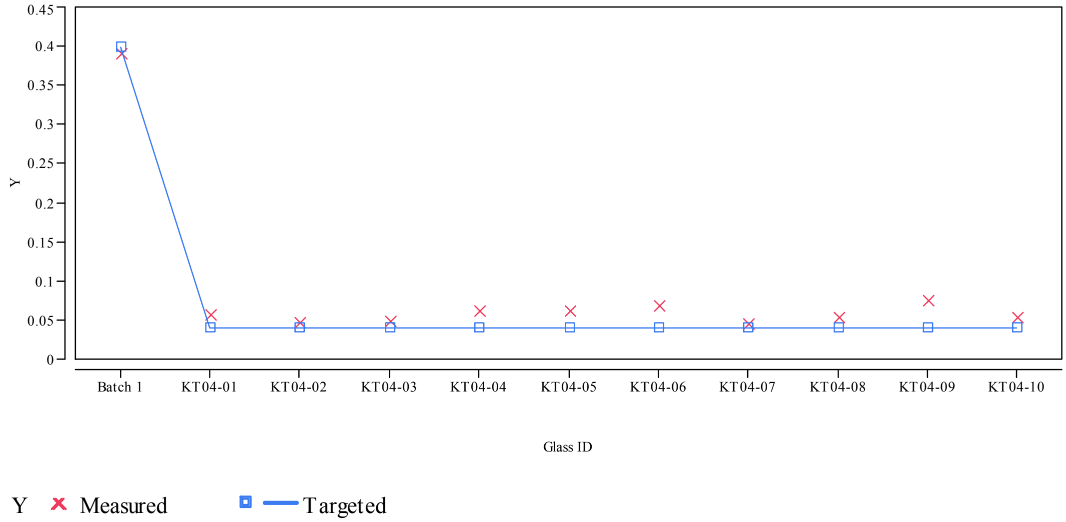
Oxide=Cr2O3 (wt%)



Y × Measured ▪ — Targeted

Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=CuO (wt%)



Oxide=Fe2O3 (wt%)

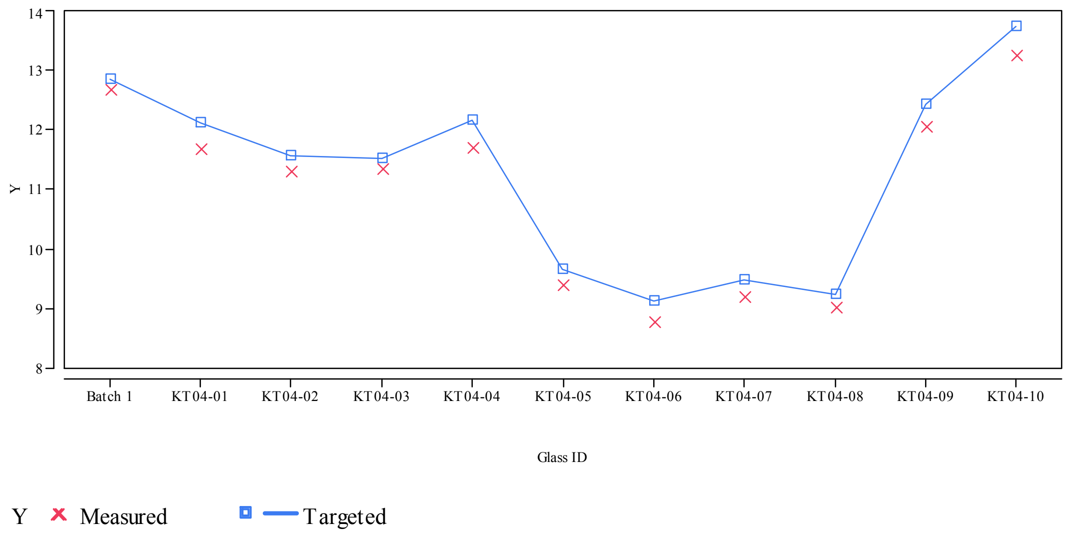
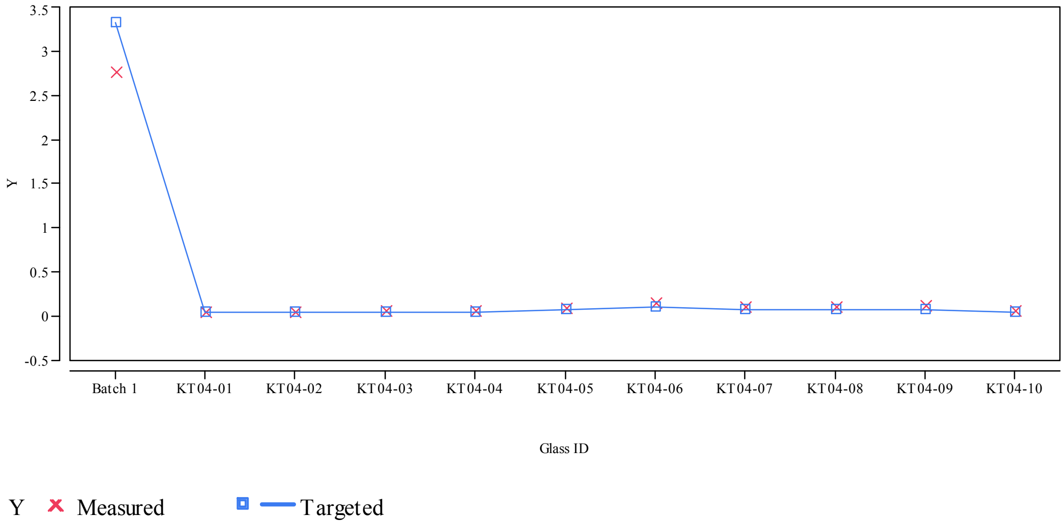


Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=K2O (wt%)



Oxide=La2O3 (wt%)

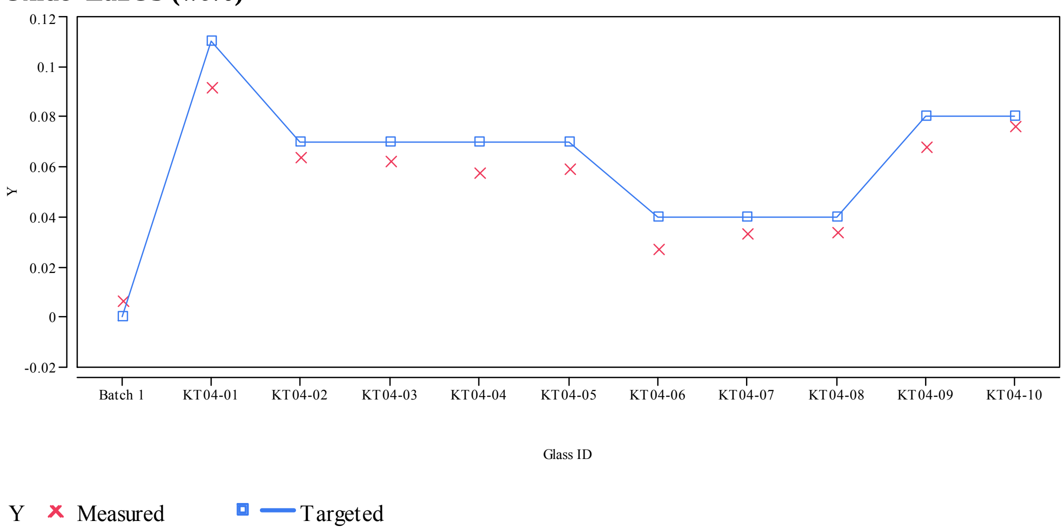
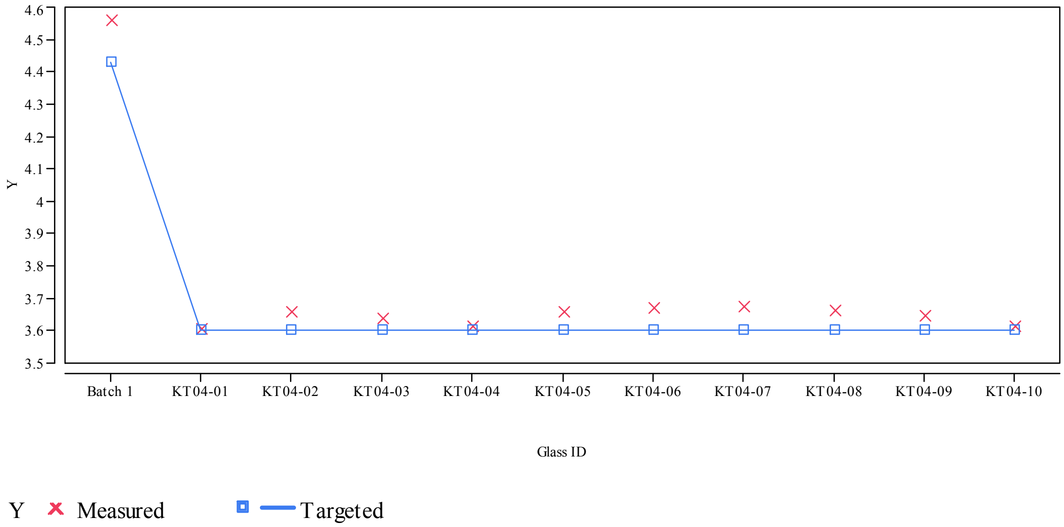


Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=Li2O (wt%)



Oxide=MgO (wt%)

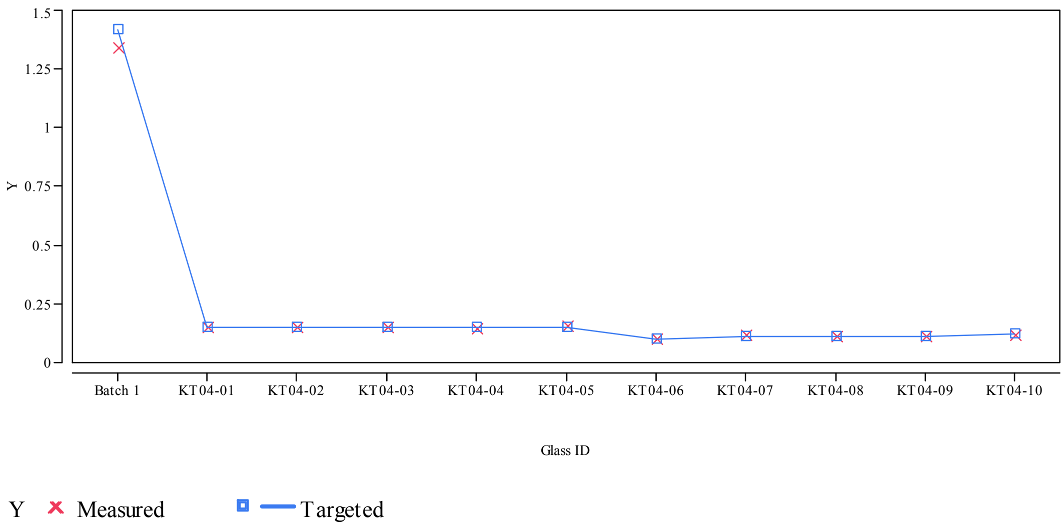
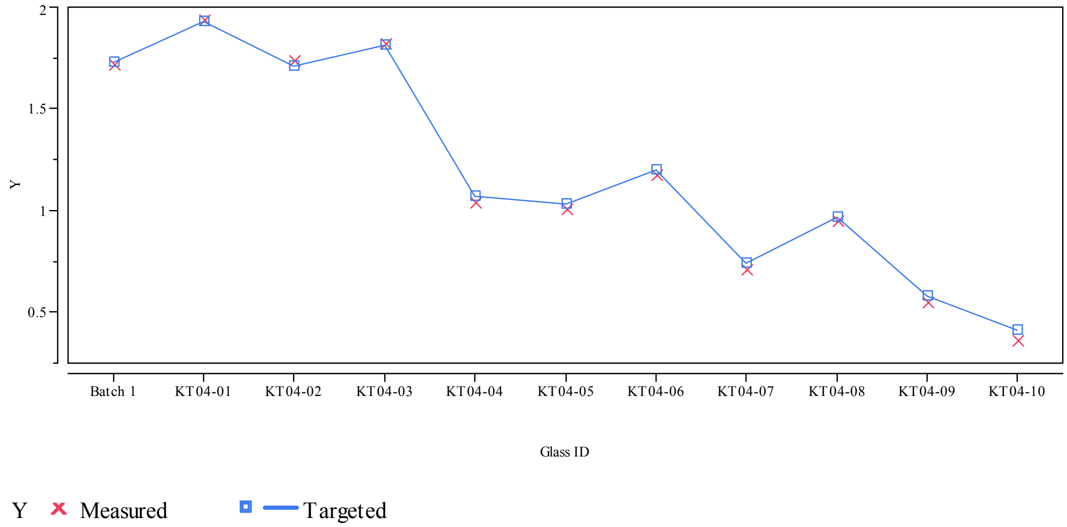


Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=MnO (wt%)



Oxide=Na2O (wt%)

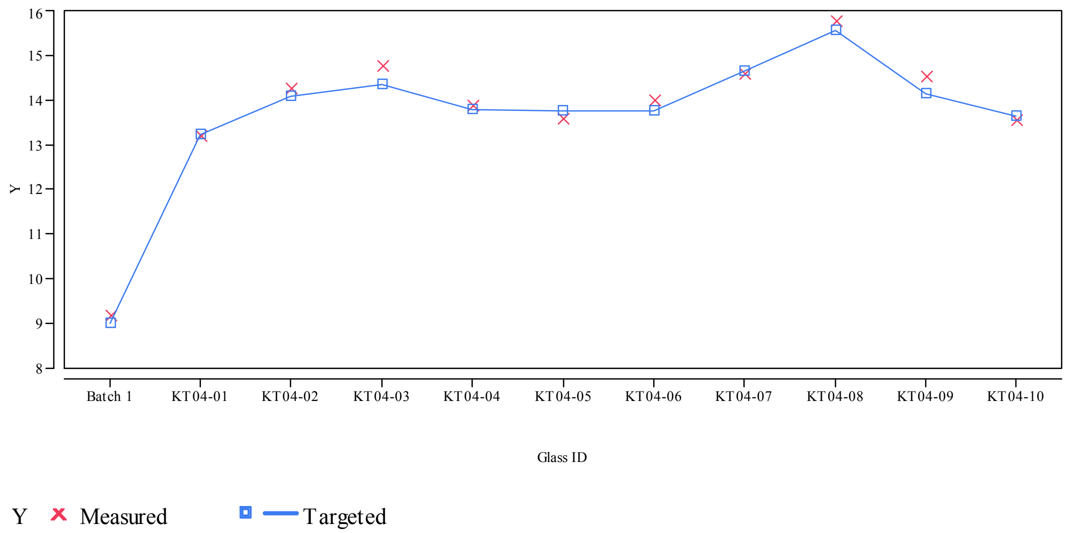
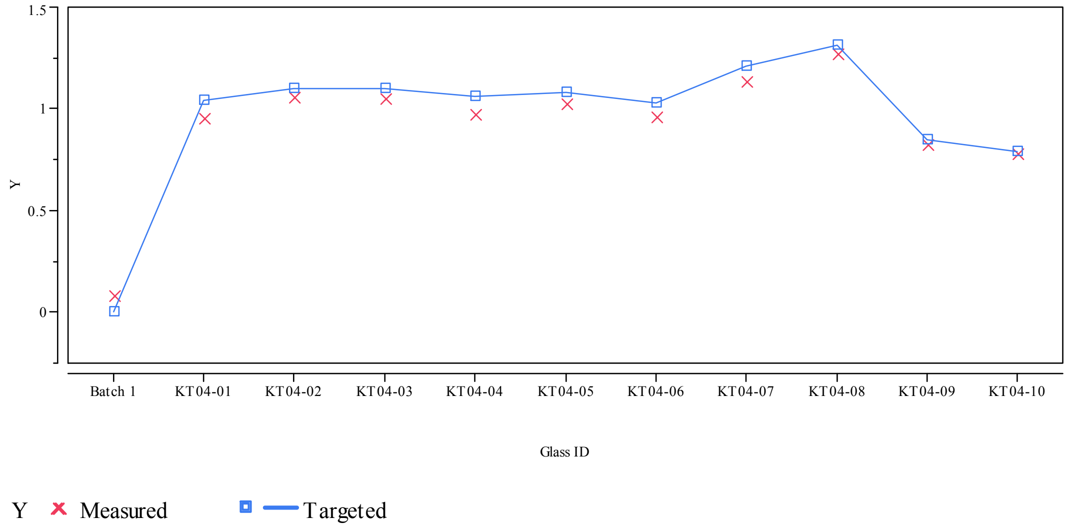


Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=Nb2O5 (wt%)



Oxide=NiO (wt%)

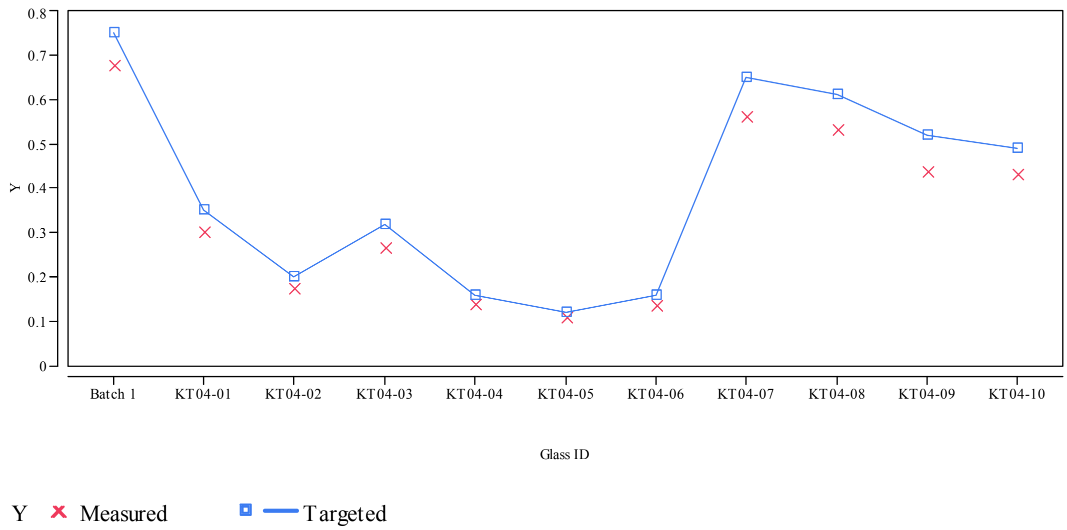
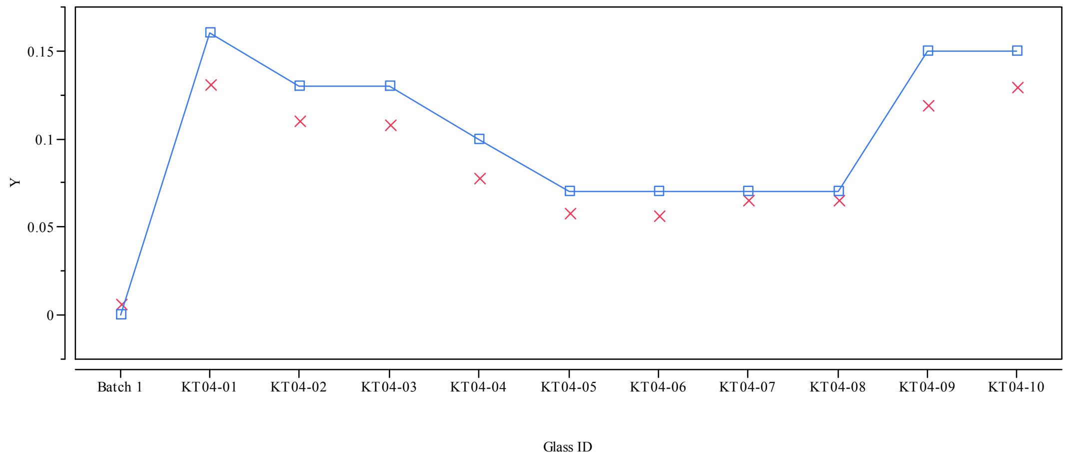


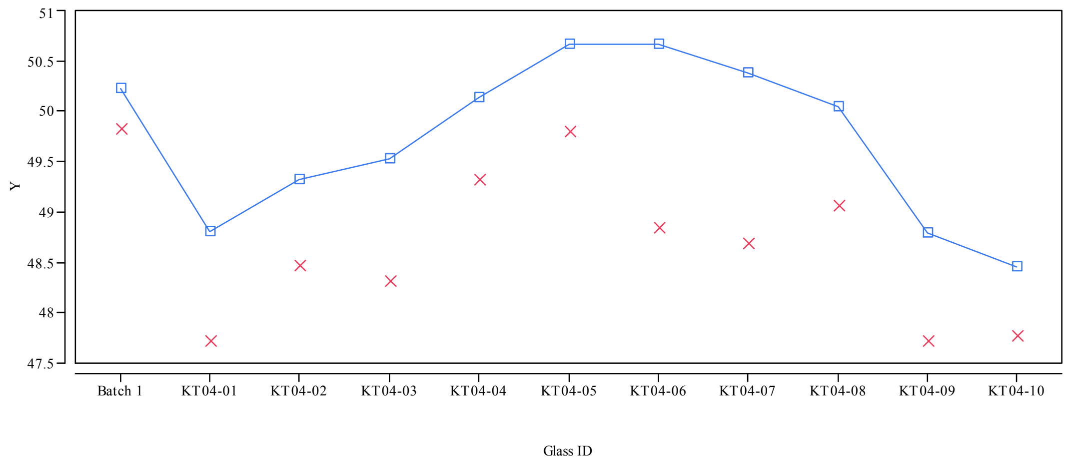
Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=PbO (wt%)



Y × Measured ▫ — Targeted

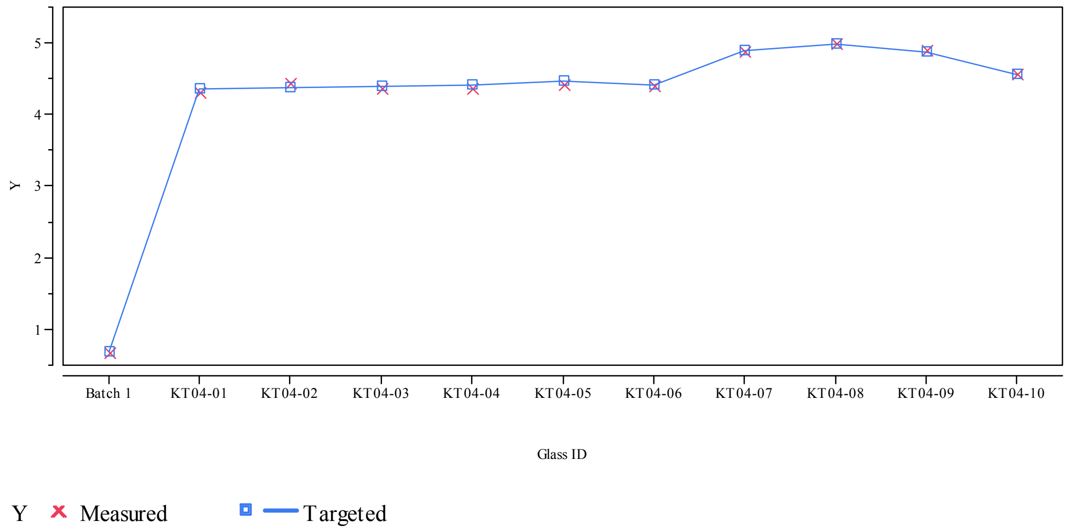
Oxide=SiO2 (wt%)



Y × Measured ▫ — Targeted

Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=TiO2 (wt%)



Oxide=ZnO (wt%)

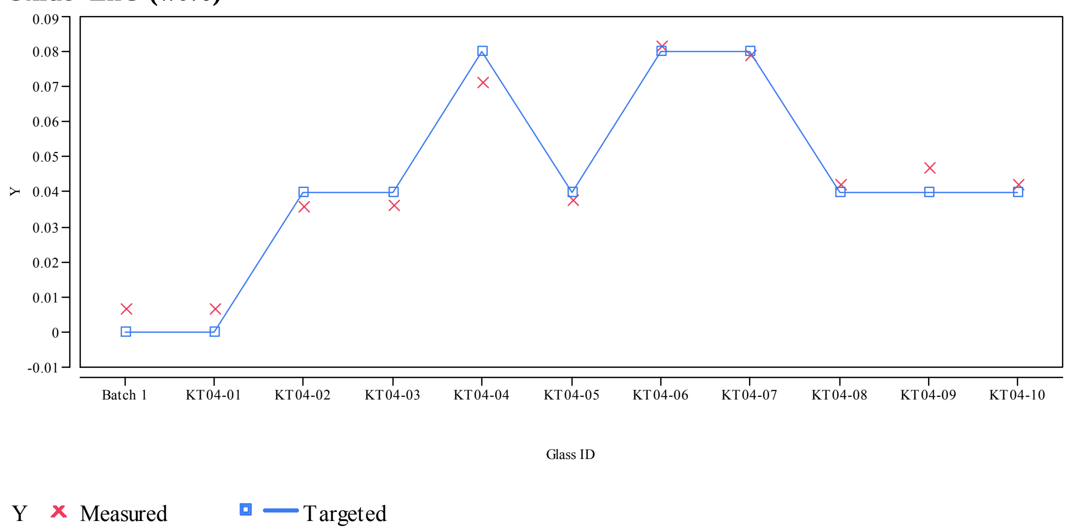
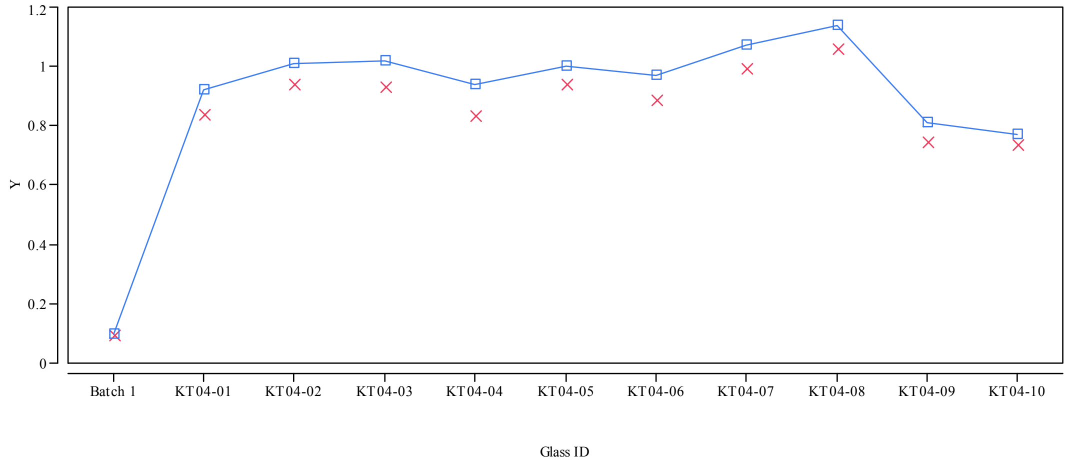


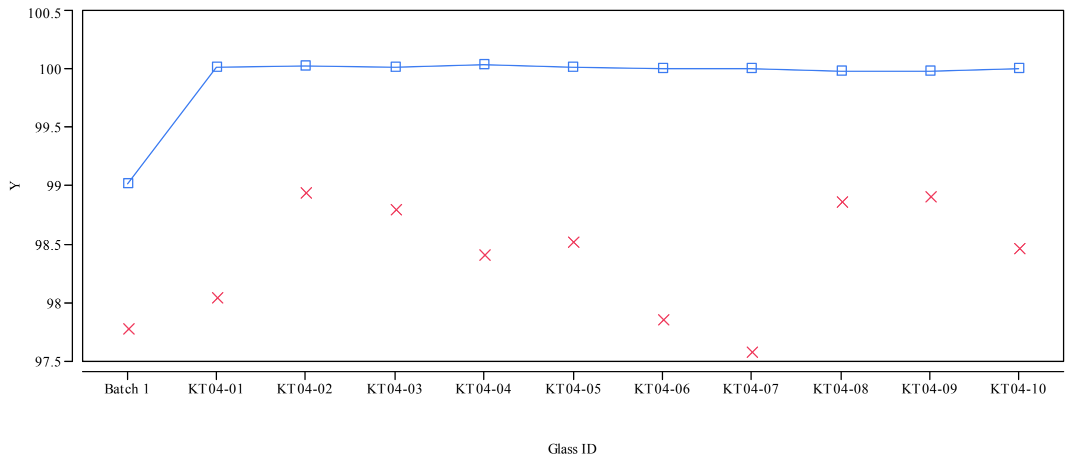
Exhibit C-4. Plots of Measured versus Targeted Concentrations by Glass ID by Oxide for the KT04-Series. (continued)

Oxide=ZrO2 (wt%)



Y × Measured ▫ — Targeted

Oxide=Sum of Oxides



Y × Measured ▫ — Targeted

Appendix D. Data Supporting the PCT Measurements of the KT01-Series Glasses

Table D-1. Measurements of the PCT Solutions for the KT01-Series Glasses As-Received (ar) and After Appropriate Adjustments (ppm).

Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
Soln Std	ref	1	1	std-11-1	21.2	9.90	82.1	47.2	21.20	9.90	82.10	47.20
KT1-HS	ccc	1	2	S76	5.83	9.98	47.9	71.2	9.72	16.63	79.83	118.67
EA	ref	1	3	S70	40.3	12.2	107	52.9	671.67	203.33	1783.34	881.67
ARM-1	ref	1	4	S85	11.0	8.30	21.5	34.4	18.33	13.83	35.83	57.33
KT1-HN	quenched	1	5	S72	8.09	11.8	91.3	81.4	13.48	19.67	152.17	135.67
KT1-HL	ccc	1	6	S78	12.9	57.7	105	173.6	21.50	96.17	175.00	289.34
blank	ref	1	7	S47	0.422	<1.00	<0.100	<0.100	0.70	0.83	0.08	0.08
KT1-HA	ccc	1	8	S16	6.16	10.3	59.8	65.8	10.27	17.17	99.67	109.67
KT1-LL	quenched	1	9	S68	7.03	11.3	63.7	72.4	11.72	18.83	106.17	120.67
KT1-LS	quenched	1	10	S37	6.71	10.7	61.3	69.5	11.18	17.83	102.17	115.84
KT1-HN	ccc	1	11	S67	7.79	12.8	85.2	82.4	12.98	21.33	142.00	137.34
KT1-HB	quenched	1	12	S56	9.54	9.58	52.1	60.9	15.90	15.97	86.84	101.50
KT1-LA	ccc	1	13	S77	7.88	12.7	66.7	79.4	13.13	21.17	111.17	132.34
KT1-LF	ccc	1	14	S59	6.38	11.3	62.4	72.6	10.63	18.83	104.00	121.00
KT1-LN	quenched	1	15	S63	6.02	10.1	43.8	63.1	10.03	16.83	73.00	105.17
KT1-LN	ccc	1	16	S07	5.94	10.2	40.9	63.1	9.90	17.00	68.17	105.17
Soln Std	ref	1	17	std-11-2	20.6	10.0	83.2	47.3	20.60	10.00	83.20	47.30
KT1-HB	ccc	1	18	S15	9.68	9.55	47.2	57.7	16.13	15.92	78.67	96.17
KT1-LL	ccc	1	19	S45	6.62	11.0	54.9	67.0	11.03	18.33	91.50	111.67
KT1-LS	ccc	1	20	S86	6.84	11.2	57.1	69.1	11.40	18.67	95.17	115.17
KT1-HK	ccc	1	21	S46	4.98	5.00	41.8	52.7	8.30	8.33	69.67	87.84
KT1-LA	quenched	1	22	S19	8.13	12.8	74.4	83.1	13.55	21.33	124.00	138.50
KT1-HF	ccc	1	23	S01	6.27	10.3	59.3	70.9	10.45	17.17	98.84	118.17
KT1-LB	ccc	1	24	S62	7.14	11.8	60.4	72.4	11.90	19.67	100.67	120.67
KT1-HF	quenched	1	25	S22	7.08	11.2	59.1	68.0	11.80	18.67	98.50	113.34
KT1-HS	quenched	1	26	S38	5.88	9.91	51.2	71.0	9.80	16.52	85.34	118.34
KT1-LF	quenched	1	27	S64	6.22	10.8	67.2	73.7	10.37	18.00	112.00	122.84
KT1-LB	quenched	1	28	S52	6.72	10.6	62.4	68.1	11.20	17.67	104.00	113.50
KT1-HA	quenched	1	29	S55	5.92	9.50	59.7	63.8	9.87	15.83	99.50	106.34
KT1-HL	quenched	1	30	S13	10.2	26.8	94.6	105	17.00	44.67	157.67	175.00
KT1-HK	quenched	1	31	S39	5.39	5.49	48.4	48.1	8.98	9.15	80.67	80.17
Soln Std	ref	1	32	std-11-3	19.6	9.68	79.4	45.7	19.60	9.68	79.40	45.70
Soln Std	ref	2	1	std-12-1	21.3	10.2	83.5	48.4	21.30	10.20	83.50	48.40
KT1-HB	quenched	2	2	S23	9.49	9.31	48.9	58.3	15.82	15.52	81.50	97.17
KT1-HB	ccc	2	3	S05	9.87	10.3	51.4	62.4	16.45	17.17	85.67	104.00
KT1-LA	ccc	2	4	S34	7.87	13.2	68.2	80.7	13.12	22.00	113.67	134.50
KT1-LF	quenched	2	5	S82	6.32	11.1	68.8	74.4	10.53	18.50	114.67	124.00
KT1-LF	ccc	2	6	S09	6.12	11.4	62.3	72.1	10.20	19.00	103.84	120.17
KT1-LL	ccc	2	7	S18	6.16	11.3	56.4	68.0	10.27	18.83	94.00	113.34
ARM-1	ref	2	8	S20	9.37	7.77	20.1	31.7	15.62	12.95	33.50	52.83
KT1-HK	ccc	2	9	S74	4.94	5.53	47.5	58.3	8.23	9.22	79.17	97.17
KT1-HN	quenched	2	10	S69	7.22	11.9	90.2	80.4	12.03	19.83	150.34	134.00
KT1-HL	ccc	2	11	S03	12.4	58.1	109	222	20.67	96.84	181.67	370.01
KT1-HN	ccc	2	12	S35	7.26	12.7	83.6	80.1	12.10	21.17	139.34	133.50
KT1-HF	ccc	2	13	S60	5.44	9.77	58.0	67.4	9.07	16.28	96.67	112.34
KT1-HF	quenched	2	14	S26	6.61	11.2	58.3	67.8	11.02	18.67	97.17	113.00
KT1-LL	quenched	2	15	S12	6.30	11.3	64.1	71.3	10.50	18.83	106.84	118.84
KT1-LB	ccc	2	16	S36	6.52	11.9	61.2	71.7	10.87	19.83	102.00	119.50
Soln Std	ref	2	17	std-12-2	20.2	10.1	83.4	48.1	20.20	10.10	83.40	48.10
KT1-LB	quenched	2	18	S04	7.14	11.5	65.1	72.8	11.90	19.17	108.50	121.34
KT1-LN	quenched	2	19	S57	5.80	10.4	44.1	69.3	9.67	17.33	73.50	115.50
EA	ref	2	20	S06	39.2	12.0	105	51.5	653.33	200.00	1750.00	858.34
KT1-LS	quenched	2	21	S30	6.48	10.8	62.2	68.8	10.80	18.00	103.67	114.67
KT1-HS	ccc	2	22	S54	5.21	9.98	47.9	69.7	8.68	16.63	79.83	116.17
KT1-LA	quenched	2	23	S42	7.37	12.8	74.6	82.1	12.28	21.33	124.34	136.84
KT1-LS	ccc	2	24	S50	6.10	11.5	58.7	69.0	10.17	19.17	97.84	115.00
KT1-LN	ccc	2	25	S80	5.42	10.5	42.1	62.4	9.03	17.50	70.17	104.00
KT1-HA	quenched	2	26	S71	5.54	9.88	63.4	64.0	9.23	16.47	105.67	106.67
KT1-HA	ccc	2	27	S84	5.33	10.2	57.7	63.4	8.88	17.00	96.17	105.67
KT1-HK	quenched	2	28	S79	5.42	5.91	52.4	52.7	9.03	9.85	87.34	87.84
KT1-HL	quenched	2	29	S27	10.7	30.1	105	117	17.83	50.17	175.00	195.00
KT1-HS	quenched	2	30	S75	4.94	9.85	50.8	69.8	8.23	16.42	84.67	116.34
Soln Std	ref	2	31	std-12-3	20.0	10.2	84.3	47.9	20.00	10.20	84.30	47.90
Soln Std	ref	3	1	std-13-1	21.1	10.0	82.3	48.4	21.10	10.00	82.30	48.40
KT1-HF	quenched	3	2	S51	7.50	11.1	57.2	67.8	12.50	18.50	95.34	113.00
KT1-HA	ccc	3	3	S14	5.99	10.0	55.5	62.8	9.98	16.67	92.50	104.67
KT1-HL	ccc	3	4	S32	12.8	58.0	106	170	21.33	96.67	176.67	283.34

