Contract No:

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Utilization of SRNL-developed Radiation-resistant Polymer in High Radiation Environments

Objective

The radiation-resistant polymer developed by the Savannah River National Laboratory is adaptable for multiple applications to enhance polymer endurance and effectiveness in radiation environments. SRNL offers to collaborate with TEPCO in evaluation, testing, and utilization of SRNL's radiation-resistant polymer in the D&D of the Fukushima Daiichi NPS. Refinement of the scope and associated costs will be conducted in consultation with TECPO.

Problem

Standard polymers used in radiation environments degrade over time, incurring the risks and costs of replacement. The radiation-resistant polymer developed by SRNL resists degradation, providing increased endurance, safety, and cost avoidance over time.

Technology

SRNL has developed a polymer using either polyvinyl alcohol (PVA) as a sacrificial coatable material or single extrude polyethylene doped with various additives that is significantly more radiation-resistant than standard polymers used in radiation environments.

In one application, SRNL has bound the radiation-resistant polymer to commercially available linear low-density polyethylene (LLDPE) radiological waste bags, allowing significantly increased tolerance to alpha-particle-absorbed dose as compared to the standard LLDPE. This increase in absorbed dose tolerance also has shown to result in dramatically increased residence time of the polymer in high radiation environments, for an effective 13X increase in absorbed dose. These materials have shown to greatly slow degradation rates as compared to commercially available LLDPE nuclear materials disposal bags. In another application, SRNL has developed and tested several additives that can be used in the commercial extrusion process for LLDPE bags. The new polymer bags exhibit alpha/beta/gamma degradation resistance.

Currently, radiological waste bags are not resistant to breakdown by radiation (left). Adding a polymer layer with embedded radiation-resistant particles prolongs the bags' function (right).

SRNL's radiation-resistant polymer is adaptable for multiple applications in radiation environments, such as fixatives or coatings. It also may be impregnated with a substance that provides visual indication of the stage of radiation absorption of the polymer.

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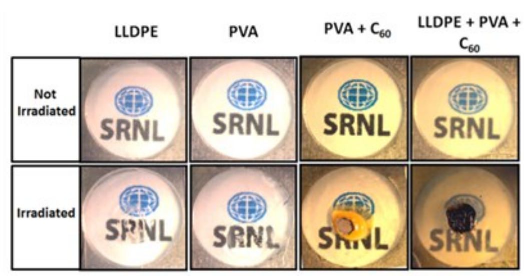

Sample	Sample thickness (μm)	Average time to failure in accelerator (min)	Average α-particle dose absorbed (rad/s)
LLDPE sheet	150 ± 10	16.5	2.92×10^{9}
PVA	150 ± 10	18.1	3.21×10^{9}
PVA doped with C_{60}	150 ± 10	123.2	2.18×10^{10}
PVA doped with C_{60} on LLDPE sheet	300 ± 20	217.5	3.85×10^{10}

Commercial LLDPE vs PVA, C60-Doped PVA, and LLDPE+ C60-Doped PVA exposure and dose absorbance data under experimental conditions.

Polymer C60 nanocomposite films manufactured into nuclear materials disposal containers with greatly increased resistance to alpha radiation