Table D-1. Measurements of the PCT Solutions for the KT01-Series Glasses As-Received (ar) and After Appropriate Adjustments (ppm). (continued)

Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
ARM-1	ref	3	5	S21	9.83	7.92	20.4	32.5	16.38	13.20	34.00	54.17
blank	ref	3	6	S83	<0.100	<1.00	0.144	<0.100	0.08	0.83	0.24	0.08
KT1-LN	ccc	3	7	S28	5.82	10.5	41.9	63.4	9.70	17.50	69.83	105.67
KT1-HB	quenched	3	8	S10	8.78	9.23	49.1	58.2	14.63	15.38	81.83	97.00
KT1-HK	quenched	3	9	S25	5.76	5.91	52.2	53.4	9.60	9.85	87.00	89.00
KT1-LF	ccc	3	10	S66	6.00	11.5	62.1	73.9	10.00	19.17	103.50	123.17
KT1-HS	quenched	3	11	S44	5.28	9.87	50.4	70.6	8.80	16.45	84.00	117.67
KT1-HS	ccc	3	12	S81	5.23	10.0	47.7	70.4	8.72	16.67	79.50	117.34
KT1-LA	quenched	3	13	S53	7.56	12.6	72.6	81.5	12.60	21.00	121.00	135.84
KT1-LF	quenched	3	14	S33	5.83	10.7	66.3	71.8	9.72	17.83	110.50	119.67
KT1-LN	quenched	3	15	S61	5.71	10.4	45.5	64.3	9.52	17.33	75.83	107.17
KT1-HK	ccc	3	16	S24	5.09	5.70	48.4	60.1	8.48	9.50	80.67	100.17
Soln Std	ref	3	17	std-13-2	20.3	10.3	84.3	49.0	20.30	10.30	84.30	49.00
KT1-HA	quenched	3	18	S49	6.19	9.88	63.5	64.6	10.32	16.47	105.84	107.67
KT1-HB	ccc	3	19	S58	9.64	10.5	51.0	62.8	16.07	17.50	85.00	104.67
KT1-LL	ccc	3	20	S02	6.32	11.5	58.2	69.7	10.53	19.17	97.00	116.17
EA	ref	3	21	S08	39.4	12.2	106	52.8	656.67	203.33	1766.67	880.00
KT1-LS	quenched	3	22	S41	6.56	10.8	61.2	68.8	10.93	18.00	102.00	114.67
KT1-HF	ccc	3	23	S65	5.71	9.71	56.4	67.8	9.52	16.18	94.00	113.00
KT1-LB	ccc	3	24	S48	6.81	11.8	59.6	71.7	11.35	19.67	99.34	119.50
KT1-HN	quenched	3	25	S31	7.31	11.8	89.4	80.4	12.18	19.67	149.00	134.00
KT1-LA	ccc	3	26	S40	7.38	12.8	67.0	79.3	12.30	21.33	111.67	132.17
KT1-HN	ccc	3	27	S11	7.21	12.7	83.1	80.6	12.02	21.17	138.50	134.34
KT1-LL	quenched	3	28	S29	6.24	11.1	61.4	70.7	10.40	18.50	102.34	117.84
KT1-HL	quenched	3	29	S17	9.87	27.5	96.4	107	16.45	45.83	160.67	178.34
KT1-LS	ccc	3	30	S43	6.20	11.4	57.5	68.9	10.33	19.00	95.84	114.84
KT1-LB	quenched	3	31	S73	6.58	11.2	63.6	71.6	10.97	18.67	106.00	119.34
Soln Std	ref	3	32	std-13-3	20.4	10.3	85.4	48.9	20.40	10.30	85.40	48.90

Table D-2. Normalized PCT Results for the KT01-Series Glasses by Heat Treatment by Compositional View.

Glass ID	Heat Treatment	Comp View	log NL[B (g/L)]	log NL[Li (g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]	NL B(g/L)	NL Li (g/L)	NL Na (g/L)	NL Si (g/L)
ARM	ref	reference	-0.3215	-0.2482	-0.3188	-0.5988	0.477	0.565	0.480	0.252
EA	ref	reference	1.2746	1.0094	1.1515	0.5836	18.821	10.220	14.175	3.834
KT1-HA	ccc	measured	-0.2102	-0.1222	-0.0666	-0.3238	0.616	0.755	0.858	0.475
KT1-HB	ccc	measured	-0.1384	-0.0852	-0.0903	-0.3083	0.727	0.822	0.812	0.492
KT1-HF	ccc	measured	-0.1588	-0.0831	-0.0108	-0.2499	0.694	0.826	0.976	0.563
KT1-HK	ccc	measured	-0.2125	0.1465	0.1585	-0.3088	0.613	1.401	1.440	0.491
KT1-HL	ccc	measured	0.1657	0.4669	0.2391	0.1791	1.465	2.930	1.734	1.510
KT1-HN	ccc	measured	-0.0694	0.0098	0.0750	-0.1891	0.852	1.023	1.188	0.647
KT1-HS	ccc	measured	-0.1875	-0.0830	-0.0928	-0.2874	0.649	0.826	0.808	0.516
KT1-LA	ccc	measured	-0.0534	0.0050	0.0085	-0.2101	0.884	1.012	1.020	0.616
KT1-LB	ccc	measured	-0.1256	-0.0339	-0.0235	-0.2526	0.749	0.925	0.947	0.559
KT1-LF	ccc	measured	-0.1779	-0.0734	-0.0253	-0.2678	0.664	0.844	0.943	0.540
KT1-LL	ccc	measured	-0.1498	-0.0669	-0.0474	-0.2705	0.708	0.857	0.897	0.536
KT1-LN	ccc	measured	-0.1959	-0.0971	-0.1301	-0.3195	0.637	0.800	0.741	0.479
KT1-LS	ccc	measured	-0.1405	-0.0524	-0.0479	-0.2667	0.724	0.886	0.896	0.541
KT1-HA	quenched	measured	-0.2056	-0.1403	-0.0338	-0.3228	0.623	0.724	0.925	0.476
KT1-HB	quenched	measured	-0.1597	-0.1181	-0.0887	-0.3213	0.692	0.762	0.815	0.477
KT1-HF	quenched	measured	-0.0735	-0.0318	-0.0085	-0.2551	0.844	0.929	0.981	0.556
KT1-HK	quenched	measured	-0.1697	0.1749	0.2049	-0.3538	0.677	1.496	1.603	0.443
KT1-HL	quenched	measured	0.0728	0.1527	0.2049	-0.0535	1.182	1.421	1.603	0.884
KT1-HN	quenched	measured	-0.0627	-0.0221	0.1066	-0.1907	0.866	0.950	1.278	0.645
KT1-HS	quenched	measured	-0.1926	-0.0878	-0.0667	-0.2872	0.642	0.817	0.858	0.516
KT1-LA	quenched	measured	-0.0549	-0.0006	0.0489	-0.1971	0.881	0.999	1.119	0.635
KT1-LB	quenched	measured	-0.1262	-0.0620	-0.0004	-0.2595	0.748	0.867	0.999	0.550
KT1-LF	quenched	measured	-0.1811	-0.0943	0.0093	-0.2653	0.659	0.805	1.022	0.543
KT1-LL	quenched	measured	-0.1397	-0.0681	0.0004	-0.2504	0.725	0.855	1.001	0.562
KT1-LN	quenched	measured	-0.1870	-0.1013	-0.1016	-0.3023	0.650	0.792	0.791	0.499
KT1-LS	quenched	measured	-0.1263	-0.0760	-0.0202	-0.2665	0.748	0.840	0.955	0.541
KT1-HA	ccc	targeted	-0.1609	-0.0931	-0.0382	-0.2923	0.690	0.807	0.916	0.510
KT1-HB	ccc	targeted	-0.1395	-0.0975	-0.1033	-0.3155	0.725	0.799	0.788	0.484
KT1-HF	ccc	targeted	-0.1526	-0.0939	-0.0270	-0.2520	0.704	0.806	0.940	0.560
KT1-HK	ccc	targeted	-0.1943	0.1802	0.1618	-0.3111	0.639	1.514	1.451	0.489
KT1-HL	ccc	targeted	0.1764	0.4605	0.2272	0.1718	1.501	2.887	1.687	1.485
KT1-HN	ccc	targeted	-0.0601	-0.0001	0.0605	-0.1943	0.871	1.000	1.150	0.639
KT1-HS	ccc	targeted	-0.1771	-0.0862	-0.1045	-0.2924	0.665	0.820	0.786	0.510
KT1-LA	ccc	targeted	-0.0601	-0.0113	0.0075	-0.2178	0.871	0.974	1.017	0.606
KT1-LB	ccc	targeted	-0.1178	-0.0413	-0.0321	-0.2555	0.762	0.909	0.929	0.555
KT1-LF	ccc	targeted	-0.1688	-0.0766	-0.0378	-0.2690	0.678	0.838	0.917	0.538
KT1-LL	ccc	targeted	-0.1359	-0.0746	-0.0612	-0.2785	0.731	0.842	0.869	0.527
KT1-LN	ccc	targeted	-0.1913	-0.1066	-0.1453	-0.3226	0.644	0.782	0.716	0.476
KT1-LS	ccc	targeted	-0.1381	-0.0616	-0.0550	-0.2714	0.728	0.868	0.881	0.535
KT1-HA	quenched	targeted	-0.1563	-0.1112	-0.0053	-0.2913	0.698	0.774	0.988	0.511
KT1-HB	quenched	targeted	-0.1609	-0.1303	-0.1017	-0.3286	0.690	0.741	0.791	0.469
KT1-HF	quenched	targeted	-0.0673	-0.0426	-0.0247	-0.2572	0.856	0.907	0.945	0.553
KT1-HK	quenched	targeted	-0.1516	0.2086	0.2082	-0.3561	0.705	1.617	1.615	0.441
KT1-HL	quenched	targeted	0.0834	0.1462	0.1930	-0.0607	1.212	1.400	1.559	0.870
KT1-HN	quenched	targeted	-0.0534	-0.0319	0.0921	-0.1959	0.884	0.929	1.236	0.637
KT1-HS	quenched	targeted	-0.1822	-0.0910	-0.0784	-0.2922	0.657	0.811	0.835	0.510
KT1-LA	quenched	targeted	-0.0616	-0.0169	0.0479	-0.2048	0.868	0.962	1.117	0.624
KT1-LB	quenched	targeted	-0.1184	-0.0694	-0.0090	-0.2624	0.761	0.852	0.979	0.547
KT1-LF	quenched	targeted	-0.1720	-0.0975	-0.0032	-0.2665	0.673	0.799	0.993	0.541
KT1-LL	quenched	targeted	-0.1258	-0.0759	-0.0134	-0.2583	0.749	0.840	0.970	0.552
KT1-LN	quenched	targeted	-0.1823	-0.1108	-0.1168	-0.3054	0.657	0.775	0.764	0.495
KT1-LS	quenched	targeted	-0.1240	-0.0851	-0.0273	-0.2712	0.752	0.822	0.939	0.536

Exhibit D-1. KT01 PCT Measurements (ppm values) in Analytical Sequence by Element.

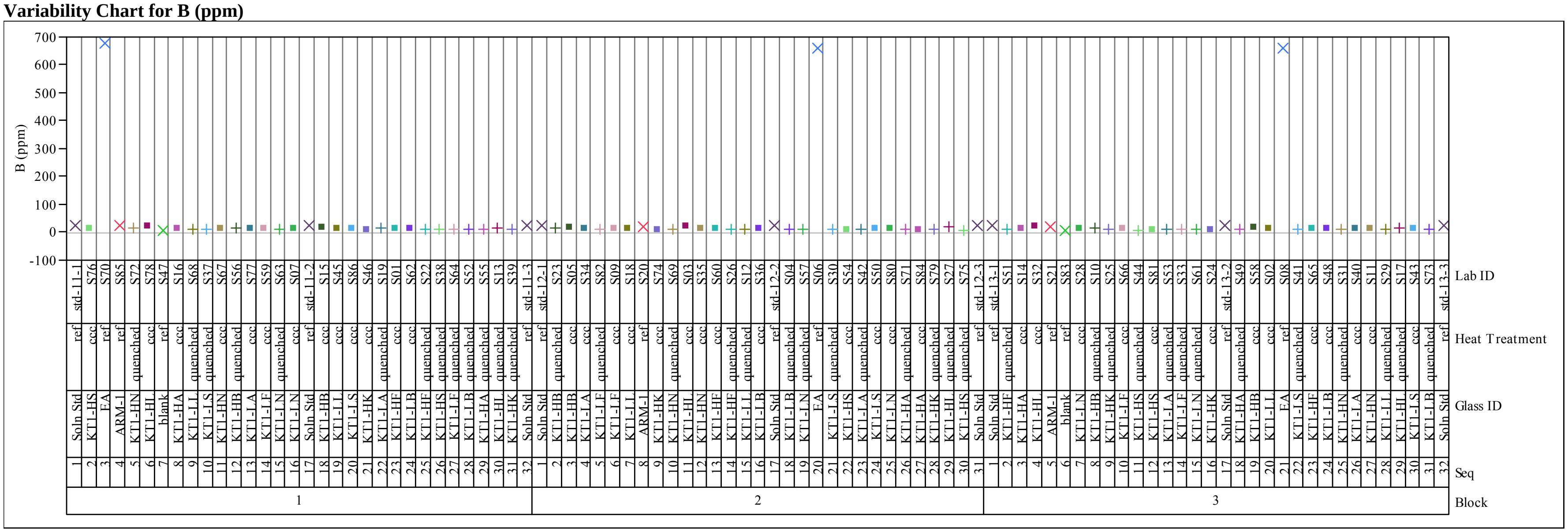


Exhibit D-1. KT01 PCT Measurements (ppm values) in Analytical Sequence by Element. (continued)

Variability Chart for Li (ppm)

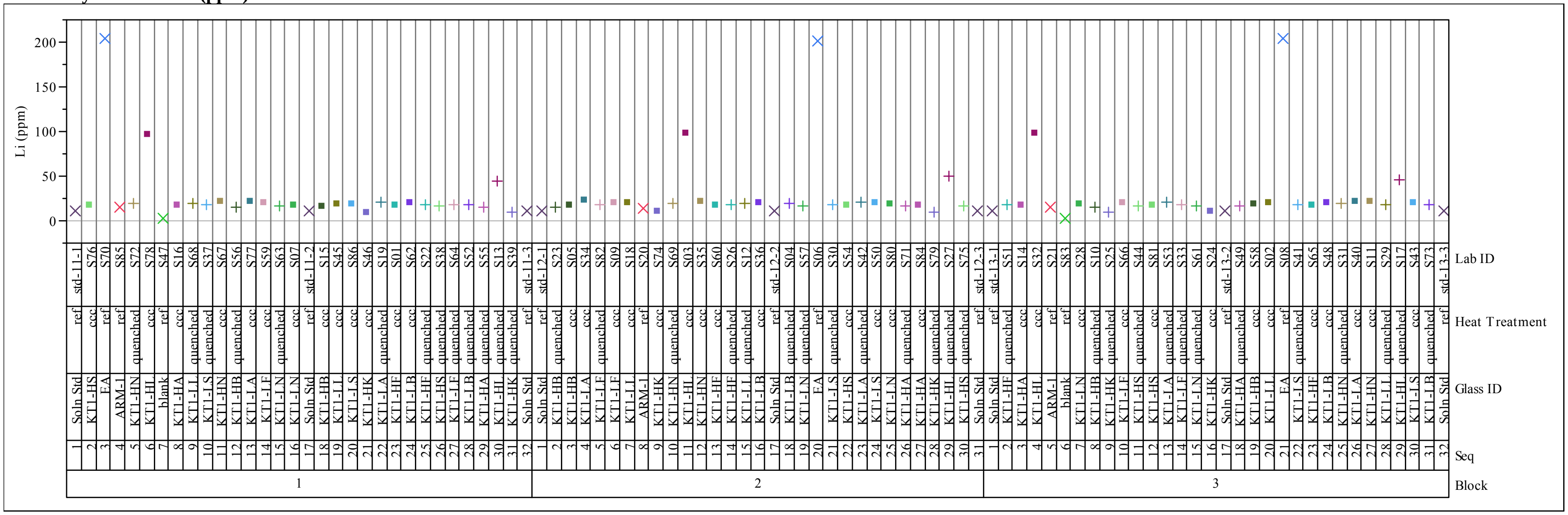


Exhibit D-1. KT01 PCT Measurements (ppm values) in Analytical Sequence by Element. (continued)

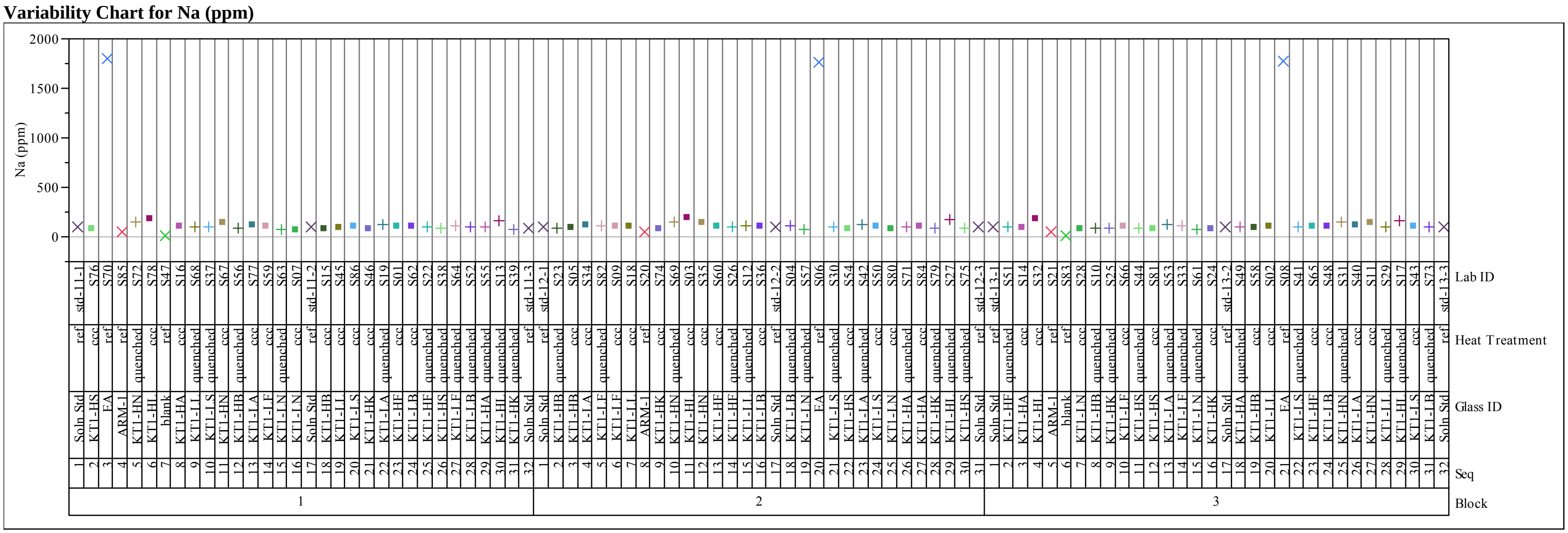


Exhibit D-1. KT01 PCT Measurements (ppm values) in Analytical Sequence by Element. (continued)

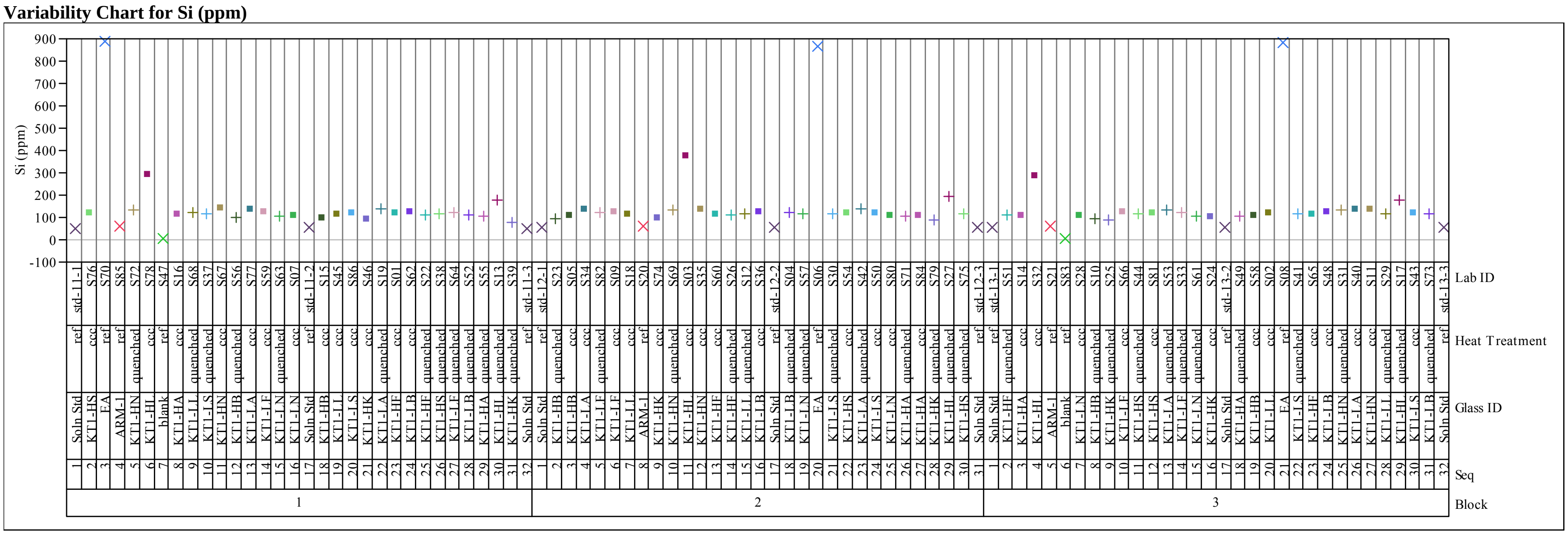
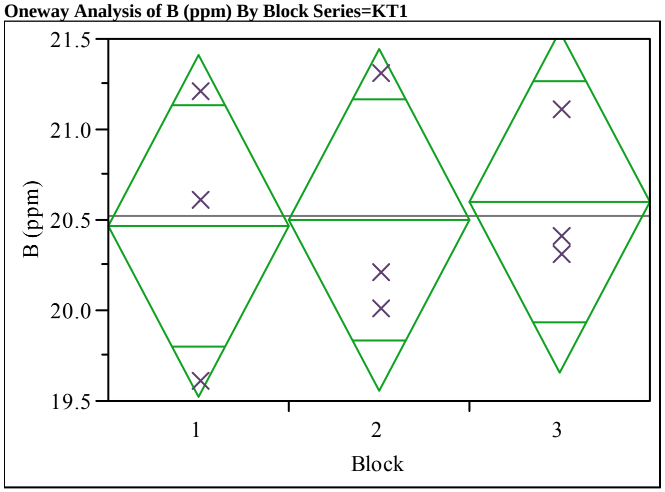


Exhibit D-2. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Multi-Element Standard Solution Results by Oxide.

Oneway Analysis of B (ppm) By Block Series=KT1



Oneway Anova
Summary of Fit

Rsquare	0.010717
Adj Rsquare	-0.31904
Root Mean Square Error	0.666667
Mean of Response	20.52222
Observations (or Sum Wgts)	9

Analysis of Variance

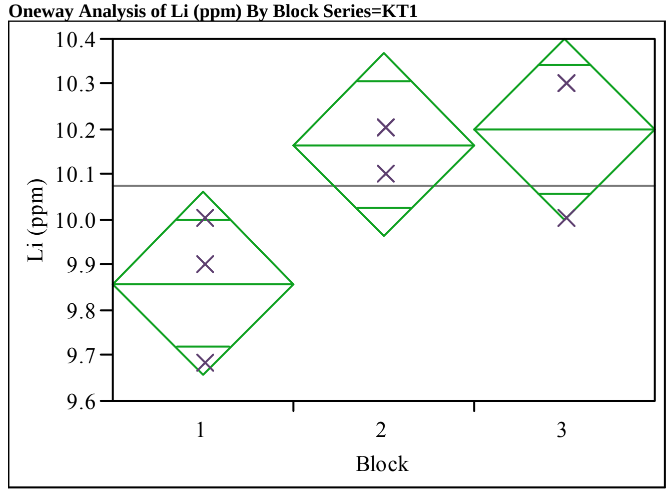
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.0288889	0.014444	0.0325	0.9682
Error	6	2.6666667	0.444444		
C. Total	8	2.6955556			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	20.4667	0.38490	19.525	21.408
2	3	20.5000	0.38490	19.558	21.442
3	3	20.6000	0.38490	19.658	21.542

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Block Series=KT1



Oneway Anova
Summary of Fit

Rsquare	0.636681
Adj Rsquare	0.515575
Root Mean Square Error	0.141578
Mean of Response	10.07556
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.21075556	0.105378	5.2572	0.0480
Error	6	0.12026667	0.020044		
C. Total	8	0.33102222			

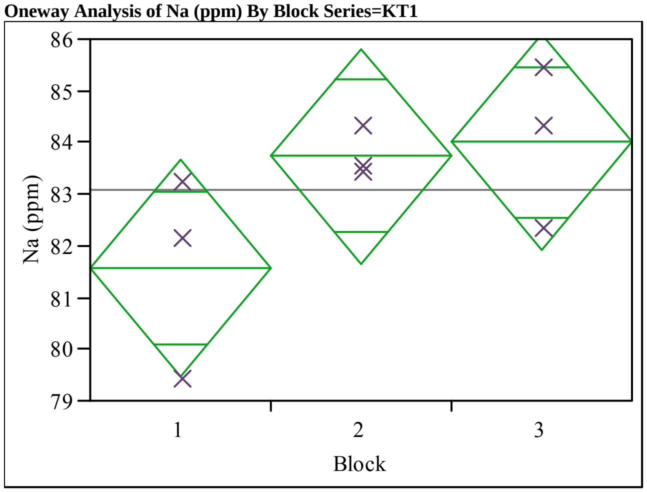
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	9.8600	0.08174	9.660	10.060
2	3	10.1667	0.08174	9.967	10.367
3	3	10.2000	0.08174	10.000	10.400

Std Error uses a pooled estimate of error variance

Exhibit D-2. Statistical Evaluation of the ICP-AES Calibration Effects from the KT01 Multi-Element Standard Solution Results by Oxide. (continued)

Oneway Analysis of Na (ppm) By Block Series=KT1



Oneway Anova
Summary of Fit

Rsquare	0.449776
Adj Rsquare	0.266367
Root Mean Square Error	1.476106
Mean of Response	83.1
Observations (or Sum Wgts)	9

Analysis of Variance

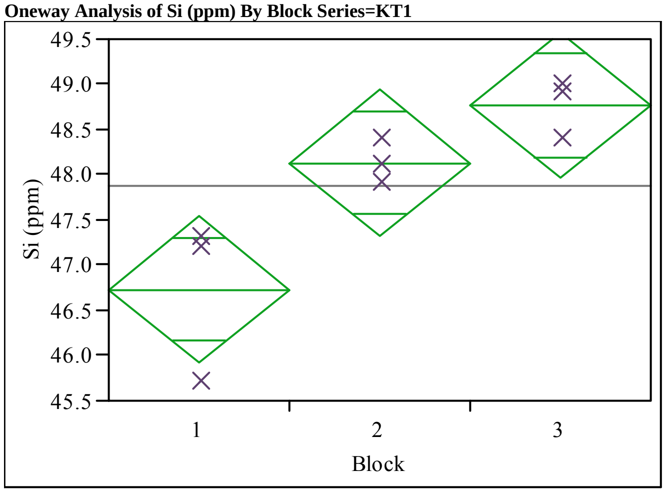
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	10.686667	5.34333	2.4523	0.1666
Error	6	13.073333	2.17889		
C. Total	8	23.760000			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	81.5667	0.85223	79.481	83.652
2	3	83.7333	0.85223	81.648	85.819
3	3	84.0000	0.85223	81.915	86.085

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Block Series=KT1



Oneway Anova
Summary of Fit

Rsquare	0.770021
Adj Rsquare	0.693361
Root Mean Square Error	0.568624
Mean of Response	47.87778
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	6.4955556	3.24778	10.0447	0.0122
Error	6	1.9400000	0.32333		
C. Total	8	8.4355556			

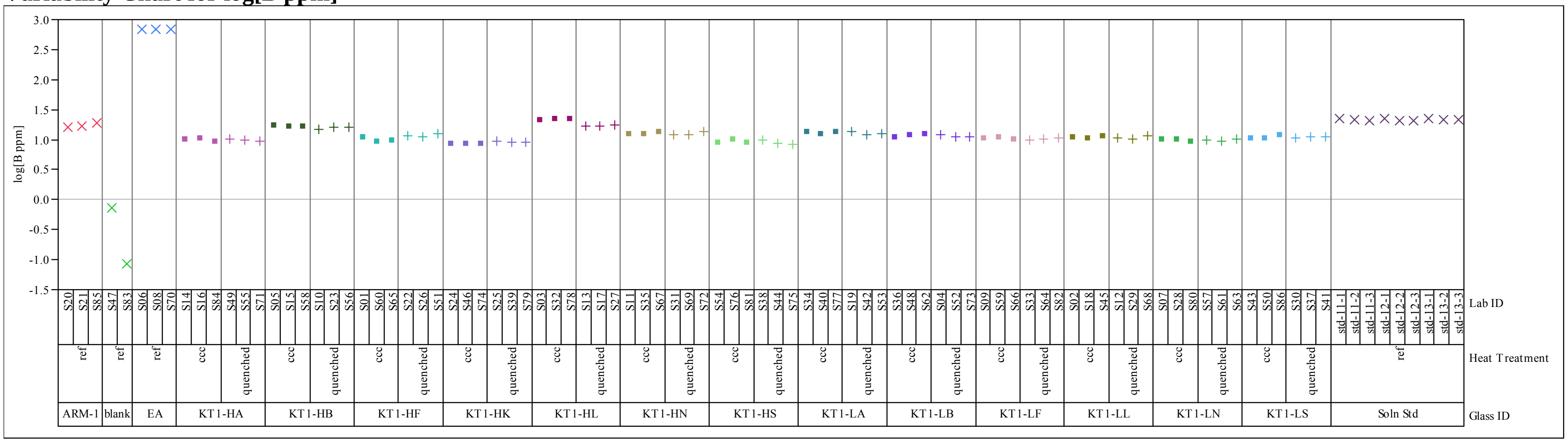
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	46.7333	0.32830	45.930	47.537
2	3	48.1333	0.32830	47.330	48.937
3	3	48.7667	0.32830	47.963	49.570

Std Error uses a pooled estimate of error variance

Exhibit D-3. KT01 PCT Results (as common logarithms) Grouped by Glass ID and Heat Treatment.

Variability Chart for log[B ppm]



Variability Chart for log[Li ppm]

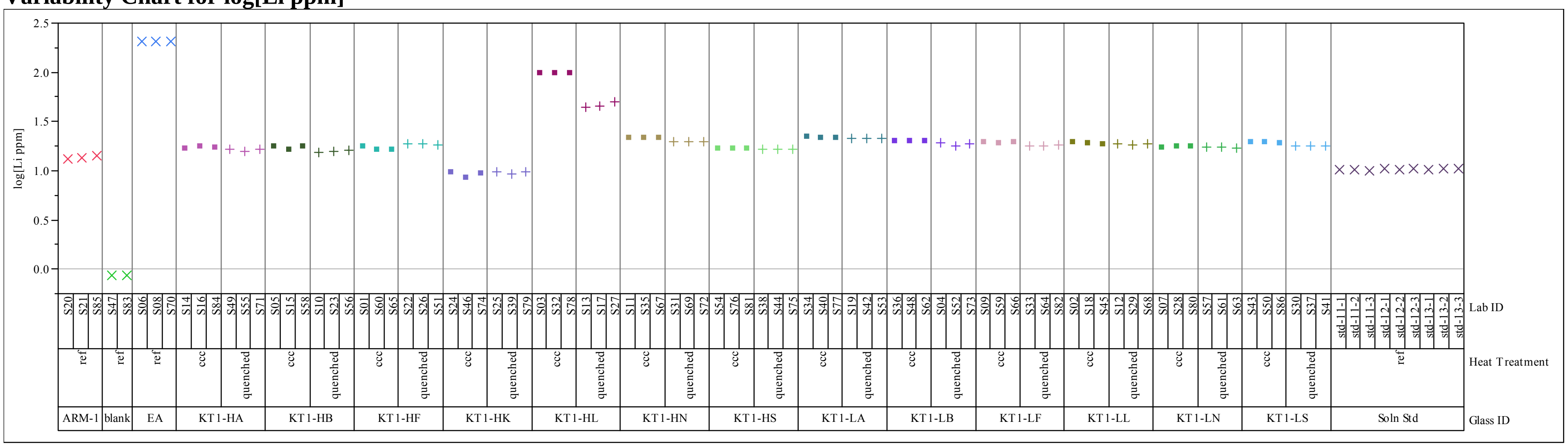
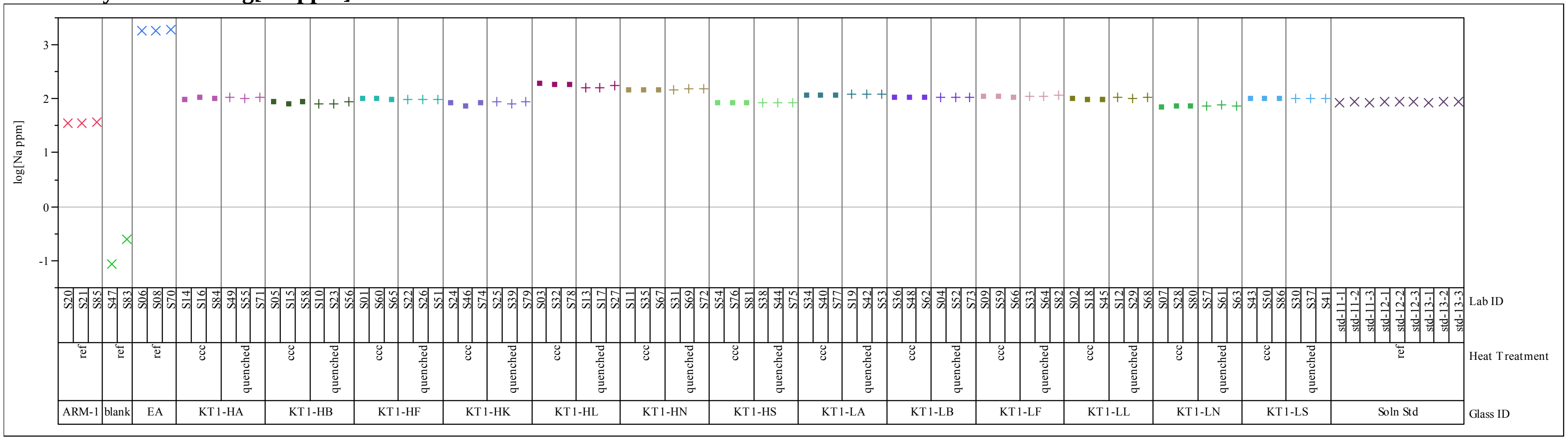


Exhibit D-3. KT01 PCT Results (as common logarithms) Grouped by Glass ID and Heat Treatment. (continued)

Variability Chart for log[Na ppm]



Variability Chart for log[Si ppm]

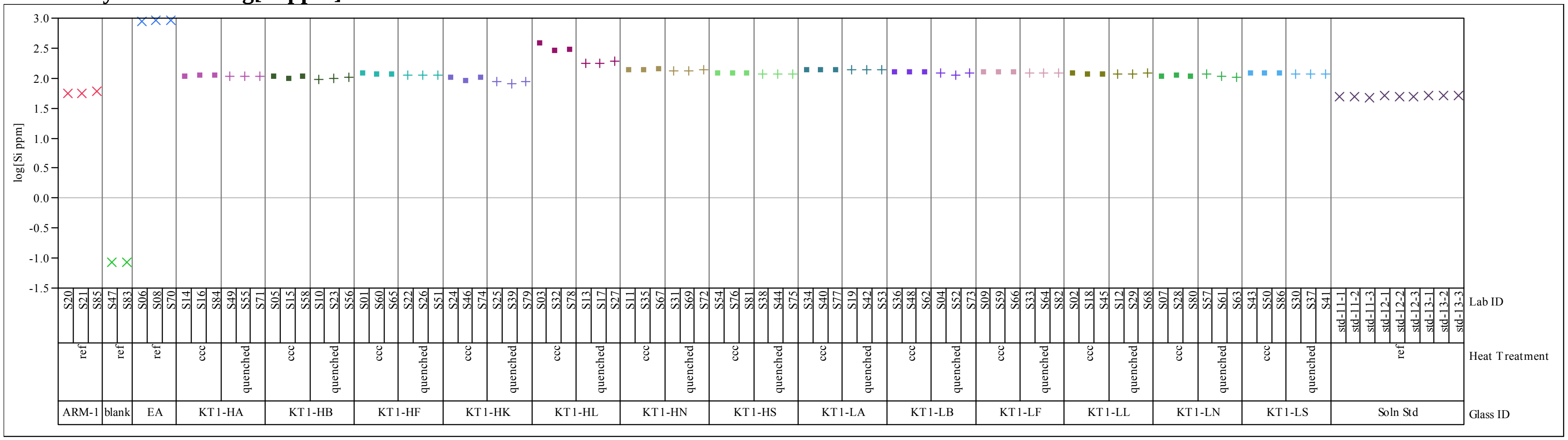


Exhibit D-4. Correlations and Scatter Plots of the KT01 Normalized PCTs Over All Compositional Views and Heat Treatments.

Multivariate Correlations

	log NL[B (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.8503	0.8862	0.9149
log NL[Li(g/L)]	0.8503	1.0000	0.9259	0.8632
log NL[Na (g/L)]	0.8862	0.9259	1.0000	0.8247
log NL[Si (g/L)]	0.9149	0.8632	0.8247	1.0000

Scatterplot Matrix

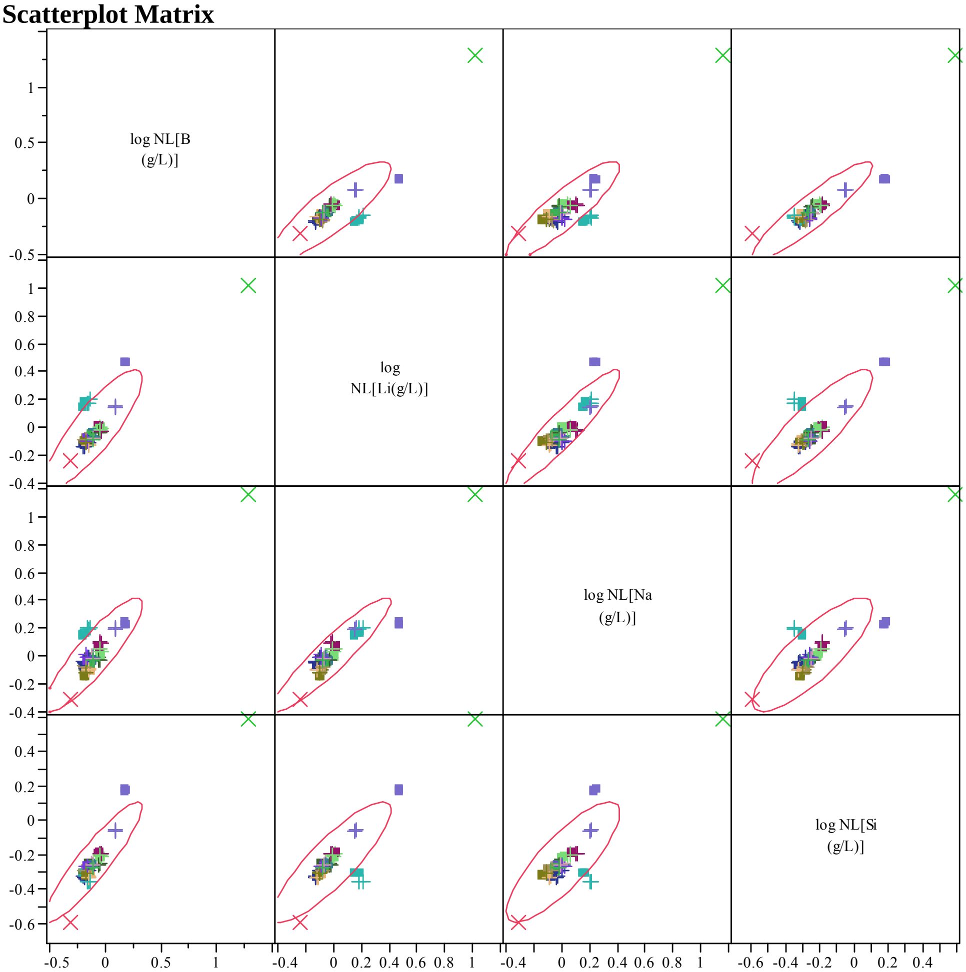
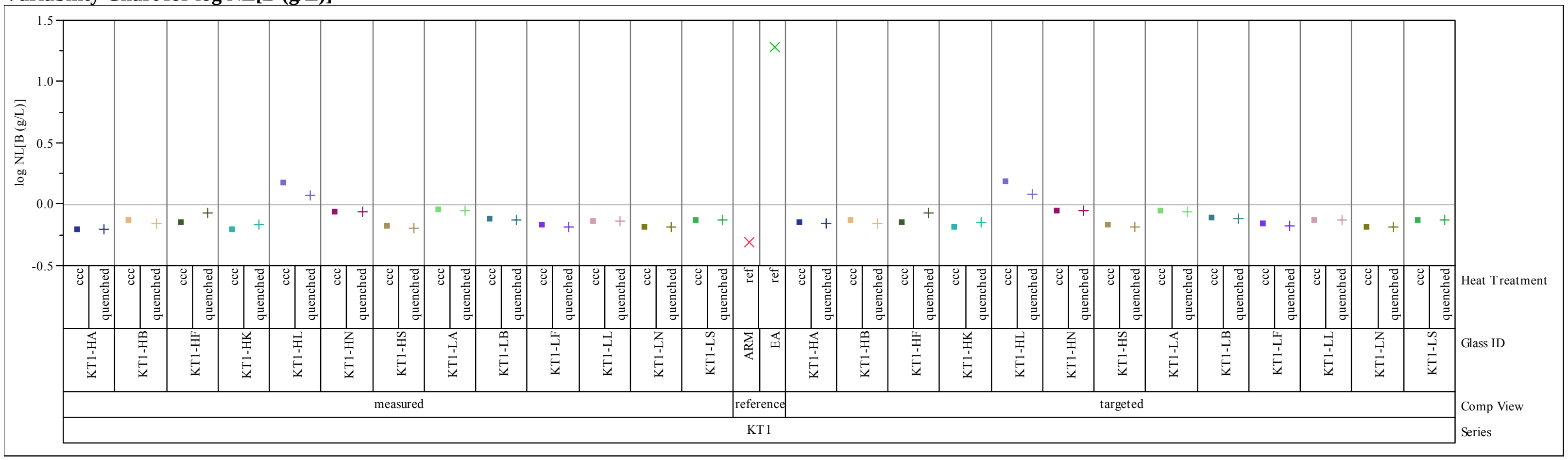


Exhibit D-5. Effects of Heat Treatment for the KT01 Glasses by Compositional View.

Variability Chart for log NL[B (g/L)]



Variability Chart for log NL[Li(g/L)]

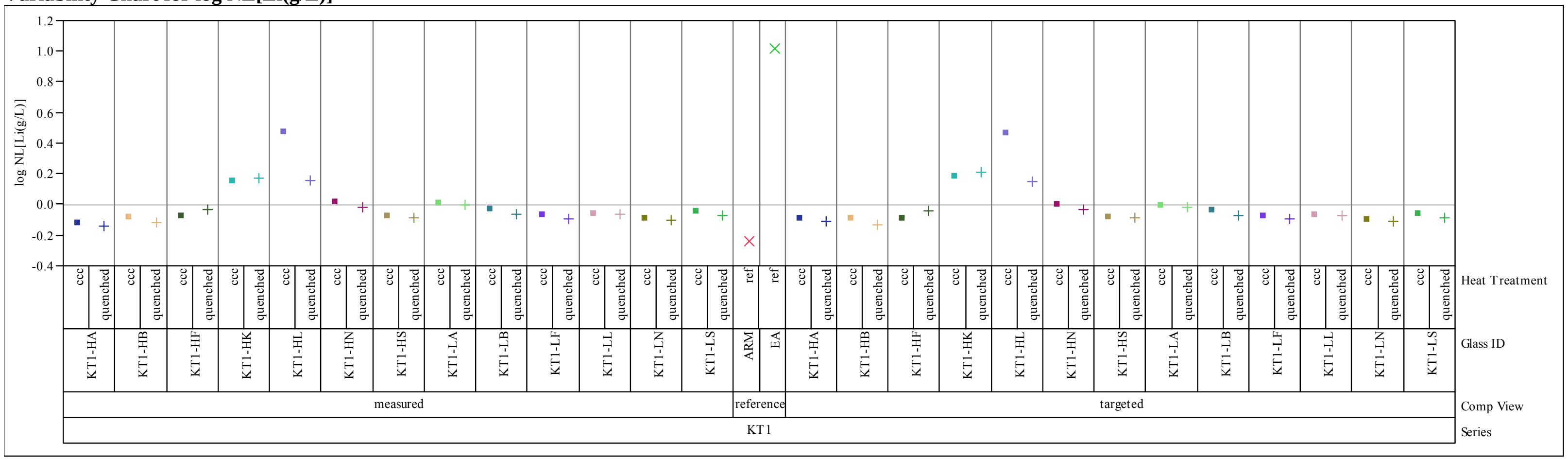
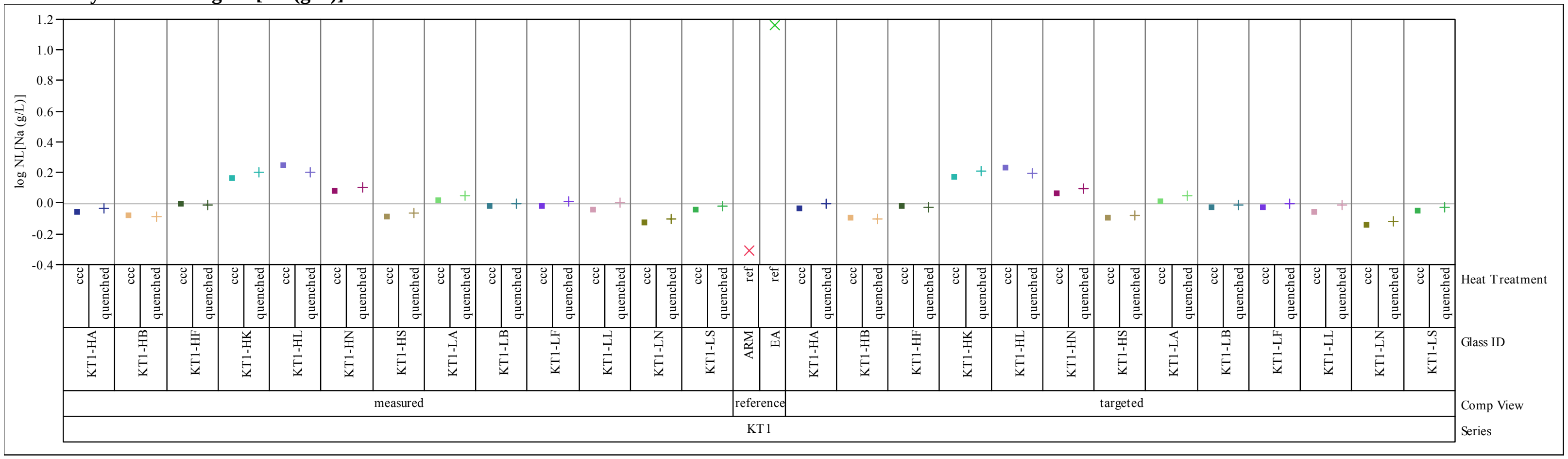


Exhibit D-5. Effects of Heat Treatment for the KT01 Glasses by Compositional View. (continued)

Variability Chart for log NL[Na (g/L)]



Variability Chart for log NL[Si (g/L)]

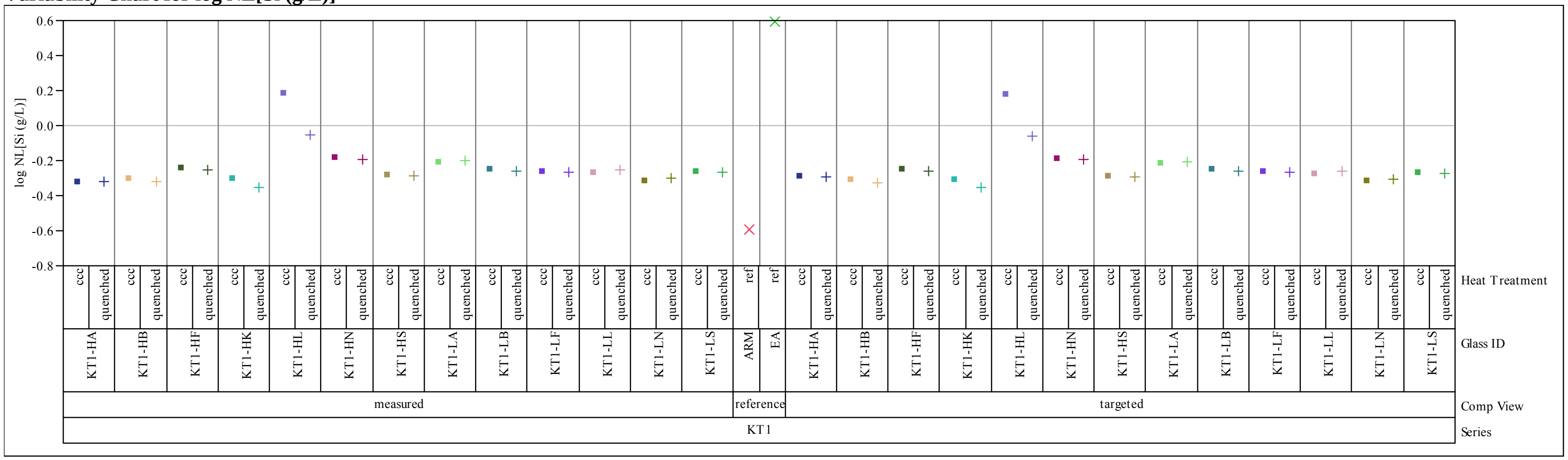
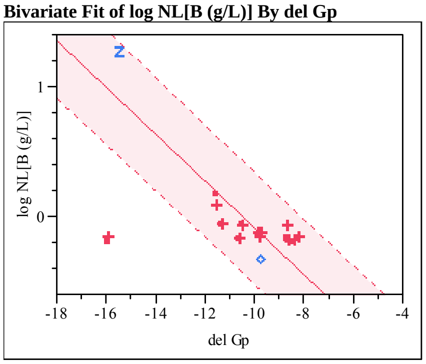


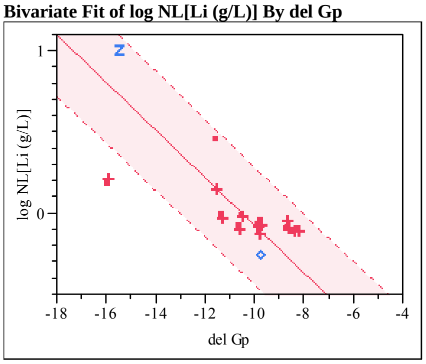
Exhibit D-6. KT01-Series PCT Measurements versus Durability Model Predictions.

Based Upon Targeted Compositions

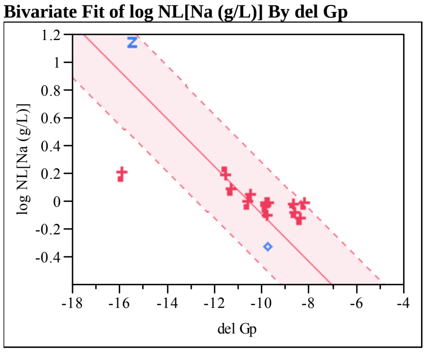
Bivariate Fit of log NL[B (g/L)] By del Gp



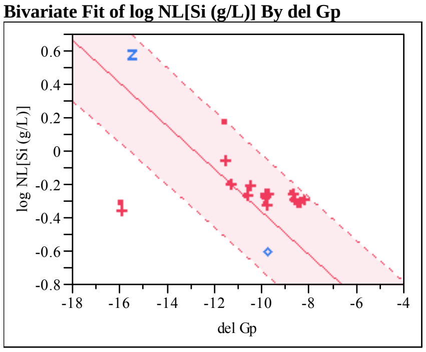
Bivariate Fit of log NL[Li (g/L)] By del Gp



Bivariate Fit of log NL[Na (g/L)] By del Gp

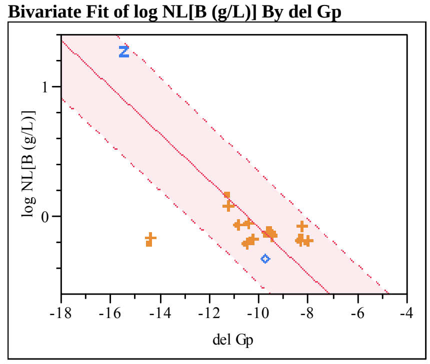


Bivariate Fit of log NL[Si (g/L)] By del Gp

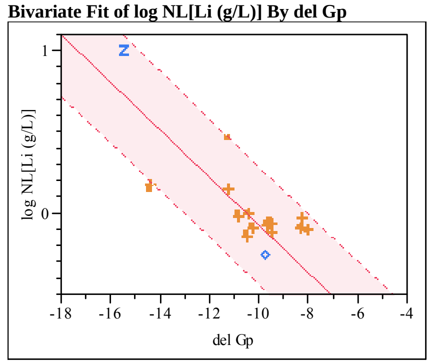


Based Upon Measured Compositions

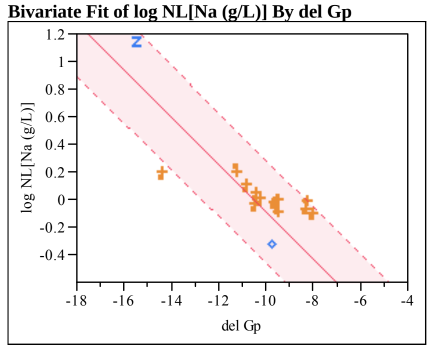
Bivariate Fit of log NL[B (g/L)] By del Gp



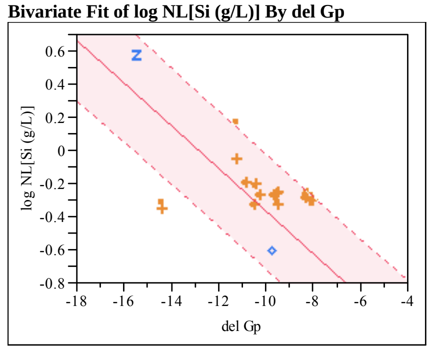
Bivariate Fit of log NL[Li (g/L)] By del Gp



Bivariate Fit of log NL[Na (g/L)] By del Gp



Bivariate Fit of log NL[Si (g/L)] By del Gp



z Environmental Assessment Benchmark Glass
◇ Approved Reference Material Glass
+ + Quenched Study Glasses
■ ■ Slowly Cooled Study Glasses

Appendix E. Data Supporting the PCT Measurements of the KT03-Series Glasses

Table E-1. Measurements of the PCT Solutions for the KT03-Series Glasses As-Received (ar) and After Appropriate Adjustments (ppm).

Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
Soln Std	ref	1	1	STD-11	20.4	10.2	85.0	50.3	20.40	10.20	85.00	50.30
KT03-HS	ccc	1	2	V76	3.32	7.48	29.2	54.7	5.53	12.47	48.67	91.17
EA	ref	1	3	V70	35.0	11.4	93.7	54.0	583.33	190.00	1561.67	900.00
KT03-HN	quenched	1	4	V72	6.06	9.48	78.4	66.7	10.10	15.80	130.67	111.17
KT03-HL	ccc	1	5	V78	6.98	48.9	76.9	146	11.63	81.50	128.17	243.34
blank	ref	1	6	V47	<0.100	<1.00	<0.100	<0.100	0.08	0.83	0.08	0.08
KT1-HA2	ccc	1	7	V16	5.03	9.39	51.1	63.6	8.38	15.65	85.17	106.00
KT03-LL	quenched	1	8	V68	5.76	11.4	54.7	64.4	9.60	19.00	91.17	107.34
KT03-LS	quenched	1	9	V37	4.50	8.44	39.69	55.7	7.50	14.07	66.15	92.84
KT03-HN	ccc	1	10	V67	5.95	10.3	71.3	66.4	9.92	17.17	118.84	110.67
KT03-HB	quenched	1	11	V56	8.93	9.43	43.9	55.6	14.88	15.72	73.17	92.67
KT03-LA	ccc	1	12	V77	6.13	10.8	51.4	64.9	10.22	18.00	85.67	108.17
KT03-LF	ccc	1	13	V59	5.46	10.8	52.9	65.2	9.10	18.00	88.17	108.67
KT03-LN	quenched	1	14	V63	6.18	10.6	46.7	62.6	10.30	17.67	77.83	104.34
KT03-LN	ccc	1	15	V07	5.12	10.2	42.0	59.1	8.53	17.00	70.00	98.50
KT03-MK	ccc	1	16	V87	4.05	6.64	34.0	46.7	6.75	11.07	56.67	77.83
KT03-HA	quenched	1	17	V93	4.16	8.22	38.3	48.7	6.93	13.70	63.83	81.17
Soln Std	ref	1	18	STD-12	19.9	9.90	78.6	49.5	19.90	9.90	78.60	49.50
KT03-HB	ccc	1	19	V15	8.88	9.40	41.0	54.6	14.80	15.67	68.33	91.00
KT03-MK	quenched	1	20	V88	3.90	6.74	34.9	44.3	6.50	11.23	58.17	73.83
ARM-1	ref	1	21	V92	9.70	7.99	19.9	35.5	16.17	13.32	33.17	59.17
KT03-LL	ccc	1	22	V45	5.37	10.8	46.9	59.3	8.95	18.00	78.17	98.84
KT03-LS	ccc	1	23	V86	4.54	8.95	38.9	57.7	7.57	14.92	64.83	96.17
KT03-HK	ccc	1	24	V46	4.41	4.56	41.5	49.6	7.35	7.60	69.17	82.67
KT03-LA	quenched	1	25	V19	5.94	10.4	53.8	64.9	9.90	17.33	89.67	108.17
KT03-HF	ccc	1	26	V01	4.78	9.38	45.8	58.8	7.97	15.63	76.33	98.00
KT03-LB	ccc	1	27	V62	5.82	10.4	48.0	61.3	9.70	17.33	80.00	102.17
KT03-HF	quenched	1	28	V22	5.56	9.26	43.5	53.4	9.27	15.43	72.50	89.00
KT03-HS	quenched	1	29	V38	3.63	7.92	31.1	57.0	6.05	13.20	51.83	95.00
KT03-LF	quenched	1	30	V64	4.12	8.29	44.9	53.8	6.87	13.82	74.83	89.67
KT03-HA	ccc	1	31	V98	5.15	9.55	52.5	61.1	8.58	15.92	87.50	101.84
KT03-LB	quenched	1	32	V52	5.67	9.70	49.0	59.1	9.45	16.17	81.67	98.50
KT1-HA2	quenched	1	33	V55	5.27	9.75	53.0	64.6	8.78	16.25	88.34	107.67
KT03-HL	quenched	1	34	V13	7.65	23.0	71.9	82.8	12.75	38.33	119.84	138.00
KT03-HK	quenched	1	35	V39	10.3	5.38	55.4	29.8	17.17	8.97	92.34	49.67
Soln Std	ref	1	36	STD-13	20.0	10.1	82.3	49.4	20.00	10.10	82.30	49.40
Soln Std	ref	2	1	STD-21	20.3	10.1	82.2	50.3	20.30	10.10	82.20	50.30
KT03-HB	quenched	2	2	V23	8.86	9.19	45.4	55.0	14.77	15.32	75.67	91.67
KT03-HB	ccc	2	3	V05	8.43	8.97	43.0	51.4	14.05	14.95	71.67	85.67
KT03-LA	ccc	2	4	V34	6.24	11.6	56.0	67.7	10.40	19.33	93.34	112.84
KT03-LF	quenched	2	5	V82	5.05	9.66	54.7	61.0	8.42	16.10	91.17	101.67
KT03-LF	ccc	2	6	V09	5.32	10.8	54.5	64.4	8.87	18.00	90.84	107.34
KT1-HA2	ccc	2	7	V18	4.92	9.54	54.4	63.1	8.20	15.90	90.67	105.17
ARM-1	ref	2	8	V20	9.43	7.88	22.4	34.9	15.72	13.13	37.33	58.17
KT03-HK	ccc	2	9	V74	4.29	4.58	42.0	49.7	7.15	7.63	70.00	82.83
KT03-HN	quenched	2	10	V69	5.99	9.77	81.6	68.3	9.98	16.28	136.00	113.84
KT03-LL	quenched	2	11	V94	5.62	11.4	56.3	63.9	9.37	19.00	93.84	106.50
KT03-HL	ccc	2	12	V03	6.98	48.9	79.4	142.4	11.63	81.50	132.34	237.34
KT03-HN	ccc	2	13	V35	5.78	10.4	73.9	66.0	9.63	17.33	123.17	110.00
KT03-HF	ccc	2	14	V60	4.74	9.98	50.2	60.3	7.90	16.63	83.67	100.50
KT03-HF	quenched	2	15	V26	5.70	9.79	47.5	55.9	9.50	16.32	79.17	93.17
KT1-HA2	quenched	2	16	V12	5.15	10.0	53.4	65.5	8.58	16.67	89.00	109.17
KT03-LB	ccc	2	17	V36	5.82	10.8	52.9	62.1	9.70	18.00	88.17	103.50
Soln Std	ref	2	18	STD-22	19.7	10.2	83.2	49.4	19.70	10.20	83.20	49.40
KT03-MK	quenched	2	19	V89	3.96	6.95	37.4	44.9	6.60	11.58	62.33	74.83
KT03-LB	quenched	2	20	V04	5.88	10.1	54.2	61.0	9.80	16.83	90.34	101.67
EA	ref	2	21	V90	34.8	11.6	97.9	54.1	580.00	193.33	1631.67	901.67
KT03-LL	ccc	2	22	V97	5.63	11.3	50.5	60.7	9.38	18.83	84.17	101.17

Table E-1. Measurements of the PCT Solutions for the KT03-Series Glasses As-Received (ar) and After Appropriate Adjustments (ppm). (continued)

Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
KT03-LN	quenched	2	23	V57	5.75	10.2	46.3	59.6	9.58	17.00	77.17	99.34
KT03-MK	ccc	2	24	V06	3.53	6.21	32.0	42.8	5.88	10.35	53.33	71.33
KT03-LS	quenched	2	25	V30	4.39	8.49	41.1	55.3	7.32	14.15	68.50	92.17
KT03-HS	ccc	2	26	V54	3.45	7.91	30.8	55.7	5.75	13.18	51.33	92.84
KT03-LA	quenched	2	27	V42	5.92	10.7	57.6	65.1	9.87	17.83	96.00	108.50
KT03-LS	ccc	2	28	V50	4.98	10.3	48.5	65.5	8.30	17.17	80.83	109.17
KT03-LN	ccc	2	29	V80	4.99	10.3	43.5	59.2	8.32	17.17	72.50	98.67
KT03-HA	quenched	2	30	V71	4.26	8.57	41.1	50.4	7.10	14.28	68.50	84.00
KT03-HA	ccc	2	31	V84	3.99	8.36	46.0	53.3	6.65	13.93	76.67	88.84
KT03-HK	quenched	2	32	V79	10.2	5.34	56.6	29.2	17.00	8.90	94.34	48.67
KT03-HL	quenched	2	33	V27	7.51	23.0	71.9	81.3	12.52	38.33	119.84	135.50
KT03-HS	quenched	2	34	V75	3.55	8.10	32.2	57.4	5.92	13.50	53.67	95.67
Soln Std	ref	2	35	STD-23	19.8	10.1	82.5	49.6	19.80	10.10	82.50	49.60
Soln Std	ref	3	1	STD-31	20.4	10.2	84.1	49.4	20.40	10.20	84.10	49.40
KT03-HF	quenched	3	2	V51	5.95	9.60	45.8	54.3	9.92	16.00	76.33	90.50
KT03-HA	ccc	3	3	V14	4.28	8.31	45.9	53.1	7.13	13.85	76.50	88.50
KT03-HL	ccc	3	4	V32	6.86	48.8	77.2	140.9	11.43	81.33	128.67	234.84
KT03-MK	quenched	3	5	V21	3.93	7.09	37.6	45.1	6.55	11.82	62.67	75.17
KT03-LS	quenched	3	6	V95	4.52	8.55	41.4	55.5	7.53	14.25	69.00	92.50
blank	ref	3	7	V83	<0.100	<1.00	<0.100	<0.100	0.08	0.83	0.08	0.08
KT03-LN	ccc	3	8	V28	4.83	9.66	42.3	55.8	8.05	16.10	70.50	93.00
KT03-HB	quenched	3	9	V10	8.49	9.18	44.7	53.2	14.15	15.30	74.50	88.67
KT03-HK	quenched	3	10	V25	10.1	5.33	54.9	29.2	16.83	8.88	91.50	48.67
KT03-LF	ccc	3	11	V66	5.59	11.4	60.2	67.0	9.32	19.00	100.34	111.67
KT03-HS	quenched	3	12	V44	3.65	8.04	33.6	56.3	6.08	13.40	56.00	93.84
KT03-HS	ccc	3	13	V81	3.56	8.04	33.3	56.2	5.93	13.40	55.50	93.67
KT03-LA	quenched	3	14	V53	5.83	10.5	55.8	63.7	9.72	17.50	93.00	106.17
KT03-LF	quenched	3	15	V33	5.29	10.3	57.6	63.6	8.82	17.17	96.00	106.00
KT03-LN	quenched	3	16	V61	5.67	10.2	46.2	58.6	9.45	17.00	77.00	97.67
KT03-HK	ccc	3	17	V24	4.37	4.74	44.3	50.0	7.28	7.90	73.83	83.34
Soln Std	ref	3	18	STD-32	19.6	10.2	82.5	48.9	19.60	10.20	82.50	48.90
KT03-HA	quenched	3	19	V49	4.58	8.82	42.2	50.5	7.63	14.70	70.33	84.17
KT03-MK	ccc	3	20	V91	3.68	6.19	31.7	41.1	6.13	10.32	52.83	68.50
ARM-1	ref	3	21	V85	9.34	8.05	21.0	34.3	15.57	13.42	35.00	57.17
KT03-HB	ccc	3	22	V58	8.41	9.13	41.0	50.9	14.02	15.22	68.33	84.84
KT03-LL	ccc	3	23	V02	5.60	11.8	52.0	62.5	9.33	19.67	86.67	104.17
EA	ref	3	24	V08	34.3	11.3	95.4	52.2	571.67	188.33	1590.00	870.00
KT1-HA2	quenched	3	25	V41	5.46	9.98	53.6	65.2	9.10	16.63	89.34	108.67
KT03-HF	ccc	3	26	V65	4.78	9.70	48.8	58.7	7.97	16.17	81.33	97.84
KT03-LB	ccc	3	27	V48	5.74	10.5	49.9	60.3	9.57	17.50	83.17	100.50
KT03-HN	quenched	3	28	V31	5.98	9.82	82.4	66.2	9.97	16.37	137.34	110.34
KT03-LA	ccc	3	29	V40	6.10	11.7	56.9	66.0	10.17	19.50	94.84	110.00
KT03-HN	ccc	3	30	V11	5.99	10.7	76.1	66.5	9.98	17.83	126.84	110.84
KT03-LL	quenched	3	31	V29	5.72	11.6	56.7	63.4	9.53	19.33	94.50	105.67
KT03-LS	ccc	3	32	V96	4.40	9.31	41.5	57.4	7.33	15.52	69.17	95.67
KT03-HL	quenched	3	33	V17	7.52	23.3	74.3	81.3	12.53	38.83	123.84	135.50
KT1-HA2	ccc	3	34	V43	4.89	9.58	52.5	63.0	8.15	15.97	87.50	105.00
KT03-LB	quenched	3	35	V73	5.72	10.1	51.5	59.9	9.53	16.83	85.84	99.84
Soln Std	ref	3	36	STD-33	19.5	10.2	82.8	48.8	19.50	10.20	82.80	48.80

Table E-2. Normalized PCT Results for the KT03-Series Glasses and KT01-HA2 by Heat Treatment by Compositional View.

Glass ID	Heat Treatment	Comp View	log NL[B (g/L)]	log NL[Li (g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]	NL B(g/L)	NL Li (g/L)	NL Na (g/L)	NL Si (g/L)
ARM	ref	reference	-0.3462	-0.2494	-0.3101	-0.5725	0.451	0.563	0.490	0.268
EA	ref	reference	1.2169	0.9836	1.1069	0.5921	16.479	9.630	12.791	3.909
KT03-HA	ccc	measured	-0.2498	-0.1320	-0.0954	-0.3239	0.563	0.738	0.803	0.474
KT03-HA	ccc	targeted	-0.2527	-0.1349	-0.0924	-0.3275	0.559	0.733	0.808	0.470
KT03-HA	quenched	measured	-0.2614	-0.1415	-0.1695	-0.3721	0.548	0.722	0.677	0.425
KT03-HA	quenched	targeted	-0.2643	-0.1444	-0.1665	-0.3757	0.544	0.717	0.682	0.421
KT03-HB	ccc	measured	-0.1846	-0.1116	-0.1527	-0.3549	0.654	0.773	0.704	0.442
KT03-HB	ccc	targeted	-0.1946	-0.1154	-0.1568	-0.3576	0.639	0.767	0.697	0.439
KT03-HB	quenched	measured	-0.1752	-0.1068	-0.1224	-0.3360	0.668	0.782	0.754	0.461
KT03-HB	quenched	targeted	-0.1852	-0.1107	-0.1266	-0.3387	0.653	0.775	0.747	0.458
KT03-HF	ccc	measured	-0.1960	-0.0743	-0.0716	-0.2813	0.637	0.843	0.848	0.523
KT03-HF	ccc	targeted	-0.2101	-0.0771	-0.0784	-0.2885	0.616	0.837	0.835	0.515
KT03-HF	quenched	measured	-0.1157	-0.0804	-0.0963	-0.3174	0.766	0.831	0.801	0.481
KT03-HF	quenched	targeted	-0.1299	-0.0833	-0.1030	-0.3247	0.742	0.826	0.789	0.473
KT03-HK	ccc	measured	-0.2173	0.1527	0.1801	-0.3496	0.606	1.421	1.514	0.447
KT03-HK	ccc	targeted	-0.2354	0.2031	0.1753	-0.3503	0.582	1.596	1.497	0.446
KT03-HK	quenched	measured	0.1522	0.2158	0.2962	-0.5782	1.420	1.644	1.978	0.264
KT03-HK	quenched	targeted	0.1341	0.2662	0.2913	-0.5789	1.362	1.846	1.956	0.264
KT03-HL	ccc	measured	-0.0598	0.3917	0.1096	0.0841	0.871	2.464	1.287	1.214
KT03-HL	ccc	targeted	-0.0614	0.3866	0.1146	0.0797	0.868	2.435	1.302	1.202
KT03-HL	quenched	measured	-0.0227	0.0663	0.0800	-0.1588	0.949	1.165	1.202	0.694
KT03-HL	quenched	targeted	-0.0243	0.0612	0.0850	-0.1631	0.946	1.151	1.216	0.687
KT03-HN	ccc	measured	-0.1141	-0.0567	0.0122	-0.2360	0.769	0.878	1.028	0.581
KT03-HN	ccc	targeted	-0.1305	-0.0568	0.0041	-0.2538	0.741	0.877	1.010	0.557
KT03-HN	quenched	measured	-0.1065	-0.0902	0.0518	-0.2310	0.783	0.812	1.127	0.587
KT03-HN	quenched	targeted	-0.1229	-0.0903	0.0437	-0.2489	0.754	0.812	1.106	0.564
KT03-HS	ccc	measured	-0.3123	-0.1428	-0.2493	-0.3731	0.487	0.720	0.563	0.424
KT03-HS	ccc	targeted	-0.3234	-0.1426	-0.2413	-0.3957	0.475	0.720	0.574	0.402
KT03-HS	quenched	measured	-0.2916	-0.1311	-0.2325	-0.3625	0.511	0.739	0.586	0.434
KT03-HS	quenched	targeted	-0.3028	-0.1309	-0.2244	-0.3851	0.498	0.740	0.596	0.412
KT03-LA	ccc	measured	-0.1200	-0.0382	-0.0643	-0.2513	0.759	0.916	0.862	0.561
KT03-LA	ccc	targeted	-0.1342	-0.0430	-0.0590	-0.2756	0.734	0.906	0.873	0.530
KT03-LA	quenched	measured	-0.1387	-0.0711	-0.0565	-0.2621	0.727	0.849	0.878	0.547
KT03-LA	quenched	targeted	-0.1529	-0.0758	-0.0511	-0.2864	0.703	0.840	0.889	0.517
KT03-LB	ccc	measured	-0.1758	-0.0628	-0.0846	-0.2981	0.667	0.865	0.823	0.503
KT03-LB	ccc	targeted	-0.1886	-0.0667	-0.0883	-0.3018	0.648	0.858	0.816	0.499
KT03-LB	quenched	measured	-0.1786	-0.0882	-0.0736	-0.3070	0.663	0.816	0.844	0.493
KT03-LB	quenched	targeted	-0.1914	-0.0921	-0.0773	-0.3106	0.644	0.809	0.837	0.489
KT03-LF	ccc	measured	-0.1859	-0.0643	-0.0651	-0.2850	0.652	0.862	0.861	0.519
KT03-LF	ccc	targeted	-0.1972	-0.0676	-0.0612	-0.2907	0.635	0.856	0.868	0.512
KT03-LF	quenched	measured	-0.2422	-0.1334	-0.0947	-0.3282	0.573	0.736	0.804	0.470
KT03-LF	quenched	targeted	-0.2535	-0.1367	-0.0908	-0.3339	0.558	0.730	0.811	0.464
KT03-LL	ccc	measured	-0.1632	-0.0658	-0.0899	-0.2897	0.687	0.859	0.813	0.513
KT03-LL	ccc	targeted	-0.1728	-0.0736	-0.0925	-0.3047	0.672	0.844	0.808	0.496
KT03-LL	quenched	measured	-0.1502	-0.0592	-0.0394	-0.2682	0.708	0.873	0.913	0.539
KT03-LL	quenched	targeted	-0.1599	-0.0669	-0.0419	-0.2833	0.692	0.857	0.908	0.521
KT03-LN	ccc	measured	-0.2146	-0.0909	-0.1400	-0.3280	0.610	0.811	0.724	0.470
KT03-LN	ccc	targeted	-0.2254	-0.0952	-0.1354	-0.3321	0.595	0.803	0.732	0.465
KT03-LN	quenched	measured	-0.1436	-0.0789	-0.1029	-0.3116	0.718	0.834	0.789	0.488
KT03-LN	quenched	targeted	-0.1545	-0.0832	-0.0982	-0.3157	0.701	0.826	0.798	0.483
KT03-LS	ccc	measured	-0.2245	-0.0942	-0.1351	-0.3247	0.596	0.805	0.733	0.474
KT03-LS	ccc	targeted	-0.2307	-0.0936	-0.1391	-0.3315	0.588	0.806	0.726	0.466
KT03-LS	quenched	measured	-0.2401	-0.1430	-0.1565	-0.3592	0.575	0.719	0.697	0.437
KT03-LS	quenched	targeted	-0.2464	-0.1424	-0.1605	-0.3660	0.567	0.720	0.691	0.431
KT03-MK	ccc	measured	-0.3057	-0.0684	-0.1427	-0.4147	0.495	0.854	0.720	0.385
KT03-MK	ccc	targeted	-0.3219	-0.0660	-0.1341	-0.4304	0.477	0.859	0.734	0.371
KT03-MK	quenched	measured	-0.2850	-0.0303	-0.0916	-0.4019	0.519	0.933	0.810	0.396
KT03-MK	quenched	targeted	-0.3012	-0.0279	-0.0831	-0.4177	0.500	0.938	0.826	0.382
KT1-HA2	ccc	measured	-0.2253	-0.1246	-0.0821	-0.2820	0.595	0.751	0.828	0.522
KT1-HA2	ccc	targeted	-0.2312	-0.1224	-0.0775	-0.2974	0.587	0.754	0.837	0.504
KT1-HA2	quenched	measured	-0.1960	-0.1064	-0.0765	-0.2694	0.637	0.783	0.839	0.538
KT1-HA2	quenched	targeted	-0.2018	-0.1042	-0.0719	-0.2848	0.628	0.787	0.847	0.519

Exhibit E-1. KT03 PCT Measurements (ppm values) in Analytical Sequence by Element.

Variability Chart for B (ppm)

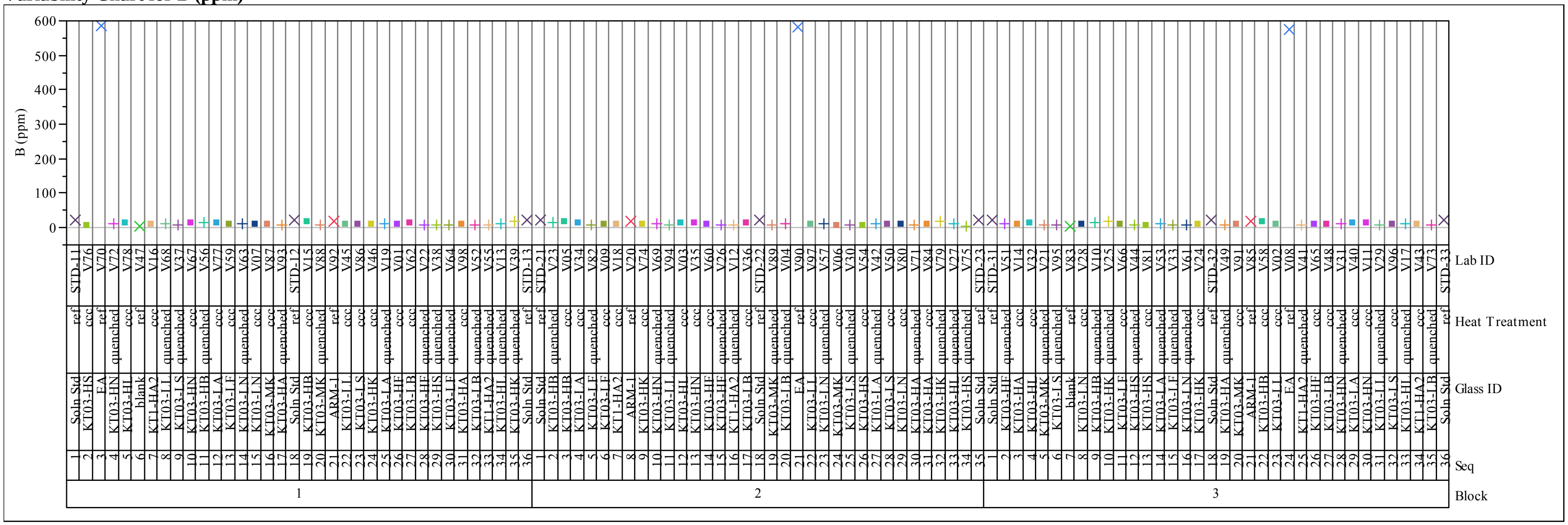


Exhibit E-1. KT03 PCT Measurements (ppm values) in Analytical Sequence by Element. (continued)

Variability Chart for Li (ppm)

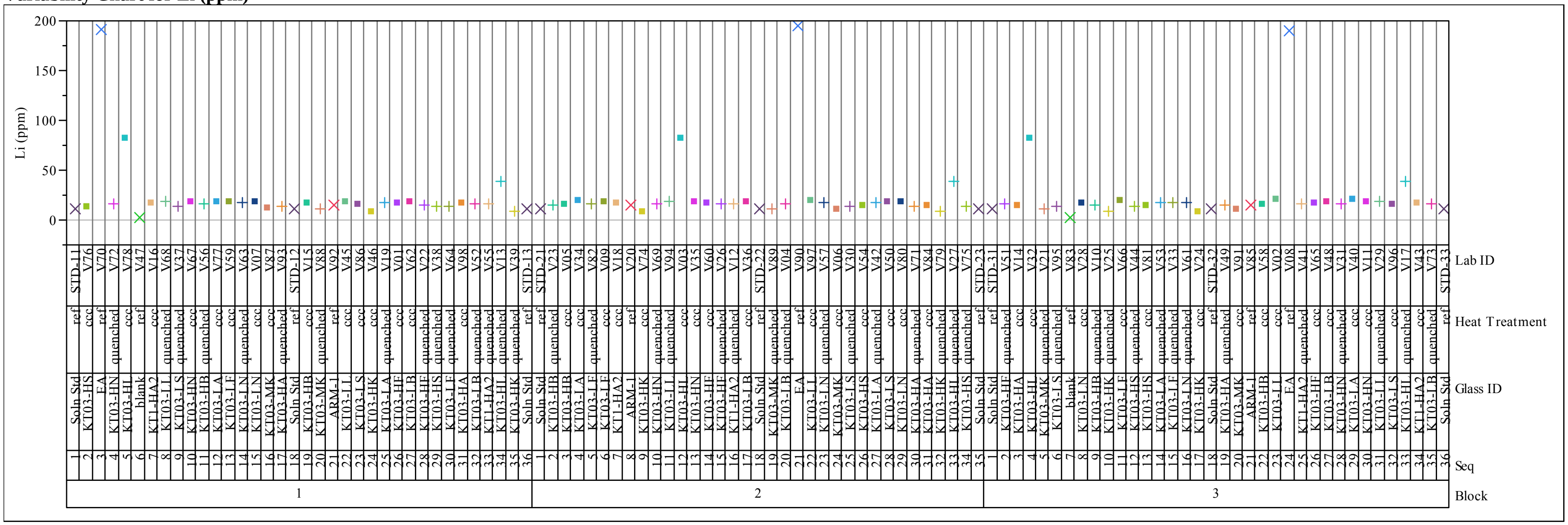


Exhibit E-1. KT03 PCT Measurements (ppm values) in Analytical Sequence by Element. (continued)

Variability Chart for Na (ppm)

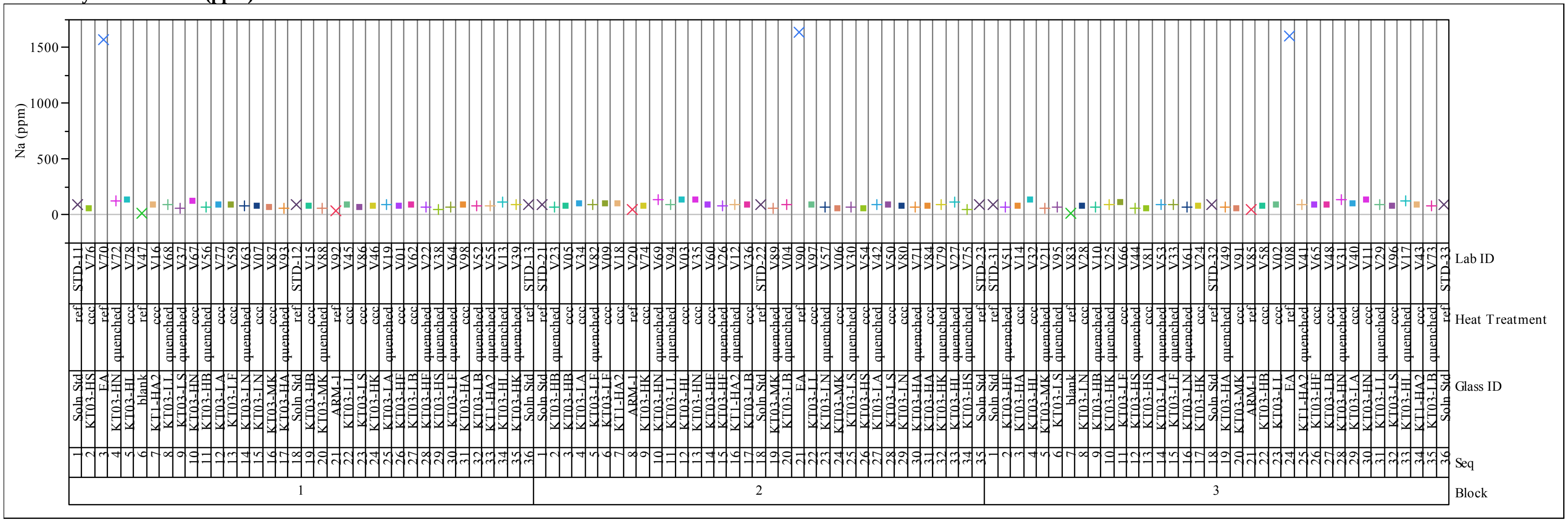


Exhibit E-1. KT03 PCT Measurements (ppm values) in Analytical Sequence by Element. (continued)

Variability Chart for Si (ppm)

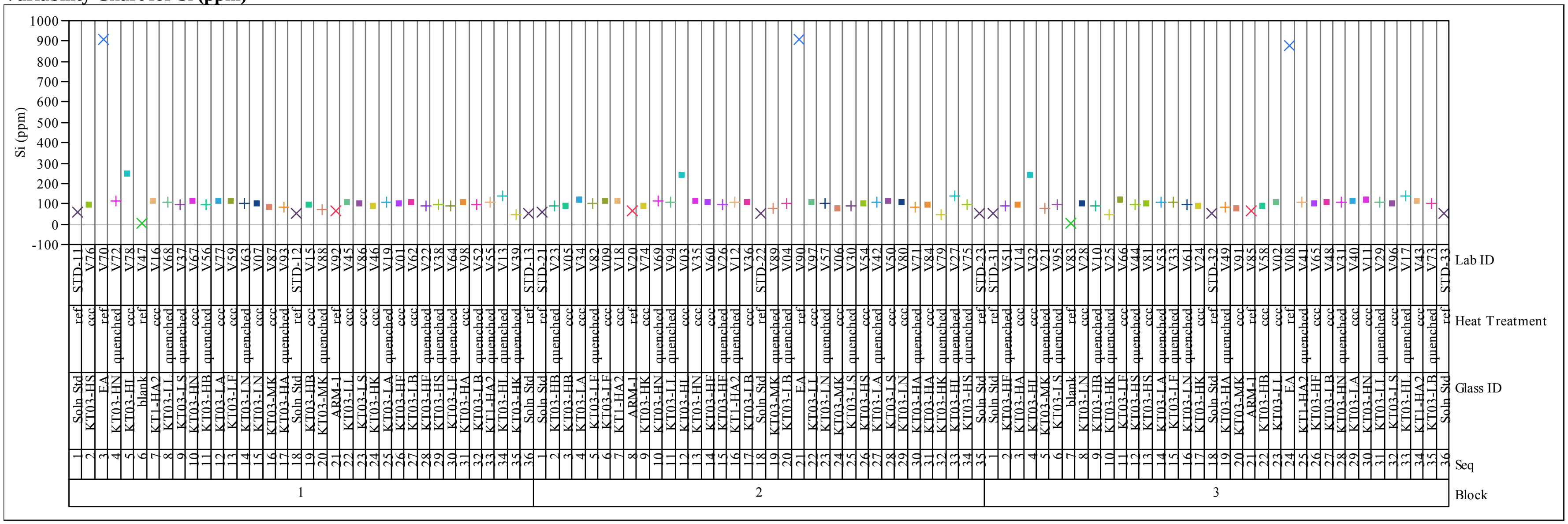
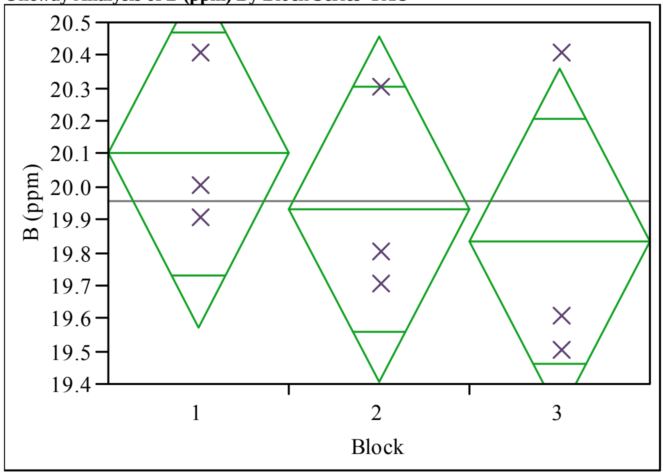


Exhibit E-2. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Multi-Element Standard Solution Results by Oxide.

Oneway Analysis of B (ppm) By Block Series=KT3



Oneway Anova
Summary of Fit

Rsquare	0.115566
Adj Rsquare	-0.17925
Root Mean Square Error	0.372678
Mean of Response	19.95556
Observations (or Sum Wgts)	9

Analysis of Variance

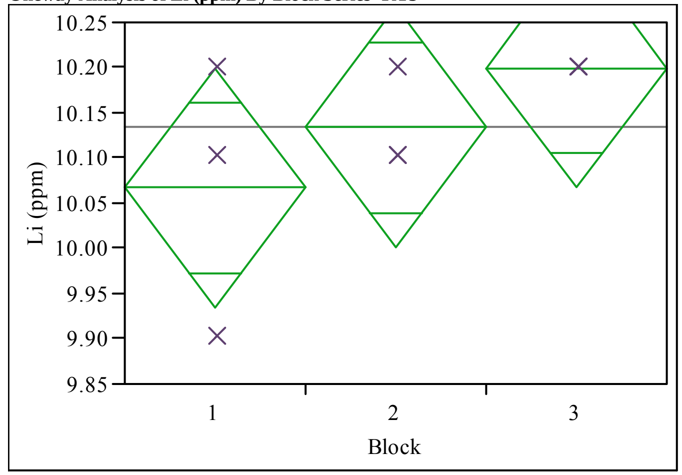
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.10888889	0.054444	0.3920	0.6918
Error	6	0.83333333	0.138889		
C. Total	8	0.94222222			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	20.1000	0.21517	19.574	20.626
2	3	19.9333	0.21517	19.407	20.460
3	3	19.8333	0.21517	19.307	20.360

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Block Series=KT3



Oneway Anova
Summary of Fit

Rsquare	0.333333
Adj Rsquare	0.111111
Root Mean Square Error	0.094281
Mean of Response	10.13333
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.02666667	0.013333	1.5000	0.2963
Error	6	0.05333333	0.008889		
C. Total	8	0.08000000			

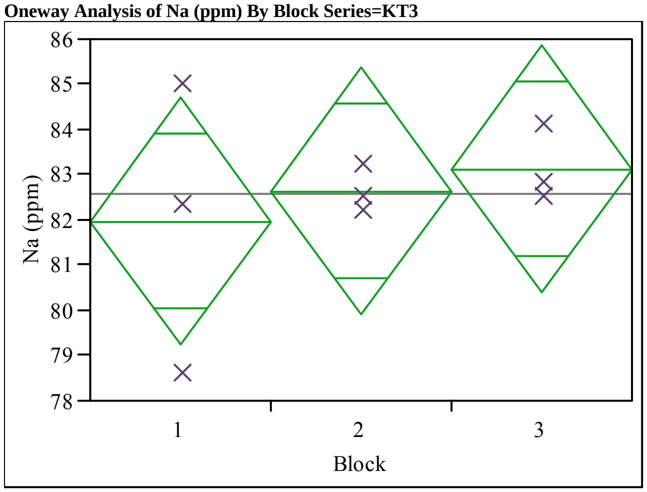
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	10.0667	0.05443	9.933	10.200
2	3	10.1333	0.05443	10.000	10.267
3	3	10.2000	0.05443	10.067	10.333

Std Error uses a pooled estimate of error variance

Exhibit E-2. Statistical Evaluation of the ICP-AES Calibration Effects from the KT03 Multi-Element Standard Solution Results by Oxide. (continued)

Oneway Analysis of Na (ppm) By Block Series=KT3



Oneway Anova
Summary of Fit

Rsquare	0.083303
Adj Rsquare	-0.22226
Root Mean Square Error	1.941649
Mean of Response	82.57778
Observations (or Sum Wgts)	9

Analysis of Variance

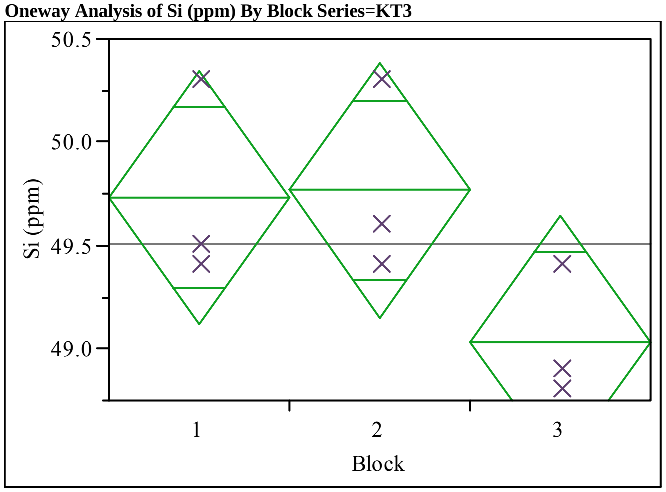
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	2.055556	1.02778	0.2726	0.7703
Error	6	22.620000	3.77000		
C. Total	8	24.675556			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	81.9667	1.1210	79.224	84.710
2	3	82.6333	1.1210	79.890	85.376
3	3	83.1333	1.1210	80.390	85.876

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Block Series=KT3



Oneway Anova
Summary of Fit

Rsquare	0.474385
Adj Rsquare	0.29918
Root Mean Square Error	0.43589
Mean of Response	49.51111
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	1.0288889	0.514444	2.7076	0.1452
Error	6	1.1400000	0.190000		
C. Total	8	2.1688889			

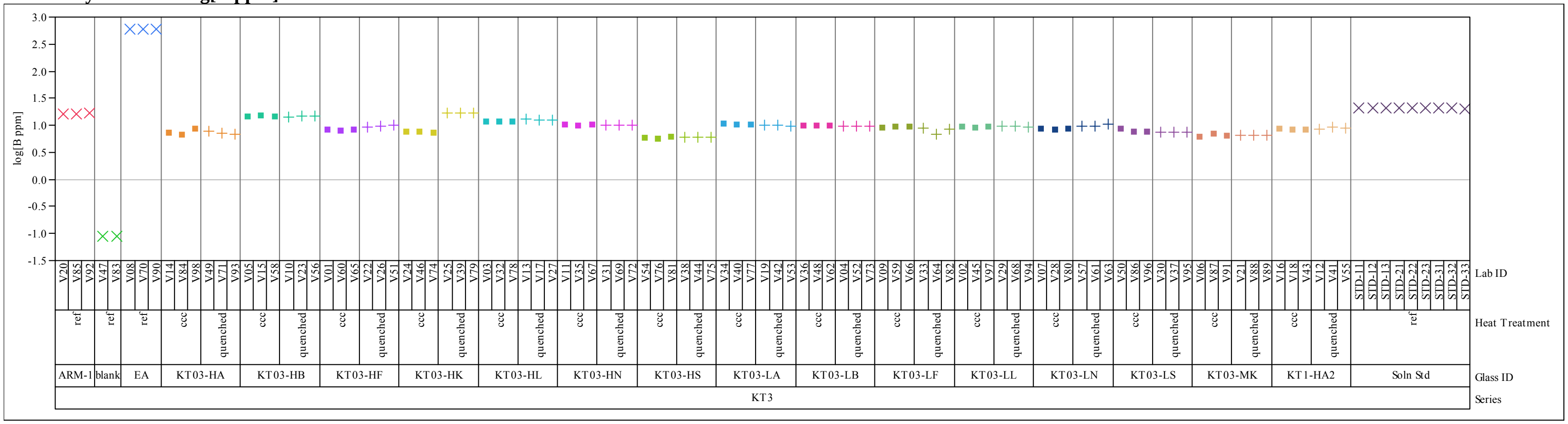
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	49.7333	0.25166	49.118	50.349
2	3	49.7667	0.25166	49.151	50.382
3	3	49.0333	0.25166	48.418	49.649

Std Error uses a pooled estimate of error variance

Exhibit E-3. KT03 PCT Results (as common logarithms) Grouped by Glass ID and Heat Treatment.

Variability Chart for log[B ppm]



Variability Chart for log[Li ppm]

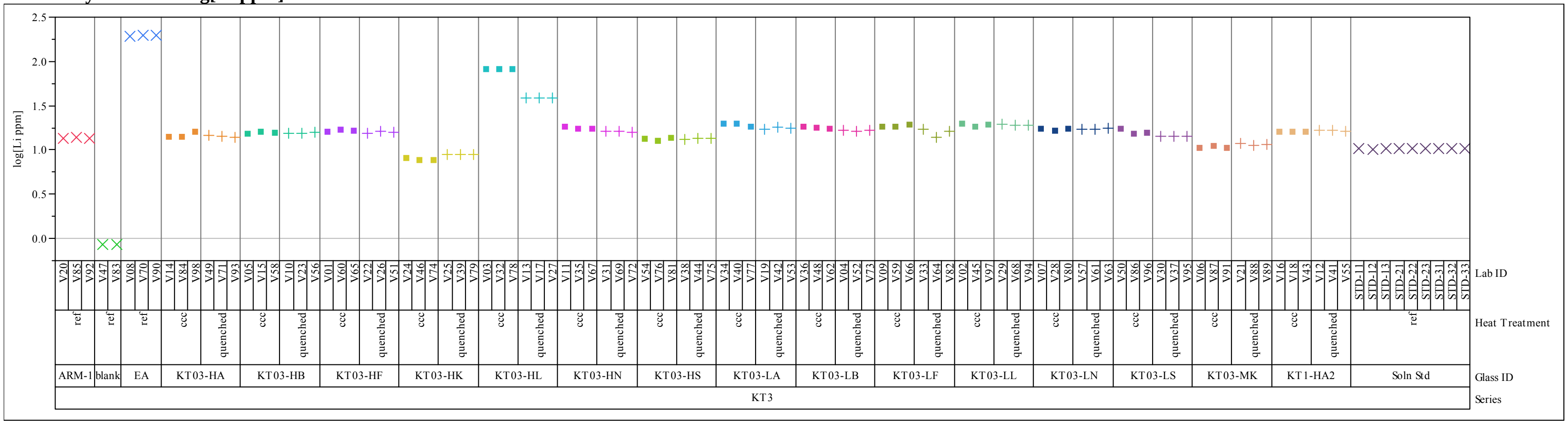
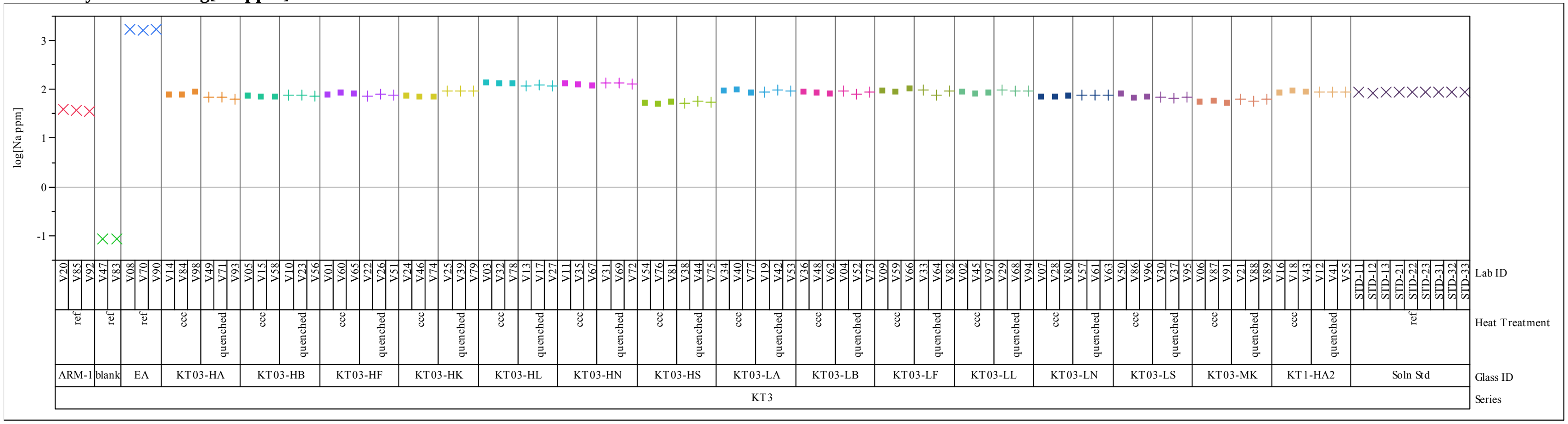


Exhibit E-3. KT03 PCT Results (as common logarithms) Grouped by Glass ID and Heat Treatment. (continued)

Variability Chart for log[Na ppm]



Variability Chart for log[Si ppm]

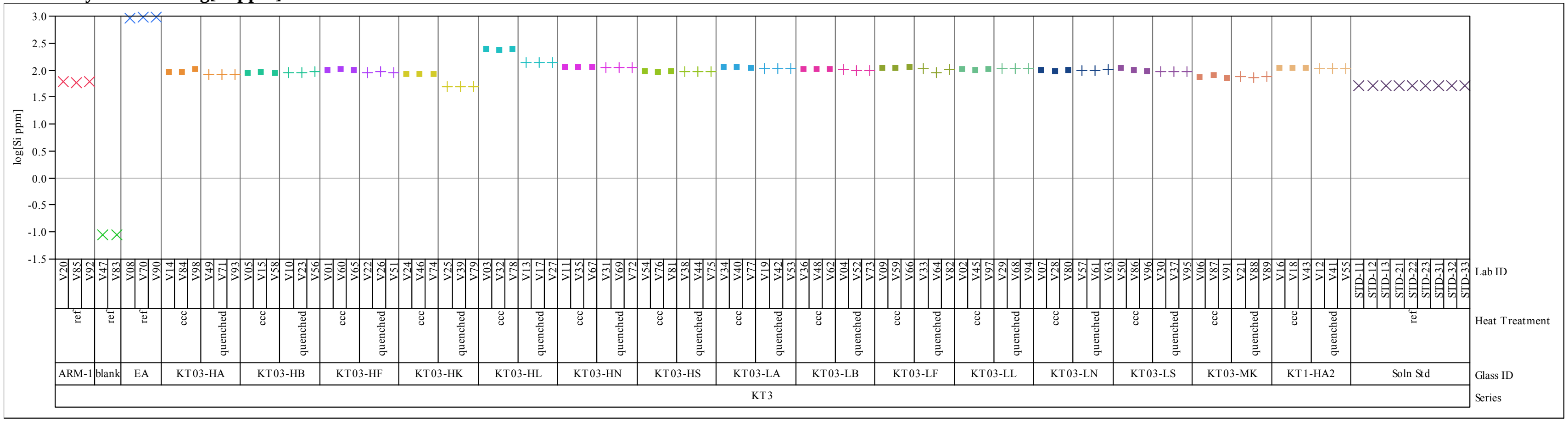


Exhibit E-4. Correlations and Scatter Plots of the KT03 Normalized PCTs Over All Compositional Views and Heat Treatments.

Multivariate Correlations

	log NL[B (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.8565	0.9279	0.7278
log NL[Li(g/L)]	0.8565	1.0000	0.9260	0.7214
log NL[Na (g/L)]	0.9279	0.9260	1.0000	0.6776
log NL[Si (g/L)]	0.7278	0.7214	0.6776	1.0000

Scatterplot Matrix

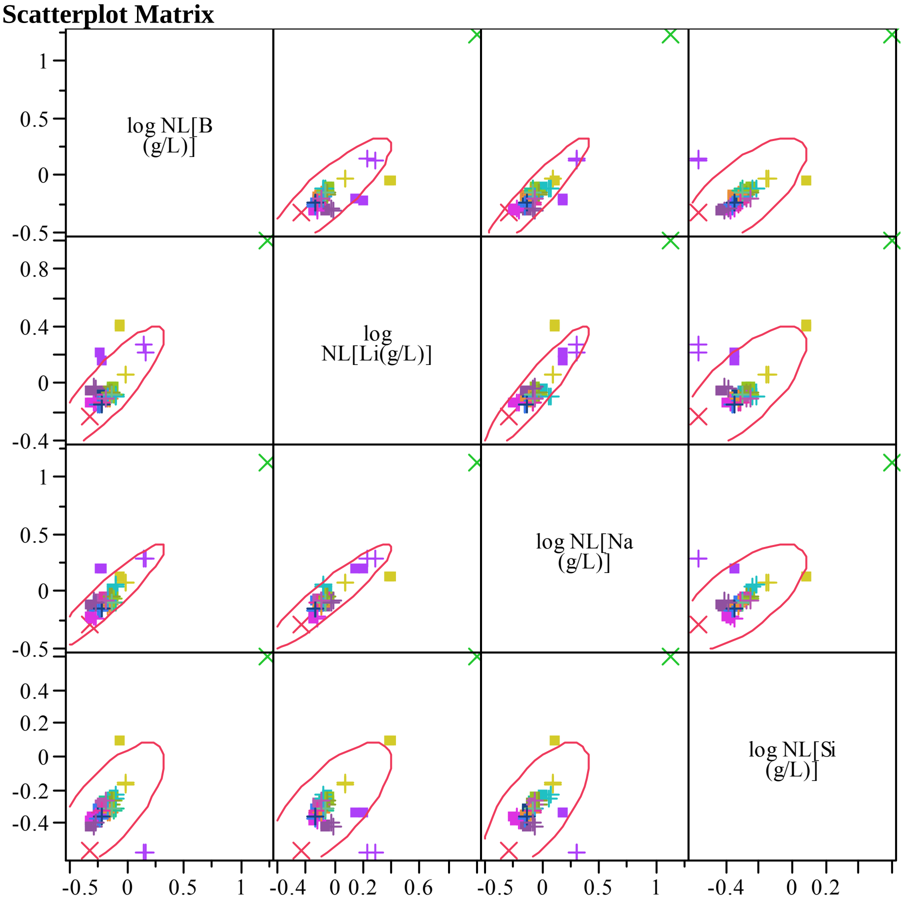
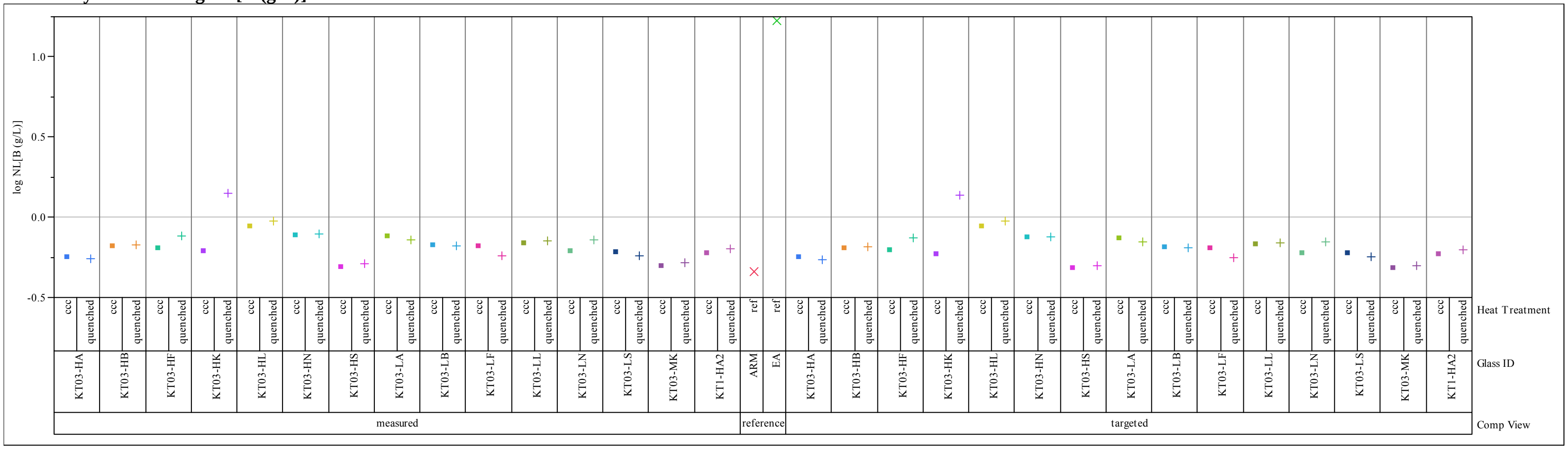


Exhibit E-5. Effects of Heat Treatment for the KT03 Glasses by Compositional View.

Variability Chart for log NL[B (g/L)]



Variability Chart for log NL[Li(g/L)]

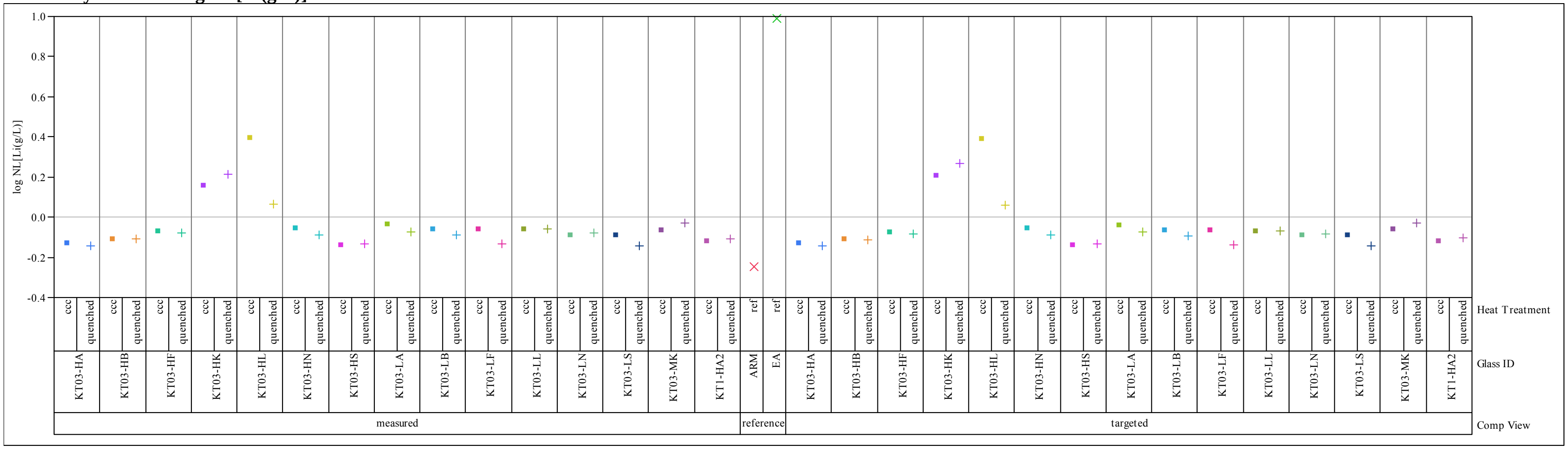
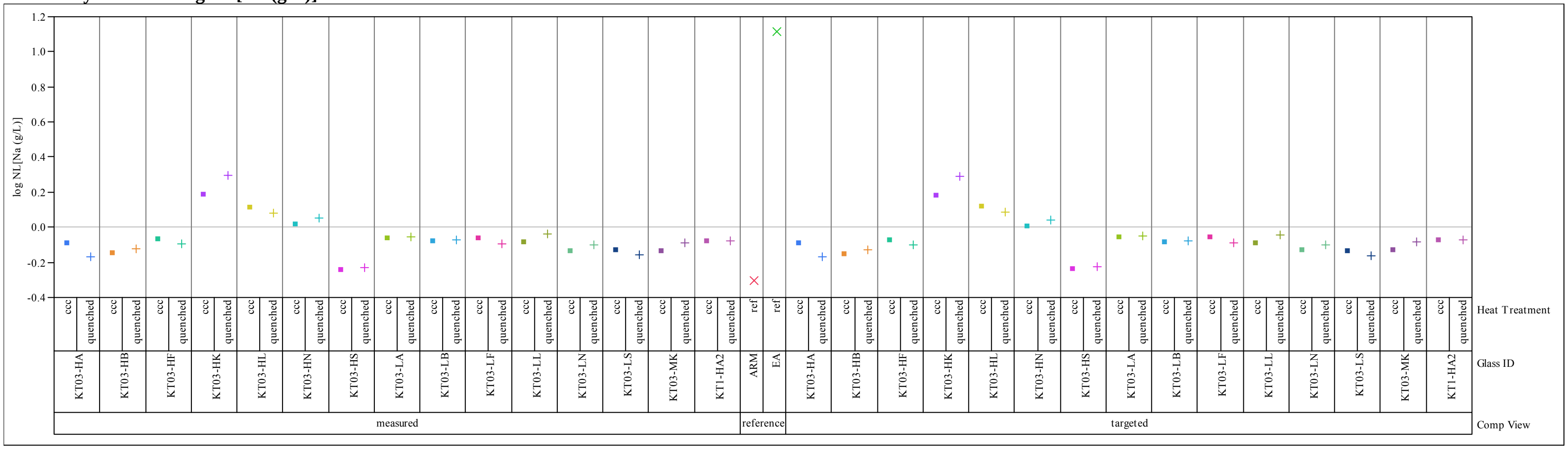


Exhibit E-5. Effects of Heat Treatment for the KT03 Glasses by Compositional View. (continued)

Variability Chart for log NL[Na (g/L)]



Variability Chart for log NL[Si (g/L)]

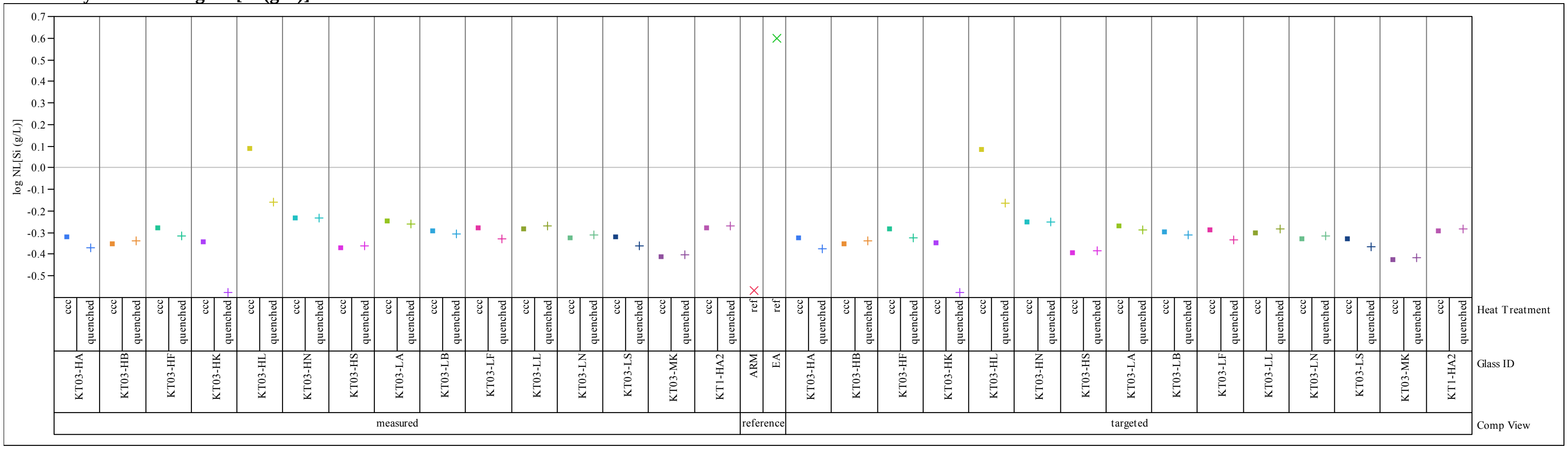
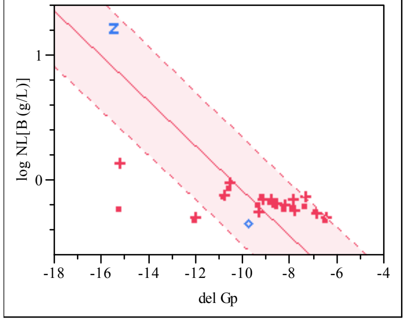


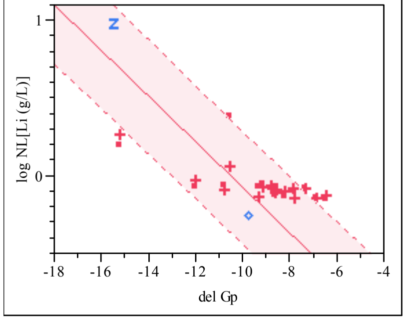
Exhibit E-6. KT03-Series PCT Measurements versus Durability Model Predictions.

Targeted Compositions

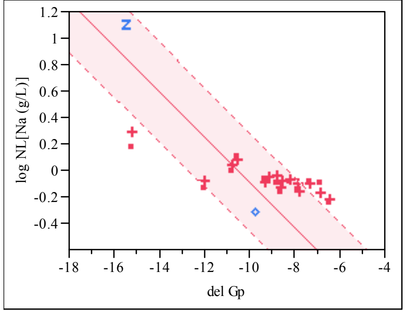
Bivariate Fit of log NL[B (g/L)] By del Gp



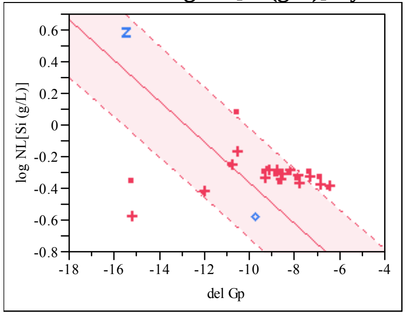
Bivariate Fit of log NL[Li (g/L)] By del Gp



Bivariate Fit of log NL[Na (g/L)] By del Gp

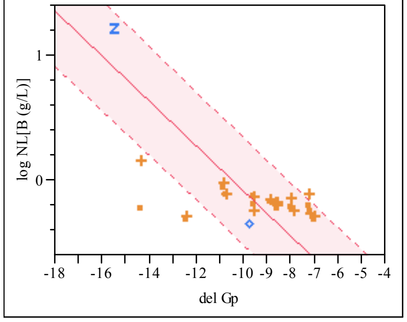


Bivariate Fit of log NL[Si (g/L)] By del Gp

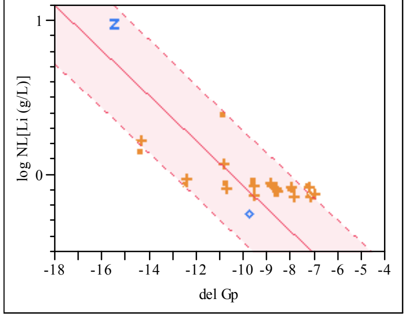


Measured Compositions

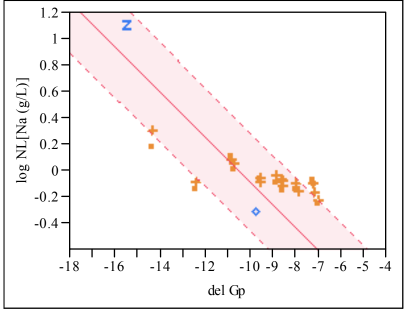
Bivariate Fit of log NL[B (g/L)] By del Gp



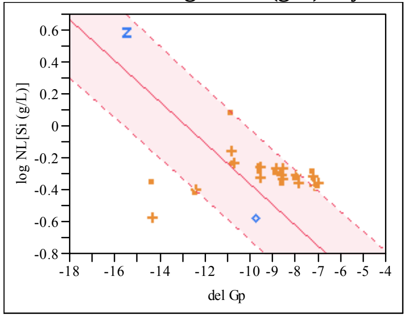
Bivariate Fit of log NL[Li (g/L)] By del Gp



Bivariate Fit of log NL[Na (g/L)] By del Gp



Bivariate Fit of log NL[Si (g/L)] By del Gp



z Environmental Assessment Benchmark Glass
◇ Approved Reference Material Glass
+ + Quenched Study Glasses
■ ■ Slowly Cooled Study Glasses

Appendix F. Data Supporting the PCT Measurements of the KT04-Series Glasses

Table F-1. Measurements of the PCT Solutions for the KT04-Series Glasses As-Received (ar) and After Appropriate Adjustments (ppm).

Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
Soln Std	ref	1	1	STD-11	20.7	10.1	82.3	49.9	20.70	10.10	82.30	49.90
KT04-01	quenched	1	2	B33	6.08	6.60	41.3	55.2	10.13	11.00	68.83	92.00
KT04-03	ccc	1	3	B10	6.91	7.33	44.3	61.0	11.52	12.22	73.83	101.67
KT04-05	ccc	1	4	B39	5.23	6.35	35.1	56.9	8.72	10.58	58.50	94.84
KT04-04	ccc	1	5	B06	6.14	7.11	38.0	61.0	10.23	11.85	63.33	101.67
KT04-03	quenched	1	6	B08	6.85	7.21	49.0	63.6	11.42	12.02	81.67	106.00
KT04-08	quenched	1	7	B16	6.35	6.65	56.7	64.6	10.58	11.08	94.50	107.67
KT04-09	ccc	1	8	B36	6.22	6.92	42.3	59.7	10.37	11.53	70.50	99.50
KT04-10	ccc	1	9	B02	6.37	7.15	38.9	59.0	10.62	11.92	64.83	98.34
EA	ref	1	10	B52	39.4	11.8	108	54.8	656.67	196.67	1800.00	913.34
KT04-06	ccc	1	11	B42	5.21	6.22	33.4	55.0	8.68	10.37	55.67	91.67
KT04-07	quenched	1	12	B49	5.69	6.36	44.1	59.6	9.48	10.60	73.50	99.34
KT04-04	quenched	1	13	B13	6.44	7.32	43.0	64.0	10.73	12.20	71.67	106.67
Soln Std	ref	1	14	STD-12	20.0	10.1	82.9	50.0	20.00	10.10	82.90	50.00
KT04-09	quenched	1	15	B60	6.56	6.98	43.9	59.9	10.93	11.63	73.17	99.84
ARM-1	ref	1	16	B01	10.08	8.34	20.8	35.7	16.80	13.90	34.67	59.50
KT04-06	quenched	1	17	B57	4.91	6.05	34.6	53.4	8.18	10.08	57.67	89.00
KT04-02	quenched	1	18	B47	6.21	6.91	43.2	58.5	10.35	11.52	72.00	97.50
KT04-10	quenched	1	19	B14	6.06	6.90	39.1	57.4	10.10	11.50	65.17	95.67
KT04-07	ccc	1	20	B66	5.49	6.49	41.4	58.8	9.15	10.82	69.00	98.00
blank	ref	1	21	B31	<0.100	<1.00	<0.100	<0.100	0.08	0.83	0.08	0.08
KT04-05	quenched	1	22	B62	5.59	7.05	41.0	63.2	9.32	11.75	68.33	105.34
KT04-08	ccc	1	23	B20	6.01	7.00	51.0	63.4	10.02	11.67	85.00	105.67
KT04-02	ccc	1	24	B28	6.01	6.95	40.6	56.9	10.02	11.58	67.67	94.84
KT04-01	ccc	1	25	B18	6.02	6.82	34.6	54.4	10.03	11.37	57.67	90.67
Soln Std	ref	1	26	STD-12	19.68	10.00	81.0	49.0	19.68	10.00	81.00	49.00
Soln Std	ref	2	1	STD-21	20.7	10.0	83.3	50.0	20.70	10.00	83.30	50.00
KT04-06	quenched	2	2	B03	4.88	6.05	35.1	53.9	8.13	10.08	58.50	89.84
KT04-06	ccc	2	3	B26	4.83	6.27	33.8	55.4	8.05	10.45	56.33	92.34
KT04-08	quenched	2	4	B43	5.79	6.42	53.8	61.7	9.65	10.70	89.67	102.84
KT04-02	quenched	2	5	B61	6.50	7.36	47.4	63.4	10.83	12.27	79.00	105.67
KT04-03	ccc	2	6	B68	6.40	7.28	45.2	60.2	10.67	12.13	75.33	100.34
KT04-01	ccc	2	7	B58	5.87	6.78	35.0	54.4	9.78	11.30	58.33	90.67
KT04-08	ccc	2	8	B41	5.64	6.72	49.3	62.1	9.40	11.20	82.17	103.50
KT04-04	quenched	2	9	B53	5.55	6.68	42.2	57.8	9.25	11.13	70.33	96.34
KT04-05	ccc	2	10	B23	4.83	6.40	37.1	57.1	8.05	10.67	61.83	95.17
KT04-05	quenched	2	11	B59	4.79	6.44	38.4	57.2	7.98	10.73	64.00	95.34
KT04-07	quenched	2	12	B30	4.87	6.05	42.5	56.6	8.12	10.08	70.83	94.34
KT04-01	quenched	2	13	B64	5.46	6.60	36.2	53.3	9.10	11.00	60.33	88.84
Soln Std	ref	2	14	STD-22	19.8	10.1	81.7	49.4	19.80	10.10	81.70	49.40
KT04-04	ccc	2	15	B67	6.39	7.05	39.8	60.5	10.65	11.75	66.33	100.84
KT04-09	quenched	2	16	B17	6.79	7.35	49.5	64.2	11.32	12.25	82.50	107.00
KT04-10	quenched	2	17	B05	6.06	6.99	42.0	58.6	10.10	11.65	70.00	97.67
KT04-02	ccc	2	18	B54	5.97	7.01	42.0	57.7	9.95	11.68	70.00	96.17
EA	ref	2	19	B09	31.8	9.60	142	53.0	530.00	160.00	2366.67	883.34
KT04-09	ccc	2	20	B48	5.95	6.61	41.1	57.2	9.92	11.02	68.50	95.34
KT04-07	ccc	2	21	B44	5.32	6.41	43.9	58.2	8.87	10.68	73.17	97.00
ARM-1	ref	2	22	B22	9.75	8.20	21.8	35.6	16.25	13.67	36.33	59.33
KT04-10	ccc	2	23	B27	6.15	7.15	40.5	59.0	10.25	11.92	67.50	98.34
KT04-03	quenched	2	24	B34	6.49	7.21	50.4	61.4	10.82	12.02	84.00	102.34
Soln Std	ref	2	25	STD-23	19.9	10.1	82.9	49.7	19.90	10.10	82.90	49.70
Soln Std	ref	3	1	STD-31	20.6	10.0	82.7	49.0	20.60	10.00	82.70	49.00
KT04-01	quenched	3	2	B32	6.59	6.86	37.9	55.7	10.98	11.43	63.17	92.84
KT04-04	quenched	3	3	B29	6.20	6.62	43.6	57.9	10.33	11.03	72.67	96.50
KT04-09	quenched	3	4	B24	6.58	6.89	45.8	59.4	10.97	11.48	76.33	99.00
KT04-02	ccc	3	5	B15	6.30	6.76	41.6	55.7	10.50	11.27	69.33	92.84
KT04-02	quenched	3	6	B19	6.22	6.65	44.0	56.7	10.37	11.08	73.33	94.50
KT04-06	quenched	3	7	B63	5.19	6.24	40.4	55.5	8.65	10.40	67.33	92.50
KT04-01	ccc	3	8	B35	6.07	6.57	35.9	53.2	10.12	10.95	59.83	88.67

Table F-1. Measurements of the PCT Solutions for the KT04-Series Glasses As-Received (ar) and After Appropriate Adjustments (ppm). (continued)

Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
KT04-08	quenched	3	9	B46	5.98	6.41	53.9	61.6	9.97	10.68	89.84	102.67
EA	ref	3	10	B40	37.5	11.3	102	52.4	625.00	188.33	1700.00	873.34
blank	ref	3	11	B25	<0.100	<1.00	<0.100	<0.100	0.08	0.83	0.08	0.08
KT04-03	quenched	3	12	B51	6.92	7.20	49.7	60.9	11.53	12.00	82.83	101.50
ARM-1	ref	3	13	B38	10.7	8.44	24.4	36.3	17.83	14.07	40.67	60.50
Soln Std	ref	3	14	STD-32	20.7	10.2	84.7	50.0	20.70	10.20	84.70	50.00
KT04-03	ccc	3	15	B56	7.34	7.33	49.6	59.9	12.23	12.22	82.67	99.84
KT04-08	ccc	3	16	B21	6.41	7.03	50.9	63.1	10.68	11.72	84.84	105.17
KT04-09	ccc	3	17	B65	6.27	6.69	43.2	57.2	10.45	11.15	72.00	95.34
KT04-10	quenched	3	18	B45	6.26	6.89	40.9	56.9	10.43	11.48	68.17	94.84
KT04-05	quenched	3	19	B55	5.22	6.35	37.8	55.7	8.70	10.58	63.00	92.84
KT04-10	ccc	3	20	B37	6.28	7.01	39.1	57.2	10.47	11.68	65.17	95.34
KT04-06	ccc	3	21	B50	5.01	6.21	34.6	54.5	8.35	10.35	57.67	90.84
KT04-07	quenched	3	22	B11	5.60	6.29	45.1	58.5	9.33	10.48	75.17	97.50
KT04-07	ccc	3	23	B04	5.66	6.41	44.1	58.8	9.43	10.68	73.50	98.00
KT04-04	ccc	3	24	B07	6.11	6.87	44.9	59.1	10.18	11.45	74.83	98.50
KT04-05	ccc	3	25	B12	5.86	6.96	41.5	62.2	9.77	11.60	69.17	103.67
Soln Std	ref	3	26	STD-33	20.5	10.0	83.0	49.2	20.50	10.00	83.00	49.20

Table F-2. Normalized PCT Results for the KT04-Series Glasses by Heat Treatment by Compositional View.

Glass ID	Heat Treatment	Comp View	log NL[B (g/L)]	log NL[Li (g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]	NL B(g/L)	NL Li (g/L)	NL Na (g/L)	NL Si (g/L)
ARM	ref	reference	-0.3161	-0.2305	-0.2859	-0.5606	0.483	0.588	0.518	0.275
EA	ref	reference	1.2339	0.9612	1.1910	0.5918	17.137	9.146	15.524	3.906
KT04-01	ccc	measured	-0.2629	-0.1740	-0.2220	-0.3941	0.546	0.670	0.600	0.404
KT04-01	ccc	targeted	-0.2713	-0.1739	-0.2236	-0.4039	0.535	0.670	0.598	0.395
KT04-01	quenched	measured	-0.2600	-0.1764	-0.1836	-0.3883	0.550	0.666	0.655	0.409
KT04-01	quenched	targeted	-0.2685	-0.1763	-0.1853	-0.3981	0.539	0.666	0.653	0.400
KT04-02	ccc	measured	-0.2523	-0.1687	-0.1844	-0.3792	0.559	0.678	0.654	0.418
KT04-02	ccc	targeted	-0.2637	-0.1622	-0.1801	-0.3868	0.545	0.688	0.661	0.410
KT04-02	quenched	measured	-0.2371	-0.1649	-0.1498	-0.3589	0.579	0.684	0.708	0.438
KT04-02	quenched	targeted	-0.2485	-0.1584	-0.1455	-0.3666	0.564	0.694	0.715	0.430
KT04-03	ccc	measured	-0.2047	-0.1413	-0.1509	-0.3510	0.624	0.722	0.706	0.446
KT04-03	ccc	targeted	-0.2113	-0.1373	-0.1399	-0.3620	0.615	0.729	0.725	0.435
KT04-03	quenched	measured	-0.2124	-0.1477	-0.1202	-0.3397	0.613	0.712	0.758	0.457
KT04-03	quenched	targeted	-0.2191	-0.1437	-0.1093	-0.3507	0.604	0.718	0.778	0.446
KT04-04	ccc	measured	-0.2438	-0.1571	-0.1794	-0.3613	0.570	0.696	0.662	0.435
KT04-04	ccc	targeted	-0.2552	-0.1557	-0.1777	-0.3684	0.556	0.699	0.664	0.428
KT04-04	quenched	measured	-0.2552	-0.1661	-0.1573	-0.3639	0.556	0.682	0.696	0.433
KT04-04	quenched	targeted	-0.2666	-0.1647	-0.1556	-0.3710	0.541	0.684	0.699	0.426
KT04-05	ccc	measured	-0.3183	-0.1908	-0.2033	-0.3765	0.480	0.645	0.626	0.420
KT04-05	ccc	targeted	-0.3250	-0.1842	-0.2095	-0.3841	0.473	0.654	0.617	0.413
KT04-05	quenched	measured	-0.3266	-0.1880	-0.1893	-0.3770	0.471	0.649	0.647	0.420
KT04-05	quenched	targeted	-0.3333	-0.1815	-0.1955	-0.3846	0.464	0.658	0.637	0.412
KT04-06	ccc	measured	-0.3404	-0.2145	-0.2625	-0.3965	0.457	0.610	0.546	0.401
KT04-06	ccc	targeted	-0.3482	-0.2067	-0.2568	-0.4124	0.448	0.621	0.554	0.387
KT04-06	quenched	measured	-0.3424	-0.2230	-0.2295	-0.4021	0.455	0.598	0.590	0.396
KT04-06	quenched	targeted	-0.3502	-0.2152	-0.2238	-0.4181	0.446	0.609	0.597	0.382
KT04-07	ccc	measured	-0.2970	-0.2012	-0.1769	-0.3672	0.505	0.629	0.665	0.429
KT04-07	ccc	targeted	-0.3090	-0.1928	-0.1794	-0.3822	0.491	0.642	0.662	0.415
KT04-07	quenched	measured	-0.3061	-0.2152	-0.1692	-0.3701	0.494	0.609	0.677	0.427
KT04-07	quenched	targeted	-0.3182	-0.2068	-0.1717	-0.3851	0.481	0.621	0.674	0.412
KT04-08	ccc	measured	-0.2592	-0.1688	-0.1430	-0.3400	0.551	0.678	0.719	0.457
KT04-08	ccc	targeted	-0.2694	-0.1616	-0.1381	-0.3488	0.538	0.689	0.728	0.448
KT04-08	quenched	measured	-0.2575	-0.1962	-0.1067	-0.3418	0.553	0.637	0.782	0.455
KT04-08	quenched	targeted	-0.2677	-0.1890	-0.1018	-0.3505	0.540	0.647	0.791	0.446
KT04-09	ccc	measured	-0.2521	-0.1781	-0.1843	-0.3629	0.560	0.664	0.654	0.434
KT04-09	ccc	targeted	-0.2599	-0.1728	-0.1740	-0.3726	0.550	0.672	0.670	0.424
KT04-09	quenched	measured	-0.2183	-0.1572	-0.1436	-0.3402	0.605	0.696	0.719	0.457
KT04-09	quenched	targeted	-0.2261	-0.1520	-0.1332	-0.3500	0.594	0.705	0.736	0.447
KT04-10	ccc	measured	-0.2430	-0.1514	-0.1827	-0.3606	0.571	0.706	0.657	0.436
KT04-10	ccc	targeted	-0.2515	-0.1500	-0.1864	-0.3668	0.560	0.708	0.651	0.430
KT04-10	quenched	measured	-0.2528	-0.1623	-0.1702	-0.3663	0.559	0.688	0.676	0.430
KT04-10	quenched	targeted	-0.2613	-0.1609	-0.1739	-0.3725	0.548	0.690	0.670	0.424

Exhibit F-1. KT04 PCT Measurements (ppm values) in Analytical Sequence by Element.

Variability Chart for B (ppm)

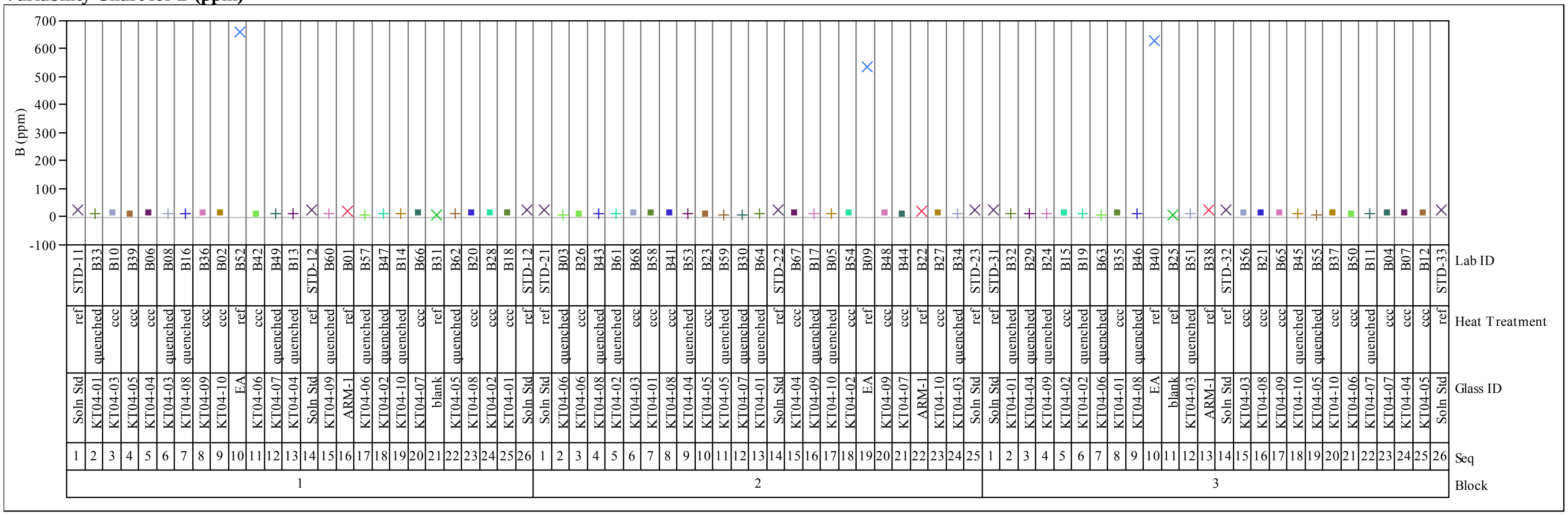


Exhibit F-1. KT04 PCT Measurements (ppm values) in Analytical Sequence by Element. (continued)

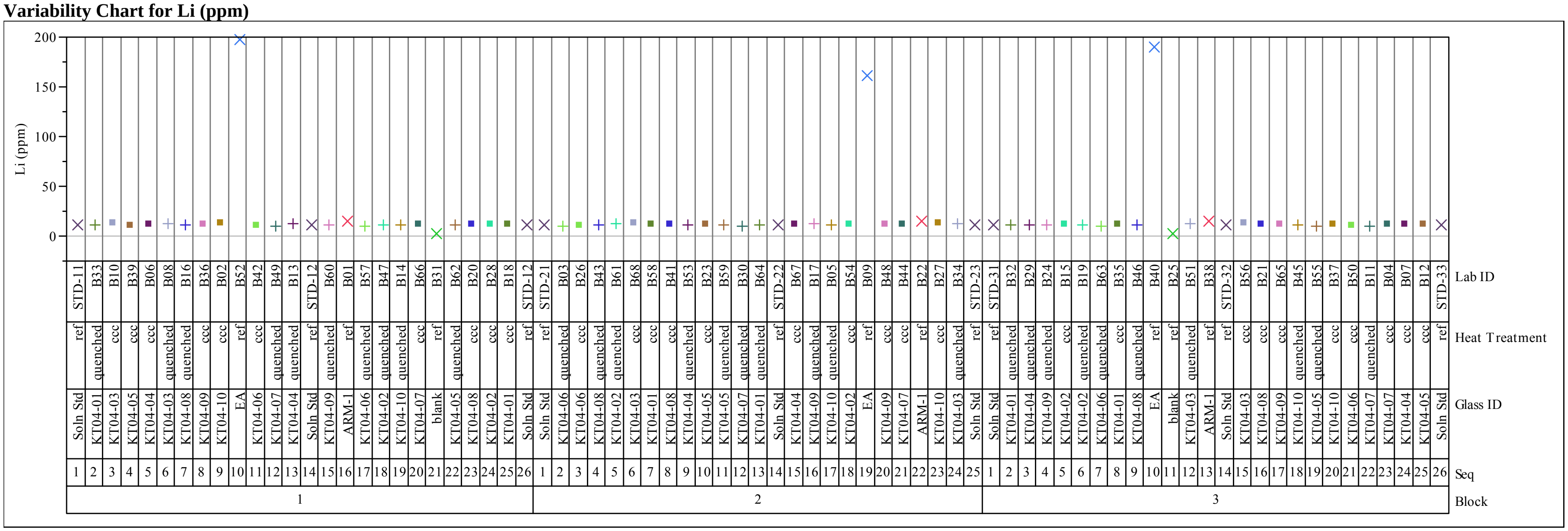


Exhibit F-1. KT04 PCT Measurements (ppm values) in Analytical Sequence by Element. (continued)

Variability Chart for Na (ppm)

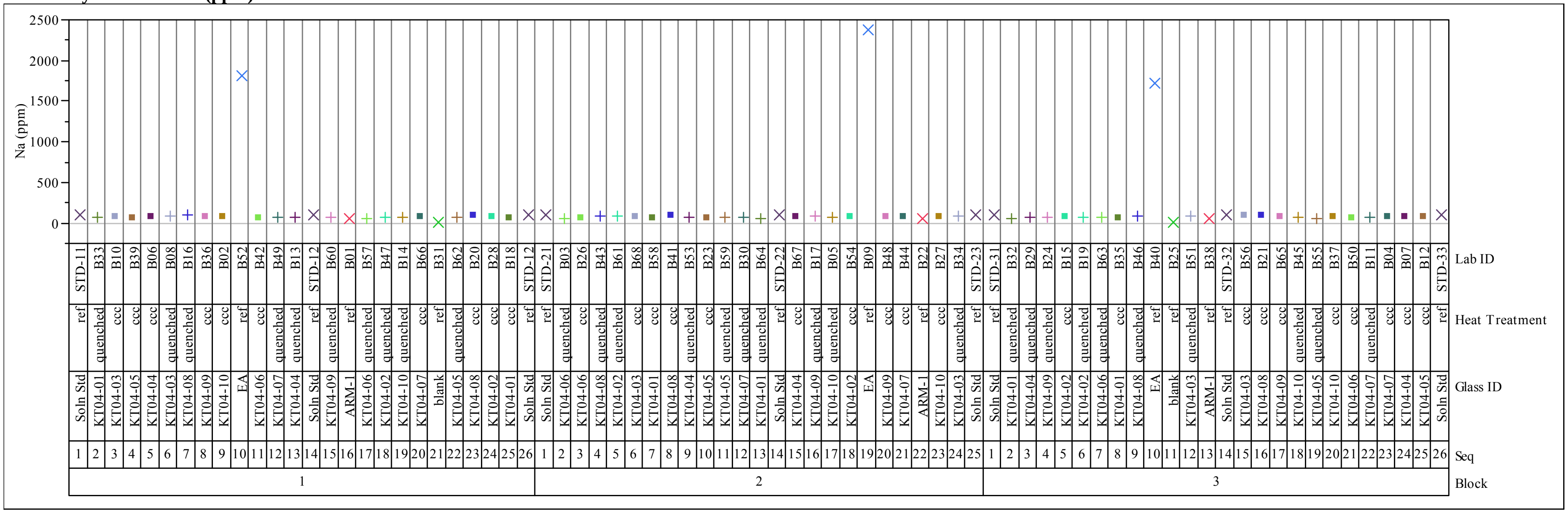


Exhibit F-1. KT04 PCT Measurements (ppm values) in Analytical Sequence by Element. (continued)

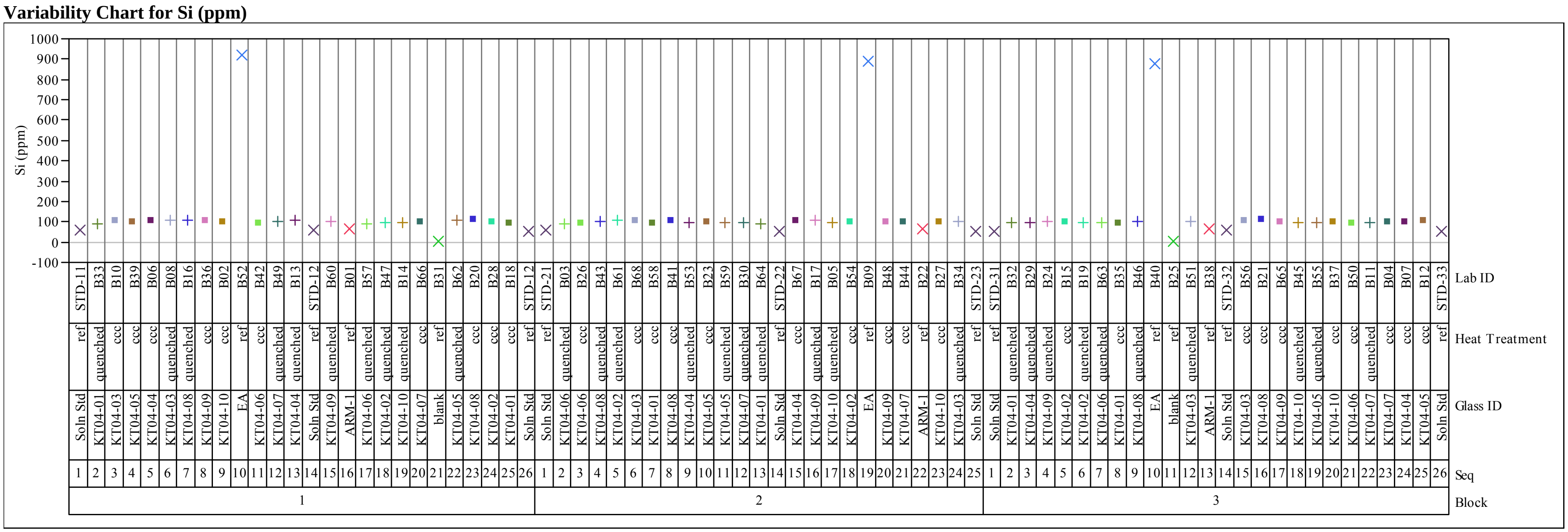
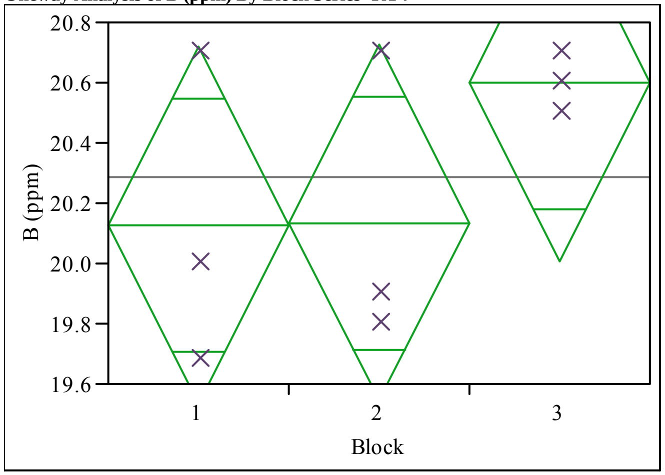


Exhibit F-2. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Multi-Element Standard Solution Results by Oxide.

Oneway Analysis of B (ppm) By Block Series=KT4



Oneway Anova
Summary of Fit

Rsquare	0.295999
Adj Rsquare	0.061331
Root Mean Square Error	0.418516
Mean of Response	20.28667
Observations (or Sum Wgts)	9

Analysis of Variance

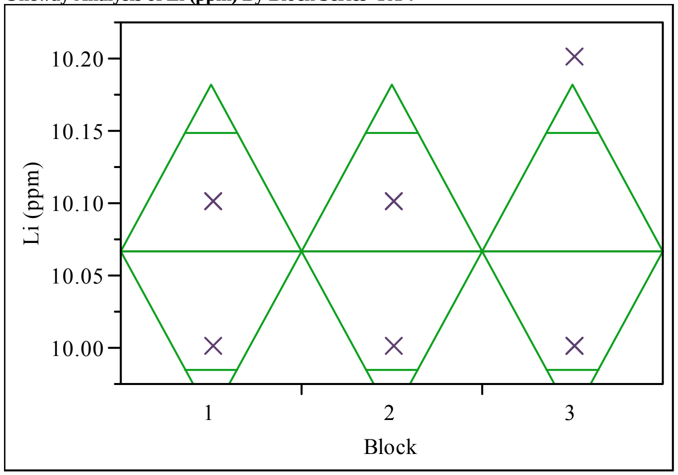
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.4418667	0.220933	1.2614	0.3489
Error	6	1.0509333	0.175156		
C. Total	8	1.4928000			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	20.1267	0.24163	19.535	20.718
2	3	20.1333	0.24163	19.542	20.725
3	3	20.6000	0.24163	20.009	21.191

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Block Series=KT4



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.33333
Root Mean Square Error	0.08165
Mean of Response	10.06667
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	1.8933e-29	9.47e-30	0.0000	1.0000
Error	6	0.04000000	0.006667		
C. Total	8	0.04000000			

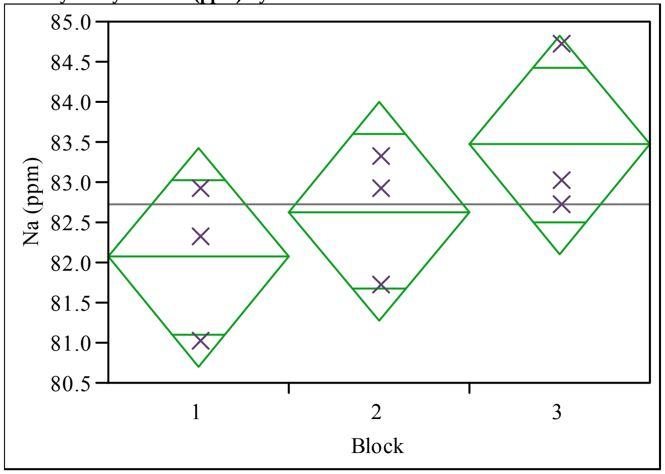
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	10.0667	0.04714	9.9513	10.182
2	3	10.0667	0.04714	9.9513	10.182
3	3	10.0667	0.04714	9.9513	10.182

Std Error uses a pooled estimate of error variance

Exhibit F-2. Statistical Evaluation of the ICP-AES Calibration Effects from the KT04 Multi-Element Standard Solution Results by Oxide. (continued)

Oneway Analysis of Na (ppm) By Block Series=KT4



Oneway Anova
Summary of Fit

Rsquare	0.346981
Adj Rsquare	0.129308
Root Mean Square Error	0.966092
Mean of Response	82.72222
Observations (or Sum Wgts)	9

Analysis of Variance

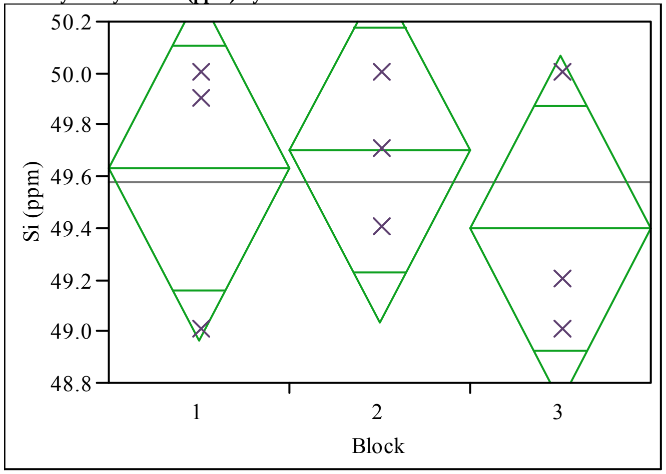
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	2.9755556	1.48778	1.5940	0.2785
Error	6	5.6000000	0.93333		
C. Total	8	8.5755556			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	82.0667	0.55777	80.702	83.431
2	3	82.6333	0.55777	81.269	83.998
3	3	83.4667	0.55777	82.102	84.831

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Block Series=KT4



Oneway Anova
Summary of Fit

Rsquare	0.099554
Adj Rsquare	-0.20059
Root Mean Square Error	0.473756
Mean of Response	49.57778
Observations (or Sum Wgts)	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	2	0.1488889	0.074444	0.3317	0.7301
Error	6	1.3466667	0.224444		
C. Total	8	1.4955556			

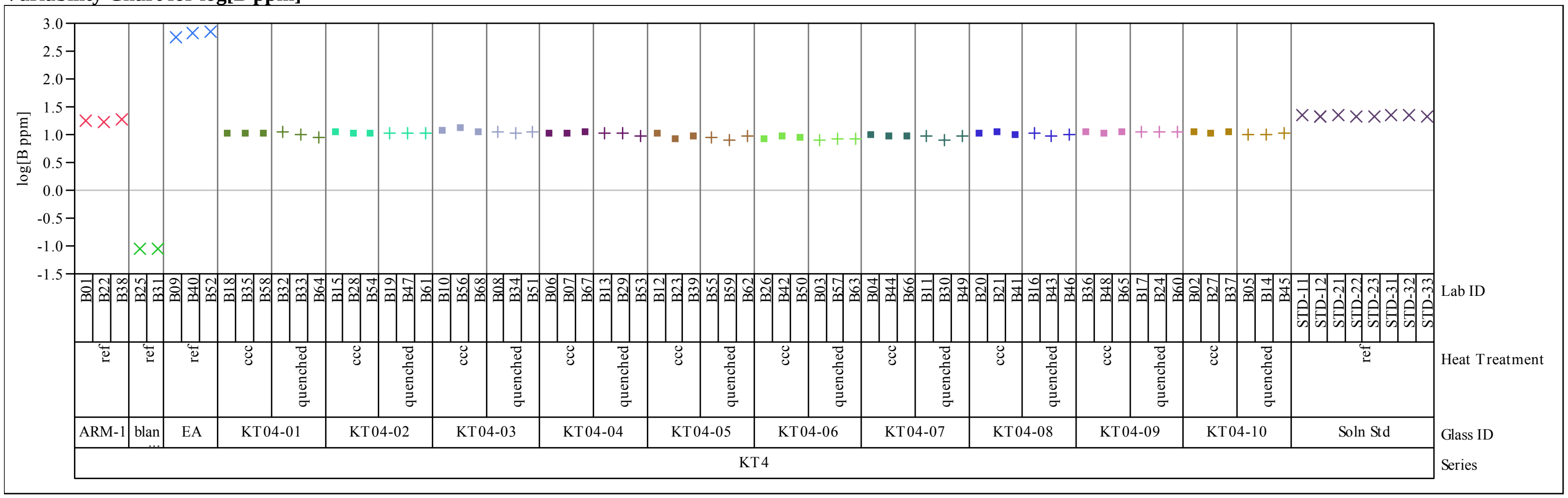
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	49.6333	0.27352	48.964	50.303
2	3	49.7000	0.27352	49.031	50.369
3	3	49.4000	0.27352	48.731	50.069

Std Error uses a pooled estimate of error variance

Exhibit F-3. KT04 PCT Results (as common logarithms) Grouped by Glass ID and Heat Treatment.

Variability Chart for log[B ppm]



Variability Chart for log[Li ppm]

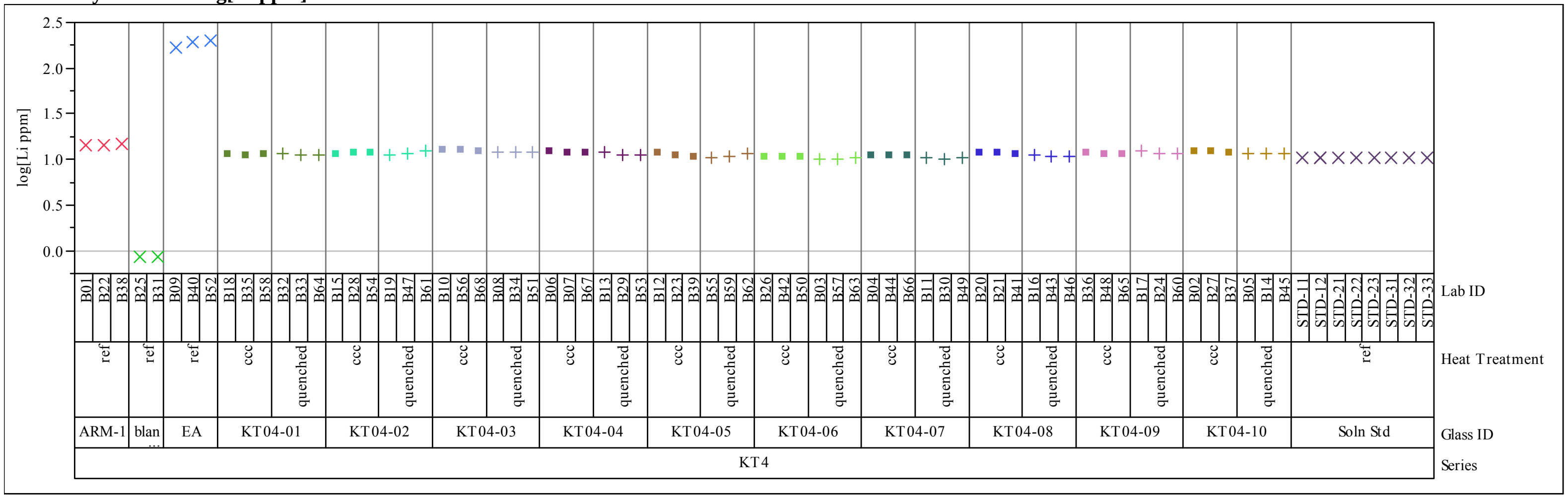
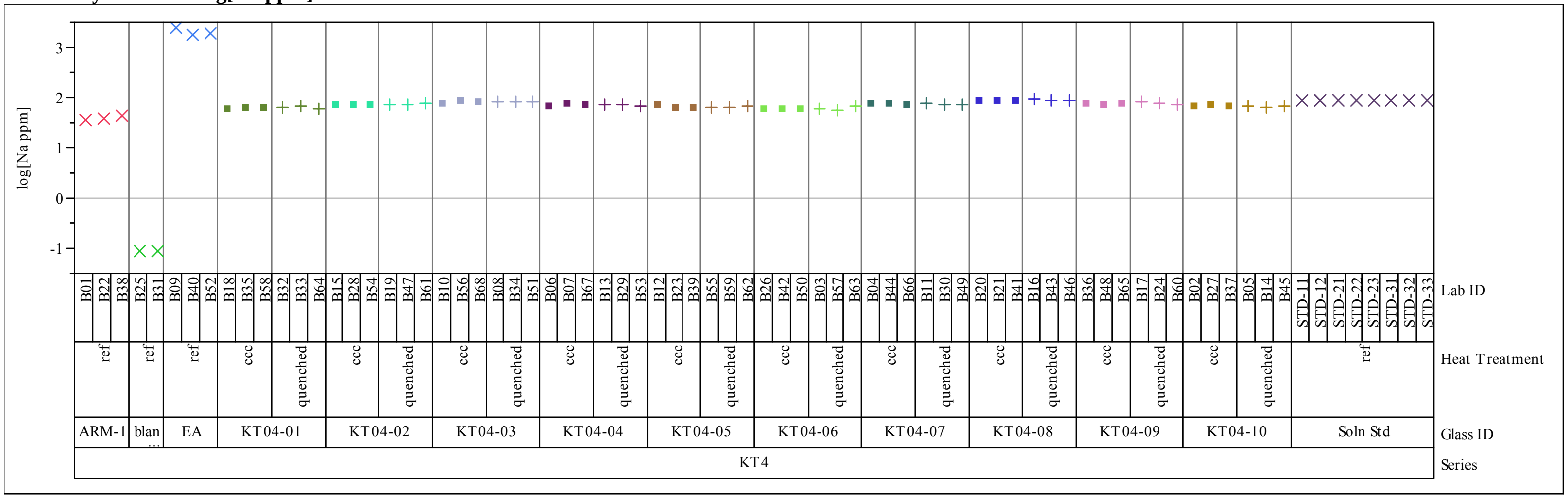


Exhibit F-3. KT04 PCT Results (as common logarithms) Grouped by Glass ID and Heat Treatment. (continued)

Variability Chart for log[Na ppm]



Variability Chart for log[Si ppm]

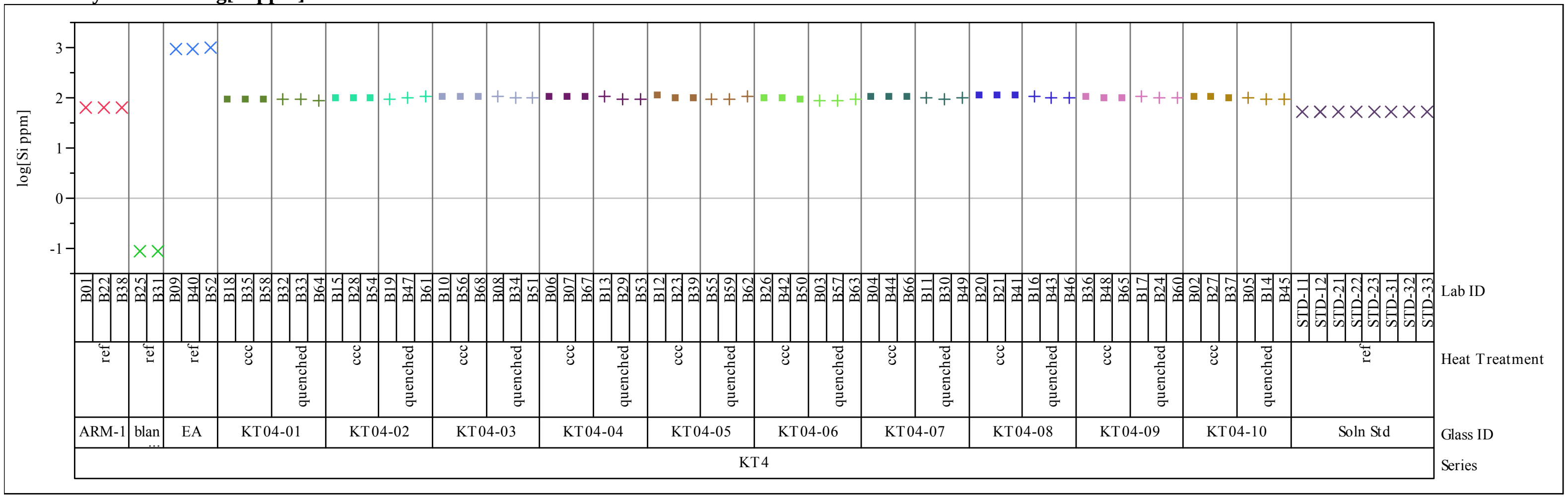


Exhibit F-4. Correlations and Scatter Plots of the KT01 Normalized PCTs Over All Compositional Views and Heat Treatments.

Multivariate Correlations

	log NL[B (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.9962	0.9901	0.9802
log NL[Li(g/L)]	0.9962	1.0000	0.9887	0.9833
log NL[Na (g/L)]	0.9901	0.9887	1.0000	0.9902
log NL[Si (g/L)]	0.9802	0.9833	0.9902	1.0000

Scatterplot Matrix

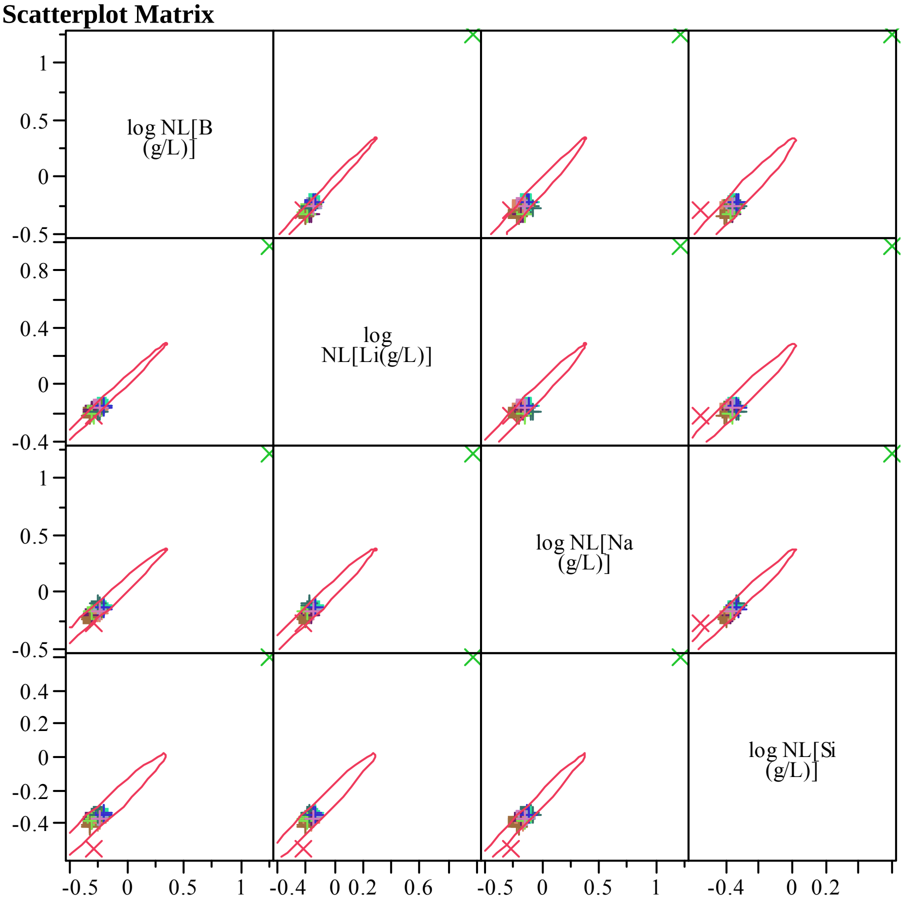
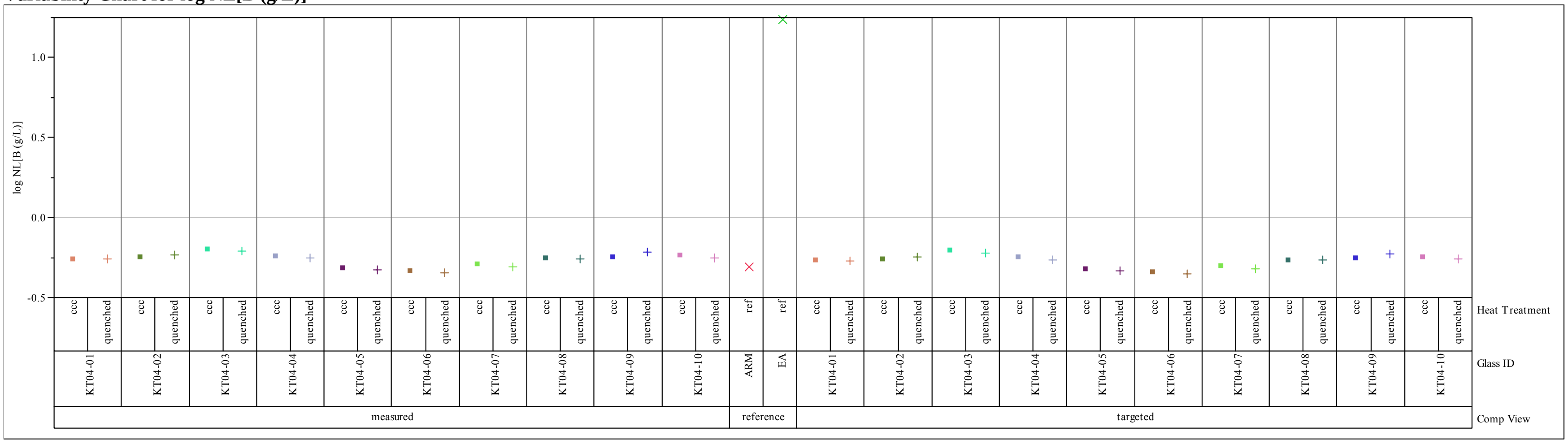


Exhibit F-5. Effects of Heat Treatment for the KT04 Glasses by Compositional View.

Variability Chart for log NL[B (g/L)]



Variability Chart for log NL[Li(g/L)]

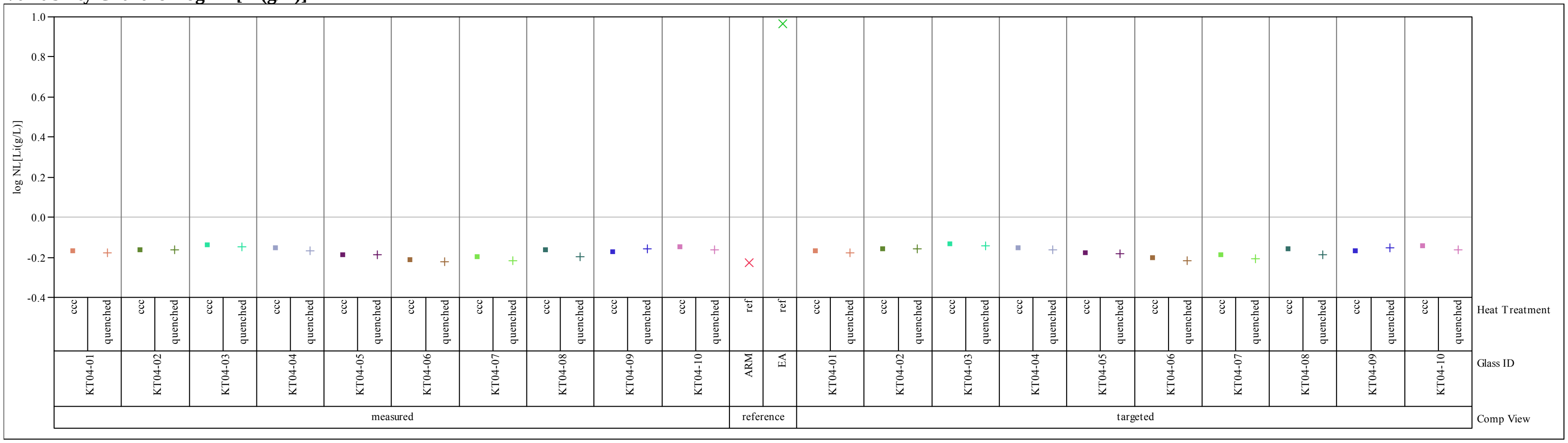
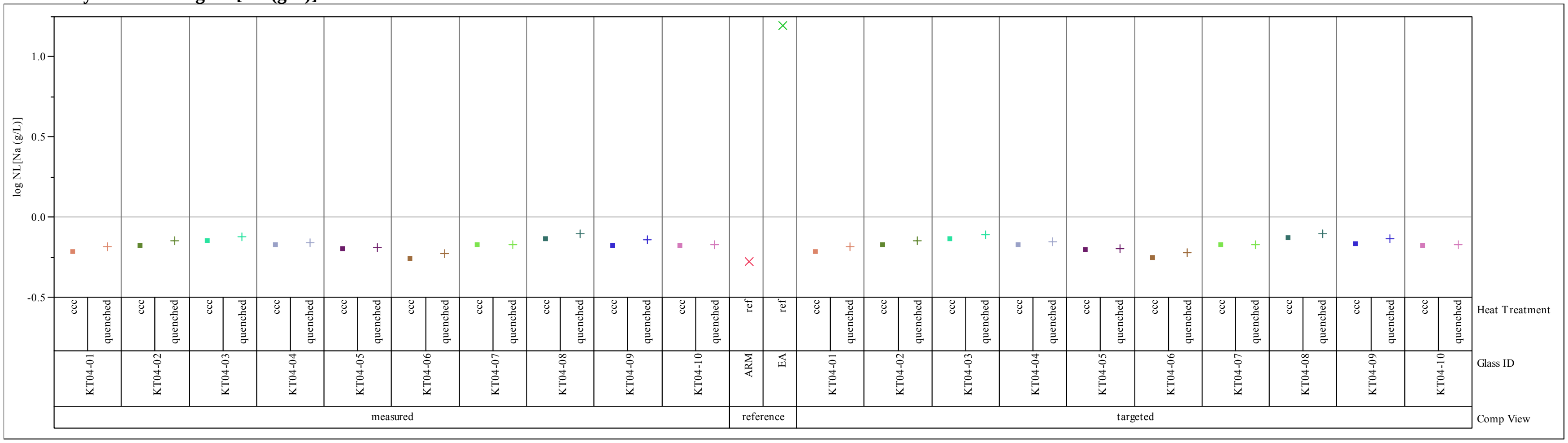


Exhibit F-5. Effects of Heat Treatment for the KT04 Glasses by Compositional View. (continued)

Variability Chart for log NL[Na (g/L)]



Variability Chart for log NL[Si (g/L)]

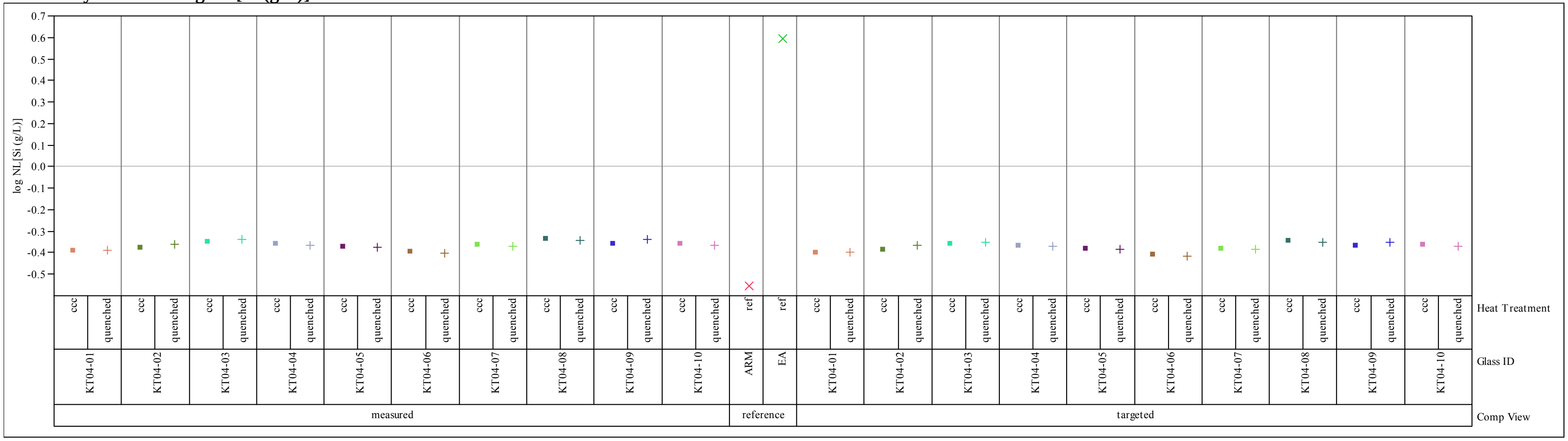
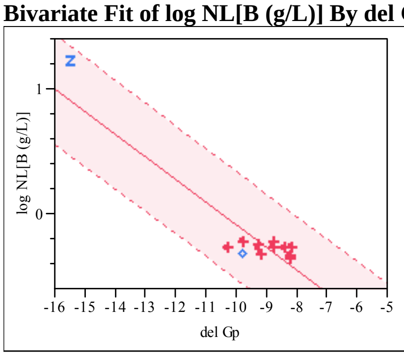


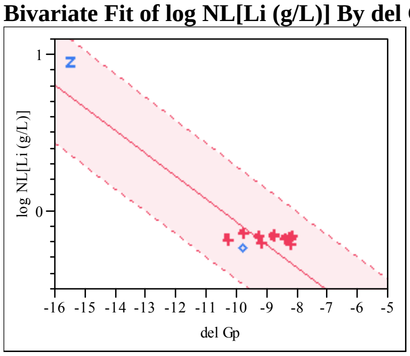
Exhibit F-6. KT04-Series PCT Measurements versus Durability Model Predictions.

Targeted Compositions

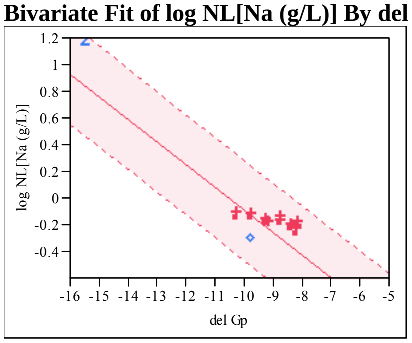
Bivariate Fit of log NL[B (g/L)] By del Gp



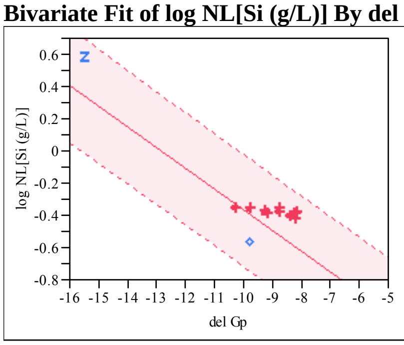
Bivariate Fit of log NL[Li (g/L)] By del Gp



Bivariate Fit of log NL[Na (g/L)] By del Gp

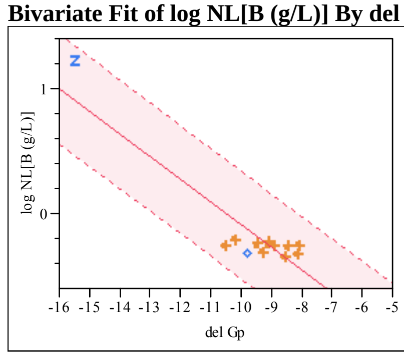


Bivariate Fit of log NL[Si (g/L)] By del Gp

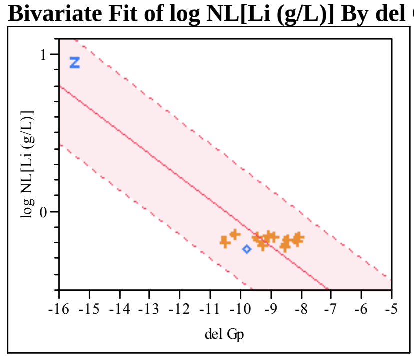


Measured Compositions

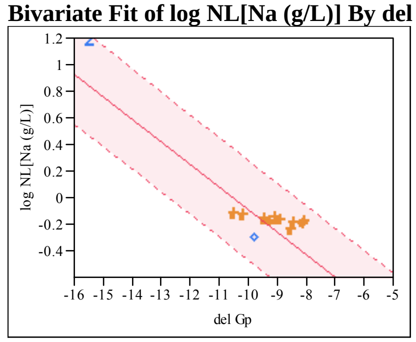
Bivariate Fit of log NL[B (g/L)] By del Gp



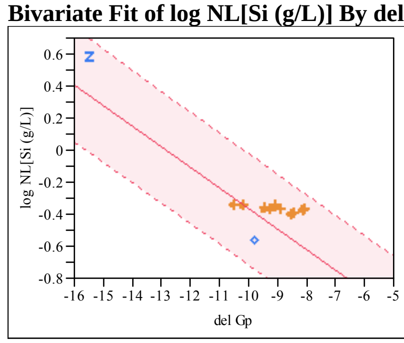
Bivariate Fit of log NL[Li (g/L)] By del Gp



Bivariate Fit of log NL[Na (g/L)] By del Gp



Bivariate Fit of log NL[Si (g/L)] By del Gp



z Environmental Assessment Benchmark Glass
◇ Approved Reference Material Glass
+ + Quenched Study Glasses
■ ■ Slowly Cooled Study Glasses

Appendix G. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT01-Series Glasses

Exhibit G-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT01-Series Glasses.

Nonlinear Fit Glass ID=KT1-HA2
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

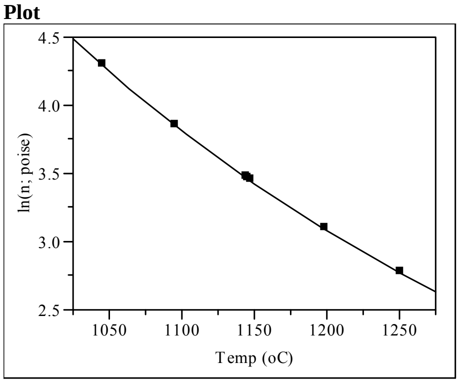
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	7.1645324e-8	1e-15
Relative Gradient	7.6493001e-8	0.000001
Gradient	7.5959064e-8	0.000001

Parameter	Current Value
C	272.58188641
B	5614.6672395
A	-2.971823046

SSE 0.0000177358
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	272.58188641	64.1049	192.315
B	5614.6672395	3212.47	9637.41
A	-2.971823046	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000177358	4	4.434e-6	0.0021057

Parameter	Estimate	ApproxStdErr
C	272.58188641	18.2833589
B	5614.6672395	238.431099
A	-2.971823046	0.13798465

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT1-HB
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

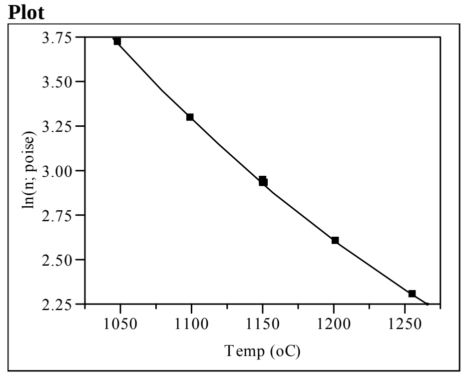
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	2.4320554e-7	1e-15
Relative Gradient	4.5877595e-8	0.000001
Gradient	4.4982146e-8	0.000001

Parameter	Current Value
C	324.46358217
B	4589.5874017
A	-2.62869328

SSE 0.0001667025
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	324.46358217	64.1049	192.315
B	4589.5874017	3212.47	9637.41
A	-2.62869328	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0001667025	4	4.1676e-5	0.0064557

Parameter	Estimate	ApproxStdErr
C	324.46358217	53.7177966
B	4589.5874017	607.154934
A	-2.62869328	0.37238254

Solved By:
Analytic NR

Exhibit G-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT01-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT1-HF
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

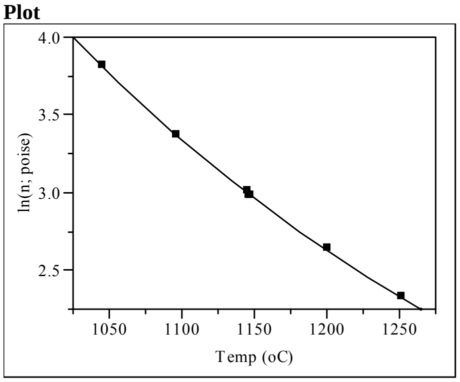
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	8.1773409e-6	1e-15
Relative Gradient	1.1457563e-7	0.000001
Gradient	1.1306394e-7	0.000001

Parameter	Current Value
C	345.3184016
B	4570.438242
A	-2.720256972

SSE 0.0003206421
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	345.3184016	64.1049	192.315
B	4570.438242	3212.47	9637.41
A	-2.720256972	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0003206421	4	8.0161e-5	0.0089532

Parameter	Estimate	ApproxStdErr
C	345.3184016	67.2536684
B	4570.438242	780.362392
A	-2.720256972	0.49328771

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT1-HK
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

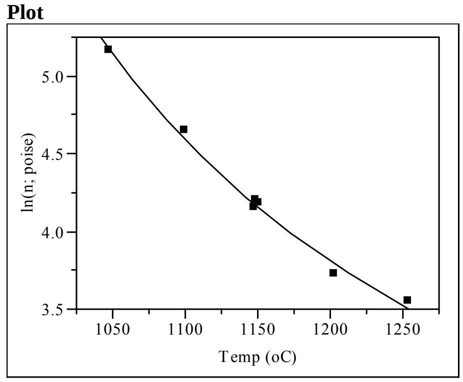
Criterion	Current	Stop Limit
Iteration	8	60
Obj Change	5.702057e-10	1e-15
Relative Gradient	3.2777485e-6	0.000001
Gradient	4.3879902e-7	0.000001

Parameter	Current Value
C	678.78098695
B	1717.9066334
A	0.5158775051

SSE 0.0105510123
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	678.78098695	64.1049	192.315
B	1717.9066334	3212.47	9637.41
A	0.5158775051	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0105510123	4	0.0026378	0.0513591

Parameter	Estimate	ApproxStdErr
C	678.78098695	115.878361
B	1717.9066334	892.470828
A	0.5158775051	0.98748363

Solved By:
Analytic NR

Exhibit G-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT01-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT1-HL
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

Warning: 1 missing Y's.

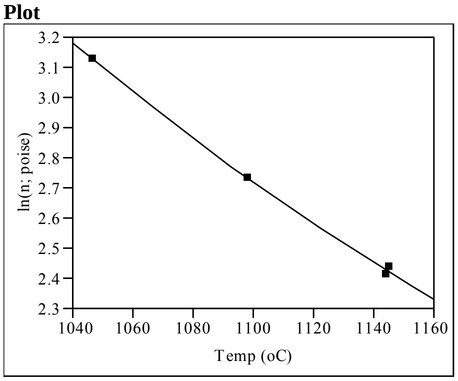
Criterion	Current	Stop Limit
Iteration	6	60
Obj Change	3.087329e-10	1e-15
Relative Gradient	0.000410057	0.000001
Gradient	9.8952592e-7	0.000001

Parameter	Current Value
C	438.21528652
B	3082.7853742
A	-1.940837674

SSE 0.0004800051
N 4

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	438.21528652	64.1049	192.315
B	3082.7853742	3212.47	9637.41
A	-1.940837674	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0004800051	1	0.00048	0.021909

Parameter	Estimate	ApproxStdErr
C	438.21528652	633.823323
B	3082.7853742	5967.14184
A	-1.940837674	4.53863241

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT1-HN
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

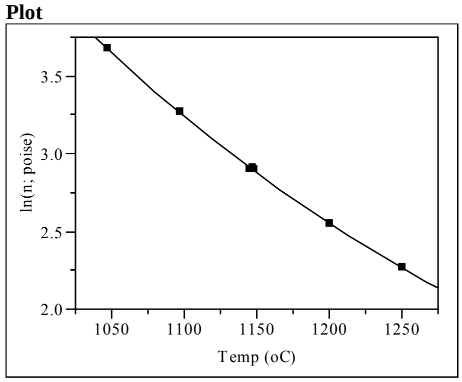
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	4.2474625e-7	1e-15
Relative Gradient	1.0947133e-7	0.000001
Gradient	1.0024282e-7	0.000001

Parameter	Current Value
C	321.68448511
B	4685.1856787
A	-2.783085186

SSE 0.0002553935
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	321.68448511	64.1049	192.315
B	4685.1856787	3212.47	9637.41
A	-2.783085186	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0002553935	4	6.3848e-5	0.0079905

Parameter	Estimate	ApproxStdErr
C	321.68448511	67.4717246
B	4685.1856787	777.663544
A	-2.783085186	0.47649683

Solved By:
Analytic NR

Exhibit G-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT01-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT1-HS
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

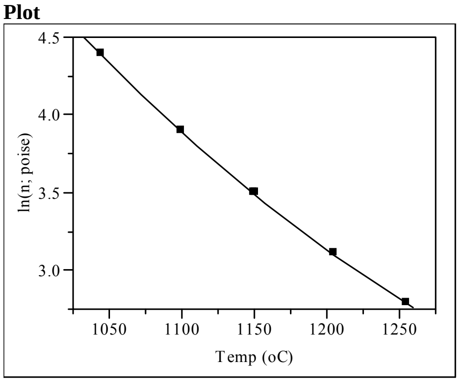
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	7.341071e-11	1e-15
Relative Gradient	2.0745692e-9	0.000001
Gradient	1.1252127e-9	0.000001

Parameter	Current Value
C	207.43634541
B	6676.2470589
A	-3.591204552

SSE 0.0000426649
N 6

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	207.43634541	64.1049	192.315
B	6676.2470589	3212.47	9637.41
A	-3.591204552	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000426649	3	1.4222e-5	0.0037712

Parameter	Estimate	ApproxStdErr
C	207.43634541	37.6916267
B	6676.2470589	541.779711
A	-3.591204552	0.2904694

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT1-LA
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

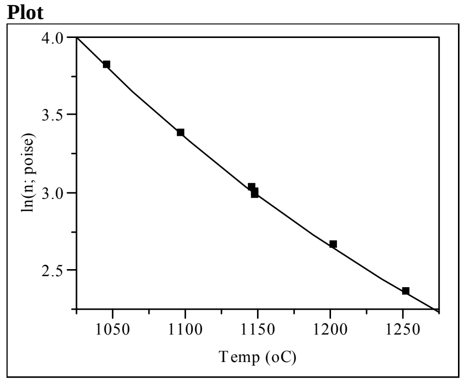
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	6.107442e-7	1e-15
Relative Gradient	4.4833869e-8	0.000001
Gradient	4.4270611e-8	0.000001

Parameter	Current Value
C	318.75966405
B	4779.9084894
A	-2.763798524

SSE 0.0006001086
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	318.75966405	64.1049	192.315
B	4779.9084894	3212.47	9637.41
A	-2.763798524	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0006001086	4	0.00015	0.0122486

Parameter	Estimate	ApproxStdErr
C	318.75966405	99.8128742
B	4779.9084894	1169.39902
A	-2.763798524	0.71383863

Solved By:
Analytic NR

Exhibit G-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT01-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT1-LB
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

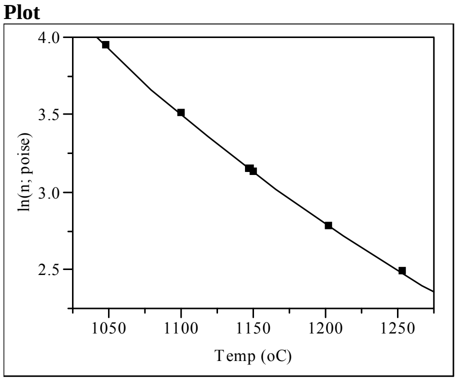
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	2.8131587e-8	1e-15
Relative Gradient	6.149598e-10	0.000001
Gradient	4.860766e-10	0.000001

Parameter	Current Value
C	275.98447951
B	5370.8378721
A	-3.018664365

SSE
0.0001054217N
7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	275.98447951	64.1049	192.315
B	5370.8378721	3212.47	9637.41
A	-3.018664365	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0001054217	4	2.6355e-5	0.0051338

Parameter	Estimate	ApproxStdErr
C	275.98447951	46.8344432
B	5370.8378721	584.273913
A	-3.018664365	0.33816303

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT1-LF
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

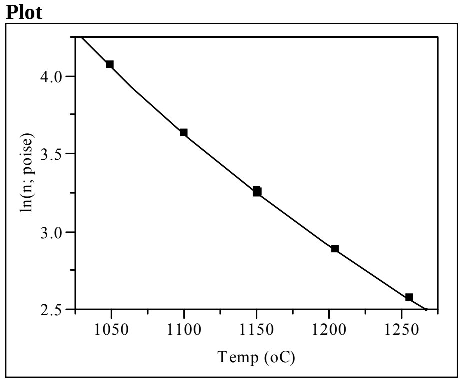
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	2.850766e-10	1e-15
Relative Gradient	3.059204e-10	0.000001
Gradient	1.282965e-10	0.000001

Parameter	Current Value
C	228.74616791
B	6086.9880788
A	-3.359017457

SSE 0.0000934483
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	228.74616791	64.1049	192.315
B	6086.9880788	3212.47	9637.41
A	-3.359017457	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000934483	4	2.3362e-5	0.0048334

Parameter	Estimate	ApproxStdErr
C	228.74616791	47.842952
B	6086.9880788	639.689463
A	-3.359017457	0.35021239

Solved By:
Analytic NR

Exhibit G-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT01-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT1-LL
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

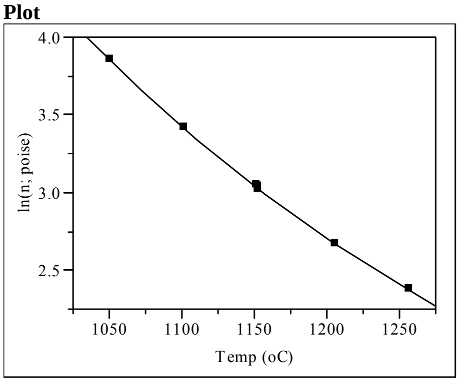
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	4.4618791e-8	1e-15
Relative Gradient	7.9156147e-9	0.000001
Gradient	4.0694908e-9	0.000001

Parameter	Current Value
C	277.95408035
B	5404.9672434
A	-3.150404726

SSE 0.0003785986
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	277.95408035	64.1049	192.315
B	5404.9672434	3212.47	9637.41
A	-3.150404726	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0003785986	4	9.465e-5	0.0097288

Parameter	Estimate	ApproxStdErr
C	277.95408035	87.5110799
B	5404.9672434	1098.17012
A	-3.150404726	0.63525034

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT1-LN
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

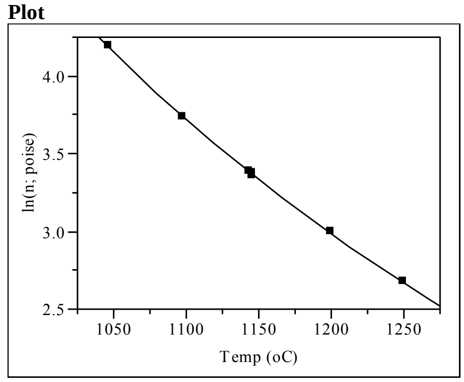
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	2.426674e-12	1e-15
Relative Gradient	1.6302144e-9	0.000001
Gradient	2.950439e-10	0.000001

Parameter	Current Value
C	188.5707596
B	6788.5163104
A	-3.729581521

SSE 0.0001099648
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	188.5707596	64.1049	192.315
B	6788.5163104	3212.47	9637.41
A	-3.729581521	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0001099648	4	0.0000275	0.0052432

Parameter	Estimate	ApproxStdErr
C	188.5707596	55.8320281
B	6788.5163104	800.281649
A	-3.729581521	0.42131481

Solved By:
Analytic NR

Exhibit G-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT01-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT1-LS
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

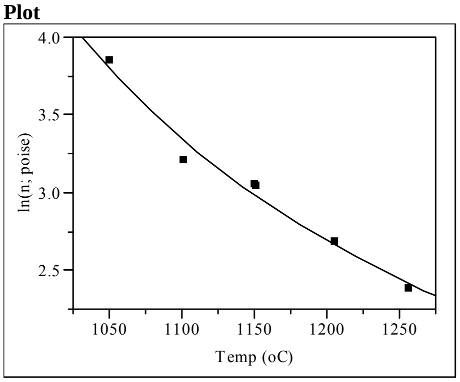
Criterion	Current	Stop Limit
Iteration	9	60
Obj Change	1.8330675e-9	1e-15
Relative Gradient	7.9215355e-6	0.000001
Gradient	6.8799919e-7	0.000001

Parameter	Current Value
C	637.91501992
B	1710.3589442
A	-0.350398854

SSE 0.0292819194
N 6

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL

Plot



Parameter	Estimate	Low	High
C	637.91501992	64.1049	192.315
B	1710.3589442	3212.47	9637.41
A	-0.350398854	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0292819194	3	0.0097606	0.098796

Parameter	Estimate	ApproxStdErr
C	637.91501992	342.817083
B	1710.3589442	2381.24385
A	-0.350398854	2.38575562

Solved By:
Analytic NR

Appendix H. Results from Fitting Fulcher Equations to the Viscosity Measurements for KT03-Series Glasses

Exhibit H-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT03-Series Glasses.

Nonlinear Fit Glass ID=KT3-HA
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

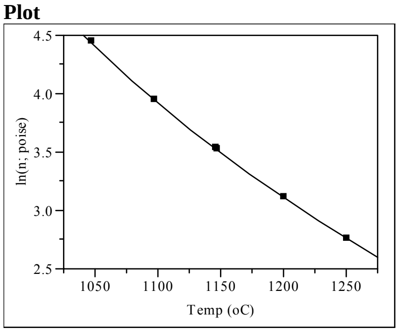
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	6.903612e-10	1e-15
Relative Gradient	1.4728099e-8	0.000001
Gradient	1.2855084e-8	0.000001

Parameter	Current Value
C	208.05031226
B	7231.2176244
A	-4.181530827

SSE 0.0000454087
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	208.05031226	64.1049	192.315
B	7231.2176244	3212.47	9637.41
A	-4.181530827	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000454087	4	1.1352e-5	0.0033693

Parameter	Estimate	ApproxStdErr
C	208.05031226	31.0909128
B	7231.2176244	484.274803
A	-4.181530827	0.2600438

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT3-HB
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

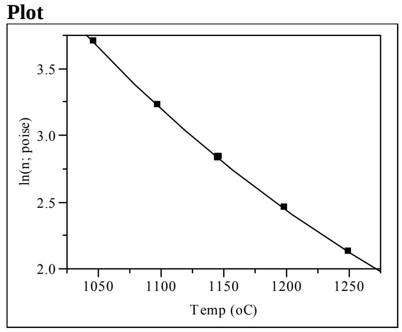
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	7.586294e-12	1e-15
Relative Gradient	2.020949e-11	0.000001
Gradient	4.177911e-12	0.000001

Parameter	Current Value
C	318.46779584
B	5238.3598816
A	-3.500526125

SSE 0.000316626
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	318.46779584	64.1049	192.315
B	5238.3598816	3212.47	9637.41
A	-3.500526125	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.000316626	4	7.9157e-5	0.008897

Parameter	Estimate	ApproxStdErr
C	318.46779584	68.22062
B	5238.3598816	876.872918
A	-3.500526125	0.53595608

Solved By:
Analytic NR

Exhibit H-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT03-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT3-HF
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

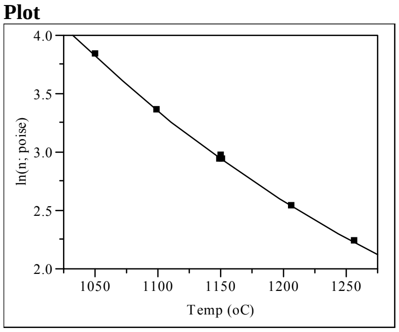
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	1.3155986e-7	1e-15
Relative Gradient	3.4415433e-8	0.000001
Gradient	3.3060663e-8	0.000001

Parameter	Current Value
C	379.51313227
B	4548.9851463
A	-2.960719018

SSE 0.0007645976
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	379.51313227	64.1049	192.315
B	4548.9851463	3212.47	9637.41
A	-2.960719018	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0007645976	4	0.0001911	0.0138257

Parameter	Estimate	ApproxStdErr
C	379.51313227	89.040187
B	4548.9851463	1068.66713
A	-2.960719018	0.70175349

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT3-HK
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

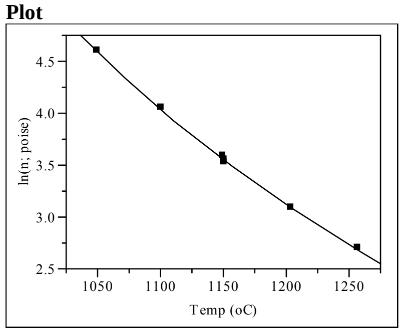
Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	2.000989e-10	1e-15
Relative Gradient	1.9026289e-8	0.000001
Gradient	3.6481148e-9	0.000001

Parameter	Current Value
C	274.16011486
B	7022.9046882
A	-4.464495881

SSE 0.0014744423
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	274.16011486	64.1049	192.315
B	7022.9046882	3212.47	9637.41
A	-4.464495881	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0014744423	4	0.0003686	0.0191992

Parameter	Estimate	ApproxStdErr
C	274.16011486	132.96427
B	7022.9046882	2160.50683
A	-4.464495881	1.24546739

Solved By:
Analytic NR

Exhibit H-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT03-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT3-HL
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

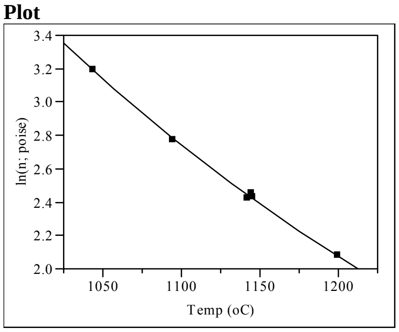
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	9.3836207e-8	1e-15
Relative Gradient	1.0086162e-7	0.000001
Gradient	4.0134529e-8	0.000001

Parameter	Current Value
C	283.33366493
B	4951.7673489
A	-3.325523525

SSE 0.0009403133
N 6

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	283.33366493	64.1049	192.315
B	4951.7673489	3212.47	9637.41
A	-3.325523525	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0009403133	3	0.0003134	0.0177042

Parameter	Estimate	ApproxStdErr
C	283.33366493	282.881716
B	4951.7673489	3387.07989
A	-3.325523525	2.041817

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT3-HN
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

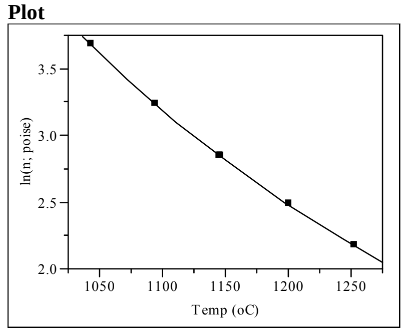
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	3.6149417e-6	1e-15
Relative Gradient	1.1115697e-7	0.000001
Gradient	1.0977152e-7	0.000001

Parameter	Current Value
C	332.03601636
B	4724.8071686
A	-2.963331902

SSE 0.0000814272
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	332.03601636	64.1049	192.315
B	4724.8071686	3212.47	9637.41
A	-2.963331902	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000814272	4	2.0357e-5	0.0045119

Parameter	Estimate	ApproxStdErr
C	332.03601636	33.8667161
B	4724.8071686	399.808301
A	-2.963331902	0.24873021

Solved By:
Analytic NR

Exhibit H-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT03-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT3-HS
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

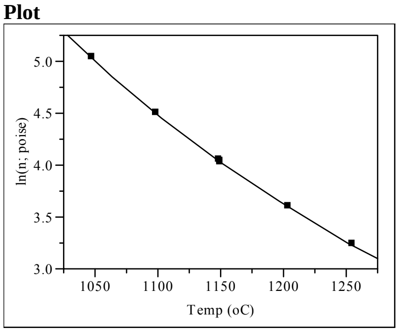
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	2.4417998e-9	1e-15
Relative Gradient	1.0508277e-9	0.000001
Gradient	9.823752e-10	0.000001

Parameter	Current Value
C	308.07590553
B	6063.424374
A	-3.17549045

SSE 0.0001333657
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	308.07590553	64.1049	192.315
B	6063.424374	3212.47	9637.41
A	-3.17549045	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0001333657	4	3.3341e-5	0.0057742

Parameter	Estimate	ApproxStdErr
C	308.07590553	38.9145957
B	6063.424374	569.914326
A	-3.17549045	0.3428464

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT3-LA
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

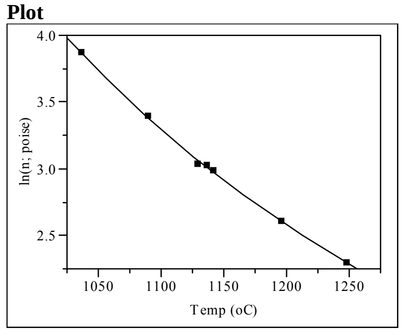
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	7.9477193e-7	1e-15
Relative Gradient	1.3639568e-7	0.000001
Gradient	1.3076597e-7	0.000001

Parameter	Current Value
C	418.19204388
B	3821.2073961
A	-2.312397962

SSE 0.0015366311
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	418.19204388	64.1049	192.315
B	3821.2073961	3212.47	9637.41
A	-2.312397962	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0015366311	4	0.0003842	0.0195999

Parameter	Estimate	ApproxStdErr
C	418.19204388	108.882141
B	3821.2073961	1175.78498
A	-2.312397962	0.82643608

Solved By:
Analytic NR

Exhibit H-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT03-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT3-LB
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

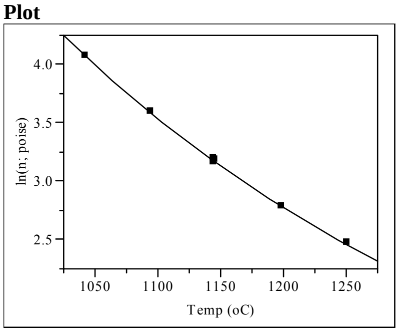
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	1.025152e-12	1e-15
Relative Gradient	3.1527484e-9	0.000001
Gradient	4.514331e-11	0.000001

Parameter	Current Value
C	339.20505893
B	4956.5286461
A	-2.980314518

SSE 0.0013103402
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	339.20505893	64.1049	192.315
B	4956.5286461	3212.47	9637.41
A	-2.980314518	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0013103402	4	0.0003276	0.0180993

Parameter	Estimate	ApproxStdErr
C	339.20505893	125.125961
B	4956.5286461	1566.83656
A	-2.980314518	0.98559983

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT3-LF
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

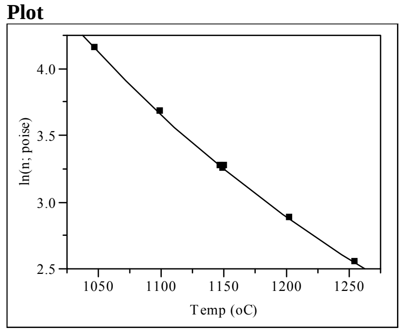
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	6.432448e-11	1e-15
Relative Gradient	6.085822e-9	0.000001
Gradient	2.684341e-10	0.000001

Parameter	Current Value
C	353.85998251
B	4834.5082625
A	-2.822146441

SSE 0.0004972067
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	353.85998251	64.1049	192.315
B	4834.5082625	3212.47	9637.41
A	-2.822146441	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0004972067	4	0.0001243	0.0111491

Parameter	Estimate	ApproxStdErr
C	353.85998251	75.7489401
B	4834.5082625	937.175834
A	-2.822146441	0.59713183

Solved By:
Analytic NR

Exhibit H-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT03-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT3-LL
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

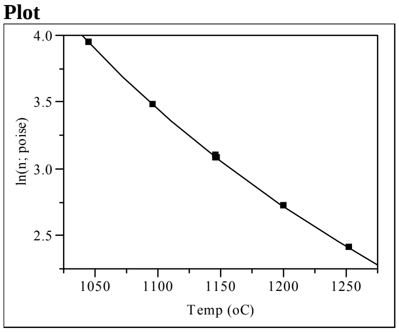
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	1.796677e-9	1e-15
Relative Gradient	9.579976e-10	0.000001
Gradient	6.420601e-10	0.000001

Parameter	Current Value
C	389.62194331
B	4202.7745014
A	-2.470966879

SSE 0.0002226681
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	389.62194331	64.1049	192.315
B	4202.7745014	3212.47	9637.41
A	-2.470966879	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0002226681	4	5.5667e-5	0.007461

Parameter	Estimate	ApproxStdErr
C	389.62194331	47.9009218
B	4202.7745014	541.871515
A	-2.470966879	0.36296616

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT3-LN
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

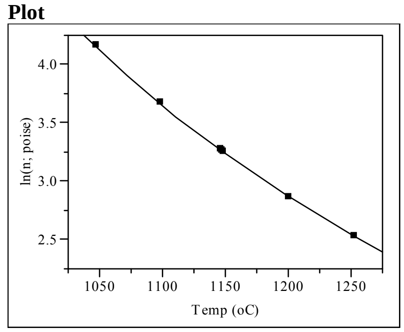
Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	5.354949e-10	1e-15
Relative Gradient	1.804656e-10	0.000001
Gradient	8.084978e-11	0.000001

Parameter	Current Value
C	343.65538061
B	5049.0507295
A	-3.026350453

SSE 0.0000598924
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	343.65538061	64.1049	192.315
B	5049.0507295	3212.47	9637.41
A	-3.026350453	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000598924	4	1.4973e-5	0.0038695

Parameter	Estimate	ApproxStdErr
C	343.65538061	26.6404698
B	5049.0507295	340.078139
A	-3.026350453	0.21410428

Solved By:
Analytic NR

Exhibit H-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT03-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT3-LS
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

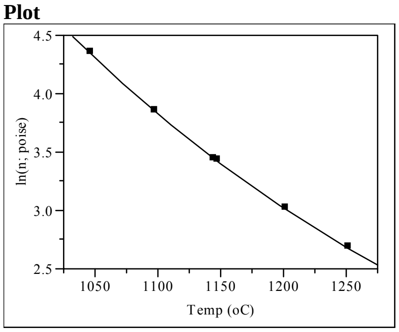
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	1.358534e-10	1e-15
Relative Gradient	1.1156219e-9	0.000001
Gradient	5.122938e-11	0.000001

Parameter	Current Value
C	315.65743096
B	5565.596038
A	-3.267217453

SSE 0.0000778801
N 6

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	315.65743096	64.1049	192.315
B	5565.596038	3212.47	9637.41
A	-3.267217453	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000778801	3	2.596e-5	0.0050951

Parameter	Estimate	ApproxStdErr
C	315.65743096	39.1293726
B	5565.596038	531.619115
A	-3.267217453	0.32287857

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT3-MK
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

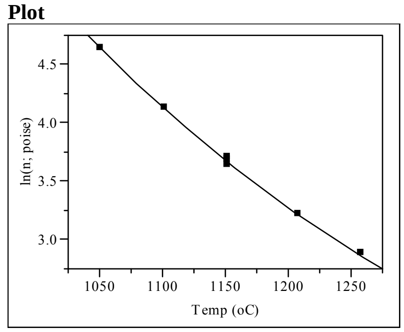
Converged in Gradient

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	1.126681e-11	1e-15
Relative Gradient	2.7204704e-8	0.000001
Gradient	2.914127e-9	0.000001

Parameter	Current Value
C	285.52010836
B	6376.7951039
A	-3.694516881

SSE 0.00286032
N 7

Edit Alpha 0.050
Convergence Criterion 0.00001
Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	285.52010836	64.1049	192.315
B	6376.7951039	3212.47	9637.41
A	-3.694516881	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.00286032	4	0.0007151	0.026741

Parameter	Estimate	ApproxStdErr
C	285.52010836	194.985934
B	6376.7951039	2910.42911
A	-3.694516881	1.69720061

Solved By:
Analytic NR

Appendix I. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT04-Series Glasses

Exhibit I-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT04-Series Glasses.

Nonlinear Fit Glass ID=KT04-01
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

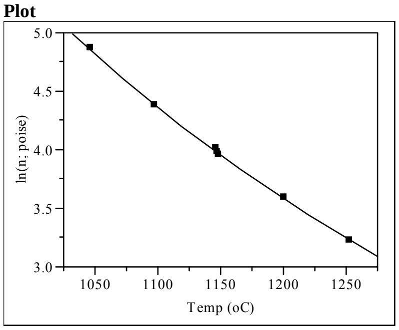
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	1.386126e-11	1e-15
Relative Gradient	3.1799932e-8	0.000001
Gradient	7.3780634e-9	0.000001

Parameter	Current Value
C	181.32801178
B	7327.581155
A	-3.613602288

SSE
0.0009651092N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	181.32801178	64.1049	192.315
B	7327.581155	3212.47	9637.41
A	-3.613602288	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0009651092	4	0.0002413	0.0155331

Parameter	Estimate	ApproxStdErr
C	181.32801178	153.937811
B	7327.581155	2360.72835
A	-3.613602288	1.23180994

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT04-02
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

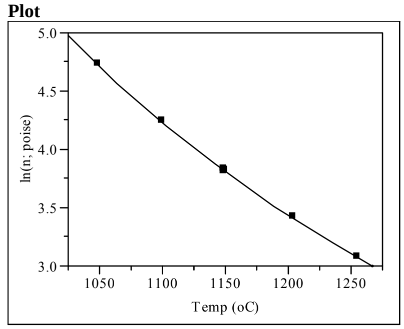
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	4.569271e-10	1e-15
Relative Gradient	2.26744e-10	0.000001
Gradient	1.742689e-10	0.000001

Parameter	Current Value
C	329.77262
B	5319.6822974
A	-2.674186479

SSE
0.0003145574N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	329.77262	64.1049	192.315
B	5319.6822974	3212.47	9637.41
A	-2.674186479	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0003145574	4	7.8639e-5	0.0088679

Parameter	Estimate	ApproxStdErr
C	329.77262	62.5783048
B	5319.6822974	825.1636
A	-2.674186479	0.50937552

Solved By:
Analytic NR

Exhibit I-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT04-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT04-03
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

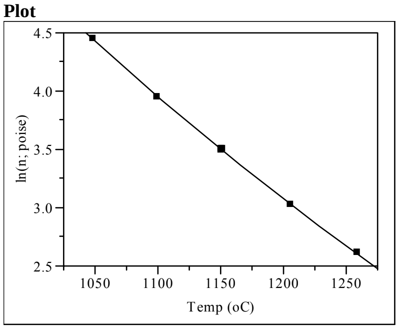
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	9	60
Obj Change	1.1376206e-7	1e-15
Relative Gradient	1.7915538e-8	0.000001
Gradient	1.6895614e-8	0.000001

Parameter	Current Value
C	-555.4147074
B	25381.824963
A	-11.384078

SSE
0.000150352N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	-555.4147074	64.1049	192.315
B	25381.824963	3212.47	9637.41
A	-11.384078	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.000150352	4	3.7588e-5	0.0061309

Parameter	Estimate	ApproxStdErr
C	-555.4147074	166.387838
B	25381.824963	4963.86389
A	-11.384078	1.45728078

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT04-04
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

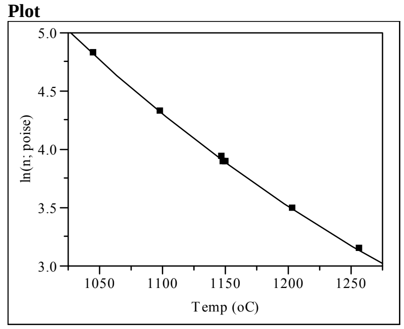
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	5.750186e-10	1e-15
Relative Gradient	7.2418306e-9	0.000001
Gradient	6.3981227e-9	0.000001

Parameter	Current Value
C	212.9132901
B	6918.5513019
A	-3.492909428

SSE
0.000730526N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	212.9132901	64.1049	192.315
B	6918.5513019	3212.47	9637.41
A	-3.492909428	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.000730526	4	0.0001826	0.0135141

Parameter	Estimate	ApproxStdErr
C	212.9132901	119.374562
B	6918.5513019	1787.08816
A	-3.492909428	0.96378268

Solved By:
Analytic NR

Exhibit I-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT04-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT04-05
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

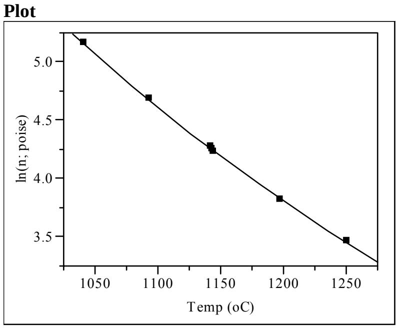
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	7.167475e-11	1e-15
Relative Gradient	4.3164007e-8	0.000001
Gradient	2.1122746e-8	0.000001

Parameter	Current Value
C	4.9693878638
B	10561.161613
A	-5.032226262

SSE
0.0007473996N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	4.9693878638	64.1049	192.315
B	10561.161613	3212.47	9637.41
A	-5.032226262	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0007473996	4	0.0001868	0.0136693

Parameter	Estimate	ApproxStdErr
C	4.9693878638	178.463509
B	10561.161613	3336.87854
A	-5.032226262	1.47401126

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT04-06
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

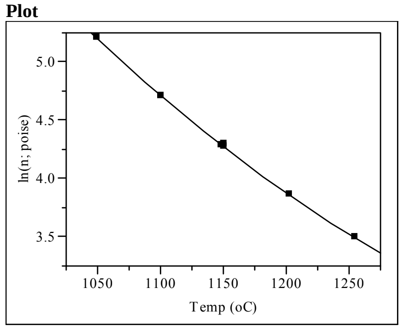
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	5.542693e-10	1e-15
Relative Gradient	2.1175056e-8	0.000001
Gradient	1.6716678e-8	0.000001

Parameter	Current Value
C	204.37554492
B	7373.7757425
A	-3.527009448

SSE
0.0004535315N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	204.37554492	64.1049	192.315
B	7373.7757425	3212.47	9637.41
A	-3.527009448	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0004535315	4	0.0001134	0.0106481

Parameter	Estimate	ApproxStdErr
C	204.37554492	96.5019596
B	7373.7757425	1522.75376
A	-3.527009448	0.81235266

Solved By:
Analytic NR

Exhibit I-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT04-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT04-07
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

Warning: 1 missing Y's.

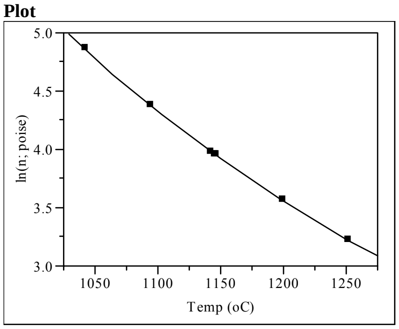
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	4.2345359e-7	1e-15
Relative Gradient	6.8647637e-7	0.000001
Gradient	6.8350202e-7	0.000001

Parameter	Current Value
C	278.82843365
B	5788.6948405
A	-2.727026561

SSE
0.0000353791N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	278.82843365	64.1049	192.315
B	5788.6948405	3212.47	9637.41
A	-2.727026561	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000353791	4	8.8448e-6	0.002974

Parameter	Estimate	ApproxStdErr
C	278.82843365	23.1726011
B	5788.6948405	314.49899
A	-2.727026561	0.18368422

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT04-08
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

Warning: 1 missing Y's.

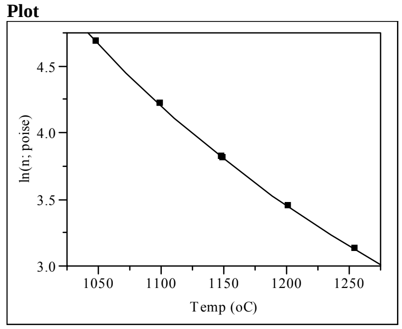
Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	8.7758115e-9	1e-15
Relative Gradient	5.5655069e-9	0.000001
Gradient	1.9185465e-9	0.000001

Parameter	Current Value
C	403.79346976
B	4141.0443353
A	-1.745806117

SSE
0.0000263364N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	403.79346976	64.1049	192.315
B	4141.0443353	3212.47	9637.41
A	-1.745806117	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000263364	4	6.5841e-6	0.002566

Parameter	Estimate	ApproxStdErr
C	403.79346976	15.8461914
B	4141.0443353	179.483315
A	-1.745806117	0.12216386

Solved By:
Analytic NR

Exhibit I-1. Results from Fitting Fulcher Equations to the Viscosity Measurements of the KT04-Series Glasses. (continued)

Nonlinear Fit Glass ID=KT04-09
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

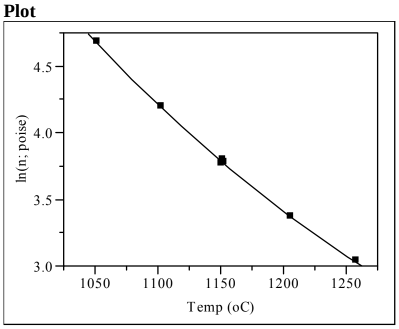
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	1.452975e-12	1e-15
Relative Gradient	1.0778618e-9	0.000001
Gradient	5.496676e-11	0.000001

Parameter	Current Value
C	289.6189852
B	5884.3540814
A	-3.050016197

SSE
0.0009961016N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	289.6189852	64.1049	192.315
B	5884.3540814	3212.47	9637.41
A	-3.050016197	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0009961016	4	0.000249	0.0157805

Parameter	Estimate	ApproxStdErr
C	289.6189852	123.16253
B	5884.3540814	1704.08327
A	-3.050016197	0.99825902

Solved By:
Analytic NR

Nonlinear Fit Glass ID=KT04-10
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel

Converged in Gradient

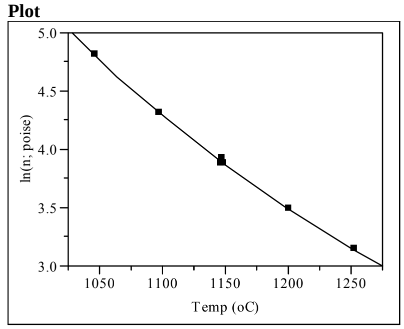
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	5	60
Obj Change	4.288577e-13	1e-15
Relative Gradient	2.990708e-10	0.000001
Gradient	1.732898e-11	0.000001

Parameter	Current Value
C	269.66452878
B	6171.9015819
A	-3.142973863

SSE
0.0009140891N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	269.66452878	64.1049	192.315
B	6171.9015819	3212.47	9637.41
A	-3.142973863	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0009140891	4	0.0002285	0.015117

Parameter	Estimate	ApproxStdErr
C	269.66452878	121.363178
B	6171.9015819	1730.37013
A	-3.142973863	0.99601914

Solved By:
Analytic NR

Appendix J. Summarized Viscosity Data for the KT01, KT03, and KT04-Series Glasses

Table J-1. Model Predicted Viscosities with Confidence Intervals (CI) and Measured Viscosities (Fulcher Fits) at 1150 °C for the KT01, KT03 and KT04-Series Glasses by Compositional View.

Compositional View	Glass ID	Viscosity Prediction (P)	Lower CI for Prediction (P)	Upper CI for Prediction (P)	Meas. Visc. (Fulcher) (P)	Model Predictable?
measured	KT1-HA2	30.63	20.86	44.96	30.79	Yes
measured	KT1-HB	21.65	14.72	31.84	18.74	Yes
measured	KT1-HF	20.09	13.66	29.56	19.29	Yes
measured	KT1-HK	29.59	20.15	43.44	64.17	No
measured	KT1-HL	9.96	6.73	14.74	10.92	Yes
measured	KT1-HN	18.78	12.76	27.64	17.69	Yes
measured	KT1-HS	44.25	30.18	64.88	32.85	Yes
measured	KT1-LA	21.75	14.79	31.99	19.82	Yes
measured	KT1-LB	26.29	17.89	38.62	22.79	Yes
measured	KT1-LF	34.40	23.44	50.47	25.75	Yes
measured	KT1-LL	24.54	16.70	36.06	21.07	Yes
measured	KT1-LN	36.79	25.08	53.98	27.97	Yes
measured	KT1-LS	24.49	16.67	35.99	19.88	Yes
targeted	KT1-HA2	34.01	23.18	49.91	30.79	Yes
targeted	KT1-HB	20.37	13.85	29.97	18.74	Yes
targeted	KT1-HF	17.78	12.08	26.19	19.29	Yes
targeted	KT1-HK	25.09	17.08	36.87	64.17	No
targeted	KT1-HL	9.84	6.65	14.56	10.92	Yes
targeted	KT1-HN	17.41	11.82	25.64	17.69	Yes
targeted	KT1-HS	43.03	29.35	63.10	32.85	Yes
targeted	KT1-LA	21.56	14.66	31.70	19.82	Yes
targeted	KT1-LB	24.56	16.71	36.10	22.79	Yes
targeted	KT1-LF	31.64	21.56	46.45	25.75	Yes
targeted	KT1-LL	23.73	16.14	34.87	21.07	Yes
targeted	KT1-LN	33.39	22.76	49.01	27.97	Yes
targeted	KT1-LS	23.43	15.94	34.45	19.88	Yes
measured	KT03-HA	35.69	24.33	52.36	32.96	Yes
measured	KT03-HB	20.91	14.22	30.76	16.43	Yes
measured	KT03-HF	17.32	11.76	25.51	18.98	Yes
measured	KT03-HK	29.25	19.92	42.94	34.95	Yes
measured	KT03-HL	8.12	5.48	12.04	10.89	Yes
measured	KT03-HN	12.96	8.78	19.13	16.66	Yes
measured	KT03-HS	55.00	37.52	80.61	56.06	Yes
measured	KT03-LA	16.86	11.45	24.83	18.34	Yes
measured	KT03-LB	24.77	16.86	36.40	22.94	Yes
measured	KT03-LF	29.35	19.99	43.10	25.8	Yes
measured	KT03-LL	19.85	13.49	29.20	21.25	Yes
measured	KT03-LN	28.48	19.39	41.82	25.41	Yes
measured	KT03-LS	37.04	25.25	54.33	30.07	Yes
measured	KT03-MK	21.47	14.60	31.57	39.72	No
targeted	KT03-HA	35.76	24.38	52.47	32.96	Yes
targeted	KT03-HB	19.71	13.39	29.00	16.43	Yes
targeted	KT03-HF	16.58	11.26	24.43	18.98	Yes
targeted	KT03-HK	25.15	17.12	36.96	34.95	Yes
targeted	KT03-HL	8.49	5.73	12.57	10.89	Yes
targeted	KT03-HN	14.60	9.90	21.52	16.66	Yes
targeted	KT03-HS	66.53	45.40	97.50	56.06	Yes
targeted	KT03-LA	22.07	15.01	32.45	18.34	Yes
targeted	KT03-LB	24.14	16.42	35.48	22.94	Yes
targeted	KT03-LF	30.77	20.96	45.16	25.8	Yes
targeted	KT03-LL	21.69	14.75	31.90	21.25	Yes
targeted	KT03-LN	29.36	19.99	43.10	25.41	Yes
targeted	KT03-LS	37.09	25.28	54.41	30.07	Yes
targeted	KT03-MK	25.13	17.10	36.93	39.72	No
measured	KT04-01	48.92	33.37	71.72	52.94	Yes
measured	KT04-02	42.17	28.75	61.83	41.91	Yes
measured	KT04-03	36.17	24.65	53.06	30.66	Yes
measured	KT04-04	46.17	31.49	67.69	45.34	Yes

Table J-1. Model Predicted Viscosities with Confidence Intervals (CI) and Measured Viscosities (Fulcher Fits) at 1150 °C for the KT01, KT03 and KT04-Series Glasses by Compositional View. (continued)

Compositional View	Glass ID	Viscosity Prediction (P)	Lower CI for Prediction (P)	Upper CI for Prediction (P)	Meas. Visc. (Fulcher) (P)	Model Predictable?
measured	KT04-05	67.12	45.80	98.36	67.32	Yes
measured	KT04-06	63.61	43.40	93.22	66.34	Yes
measured	KT04-07	48.06	32.78	70.46	51.21	Yes
measured	KT04-08	39.55	26.97	58.01	45.69	Yes
measured	KT04-09	37.76	25.74	55.39	40.99	Yes
measured	KT04-10	41.67	28.42	61.11	44.34	Yes
targeted	KT04-01	50.58	34.51	74.15	52.94	Yes
targeted	KT04-02	45.06	30.73	66.06	41.91	Yes
targeted	KT04-03	41.22	28.10	60.45	30.66	Yes
targeted	KT04-04	47.35	32.30	69.42	45.34	Yes
targeted	KT04-05	68.04	46.43	99.71	67.32	Yes
targeted	KT04-06	72.52	49.48	106.27	66.34	Yes
targeted	KT04-07	52.90	36.09	77.53	51.21	Yes
targeted	KT04-08	43.03	29.34	63.10	45.69	Yes
targeted	KT04-09	41.69	28.43	61.14	40.99	Yes
targeted	KT04-10	41.36	28.20	60.66	44.34	Yes

Exhibit J-1. Plots of Measured Versus Predicted Viscosity Values by Series Based on Measured and Target Compositions.

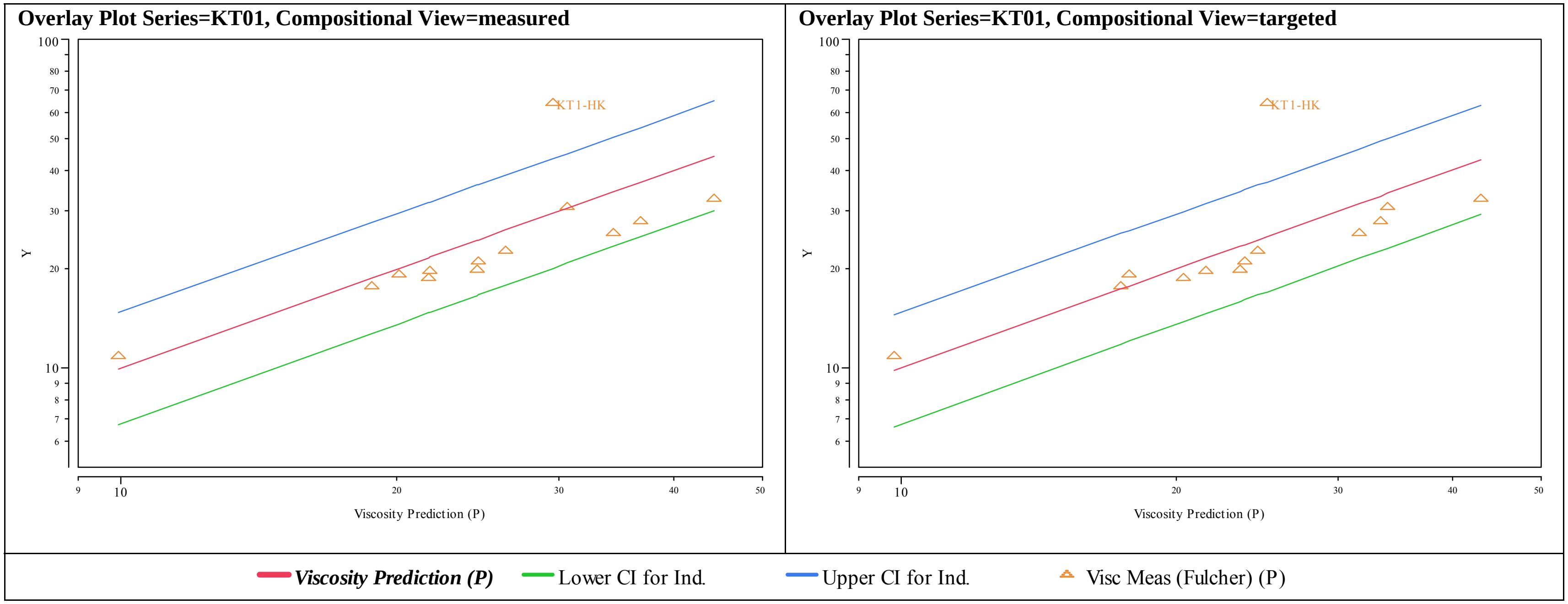
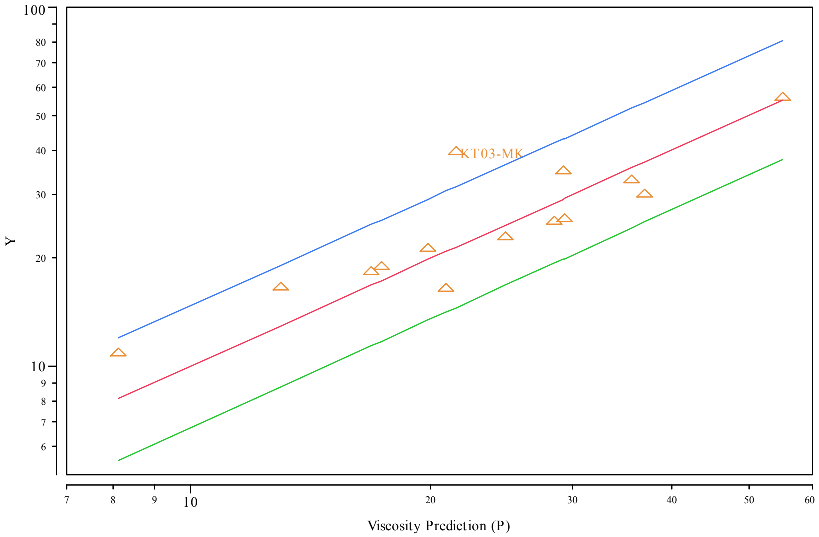
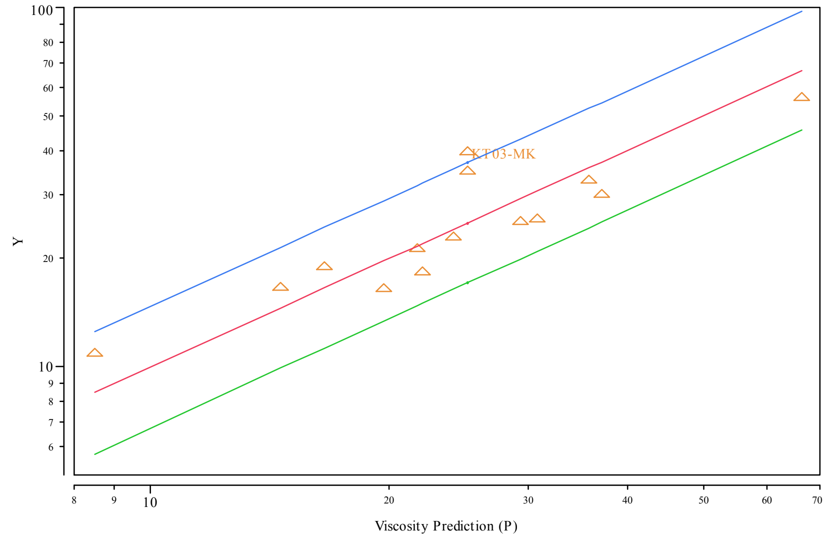


Exhibit J-1. Plots of Measured Versus Predicted Viscosity Values by Series Based on Measured and Target Compositions. (continued)

Overlay Plot Series=KT03, Compositional View=measured



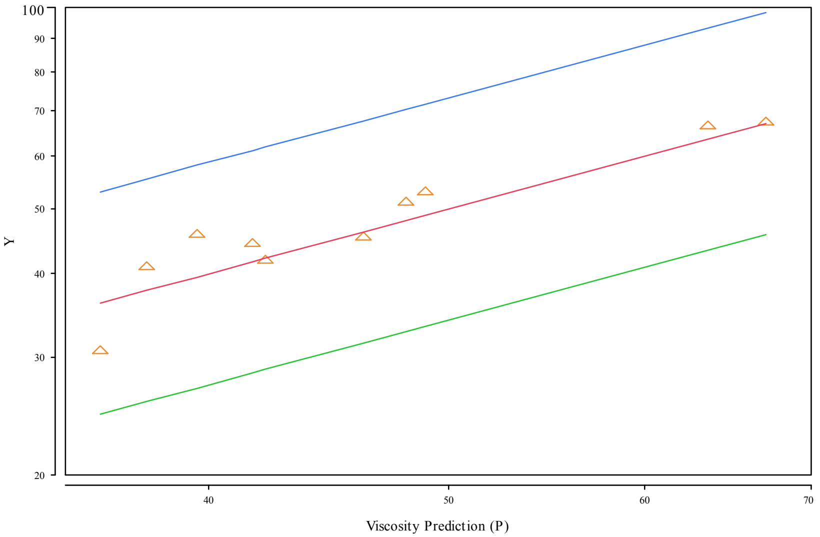
Overlay Plot Series=KT03, Compositional View=targeted



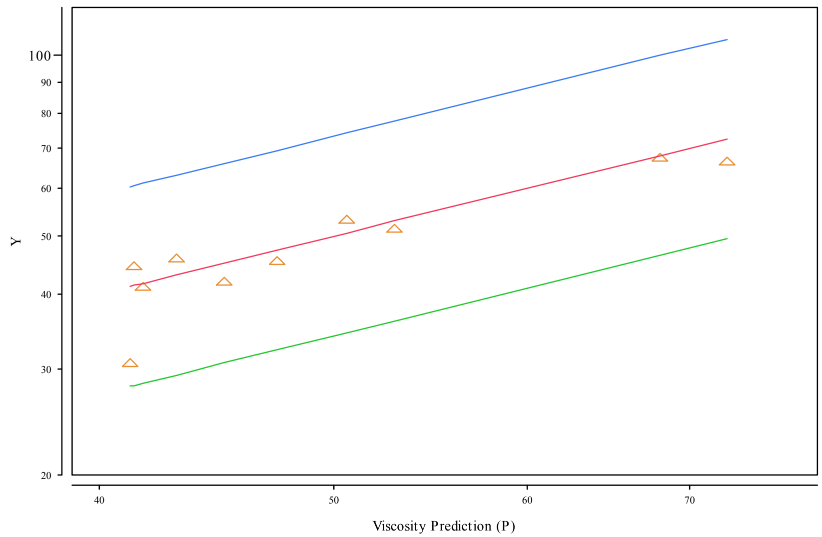
Viscosity Prediction (P) Lower CI for Ind. Upper CI for Ind. Visc Meas (Fulcher) (P)

Exhibit J-1. Plots of Measured Versus Predicted Viscosity Values by Series Based on Measured and Target Compositions. (continued)

Overlay Plot Series=KT04, Compositional View=measured



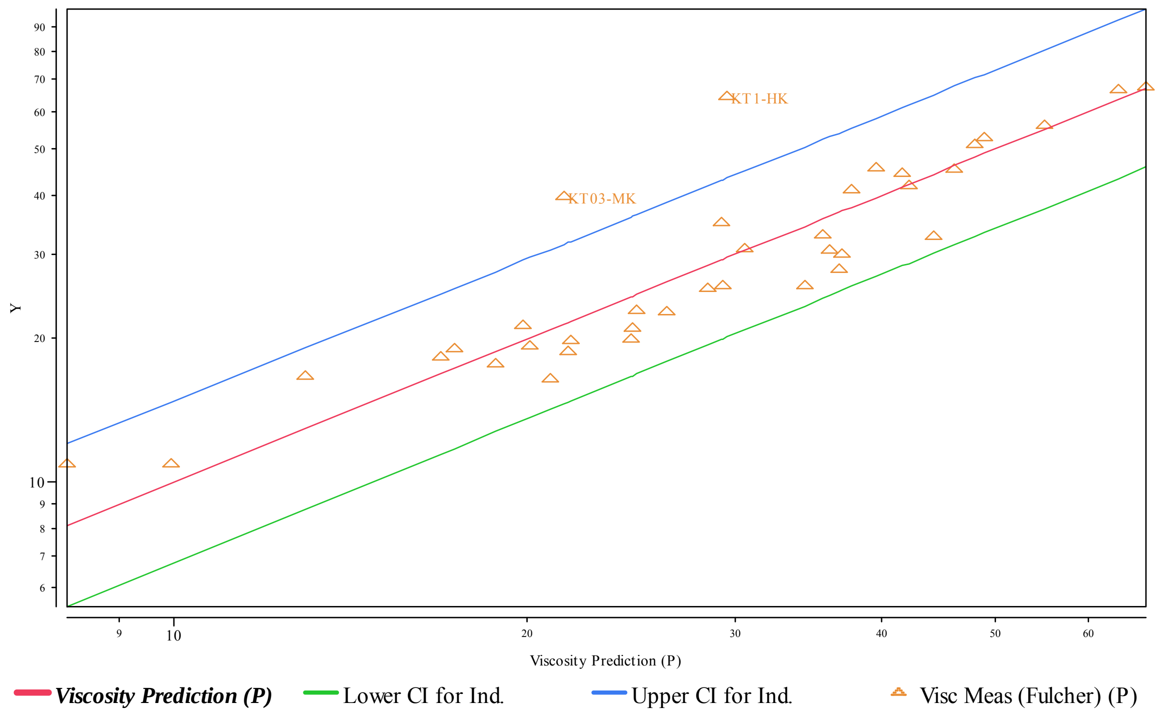
Overlay Plot Series=KT04, Compositional View=targeted



Viscosity Prediction (P) Lower CI for Ind. Upper CI for Ind. Visc Meas (Fulcher) (P)

Exhibit J-2. Plots of Measured Versus Predicted Viscosity Values for all of the KT01, KT03 and KT04-Series Glasses, Based on Measured and Target Compositions.

Overlay Plot Compositional View=measured



Overlay Plot Compositional View=targeted

Distribution:

J. W. Amoroso, 999-W
C. J. Bannochie, 773-42A
A. B. Barnes, 999-W
A. L. Billings, 999-W
J. M. Bricker, 704-27S
M. A. Broome, 704-29S
C. L. Crawford, 773-42A
D. A. Crowley, 773-43A
R. E. Edwards, 766-H
T. B. Edwards, 999-W
T. L. Fellinger, 704-26S
S. D. Fink, 773-A
K. M. Fox, 999-W
B. J. Giddings, 786-5A
J. M. Gillam, 766-H
B. A. Hamm, 766-H
C. C. Herman, 999-W
D. T. Herman, 735-11A
R. N. Hinds, 704-S
E. W. Holtzscheiter, 704-15S
T. H. Huff, 766-H
J. F. Iaukea, 704-30S
C. M. Jantzen, 773-A
F. C. Johnson, 999-W
D. C. Koopman, 999-W
D. D. Larsen, 766-H
P. L. Lee, 703-41A
S. L. Marra, 773-A
D. H. Miller, 999-W
J. E. Occhipinti, 704-S
D. K. Peeler, 999-W
F. M. Pennebaker, 773-42A
J. W. Ray, 704-S
M. A. Rios-Armstrong, 766-H
H. B. Shah, 766-H
D. C. Sherburne, 704-S
A. V. Staub, 704-27S
M. E. Stone, 999-W
J. P. Vaughan, 773-41A