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# MAX phase materials and MXenes as hydrogen barrier coatings

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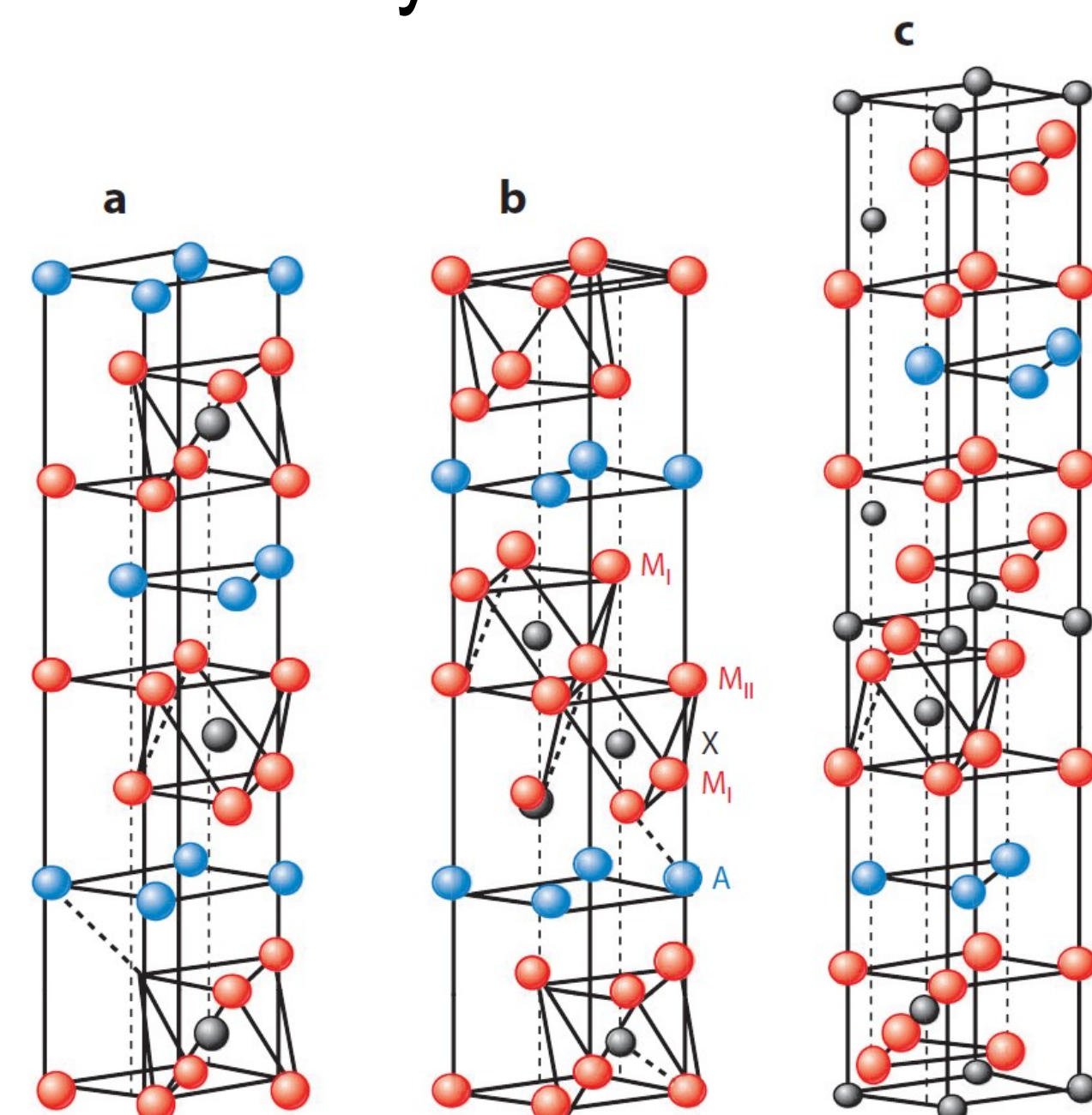
## Introduction

- Most structural alloys used in neutron environments display high diffusivities of hydrogen and its isotopes.
- Permeation barriers are a key supporting technology for both next generation fusion reactors and the national security enterprise
- Previous research suggests that most barrier materials which perform well in laboratory experiments fail when placed in radiation environments.

## Methods

MAX phase materials

- A class of layered carbides and nitrides
- currently being investigated for fission applications
- excellent stability under neutron irradiation



**Figure 1** MAX phase unit cells: (a) 211, (b) 312, and (c) 413 phases.<sup>1</sup>

## Acknowledgement

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## Develop hydrogen isotope permeation barriers suitable for neutron irradiation environments based on MAX phase materials.

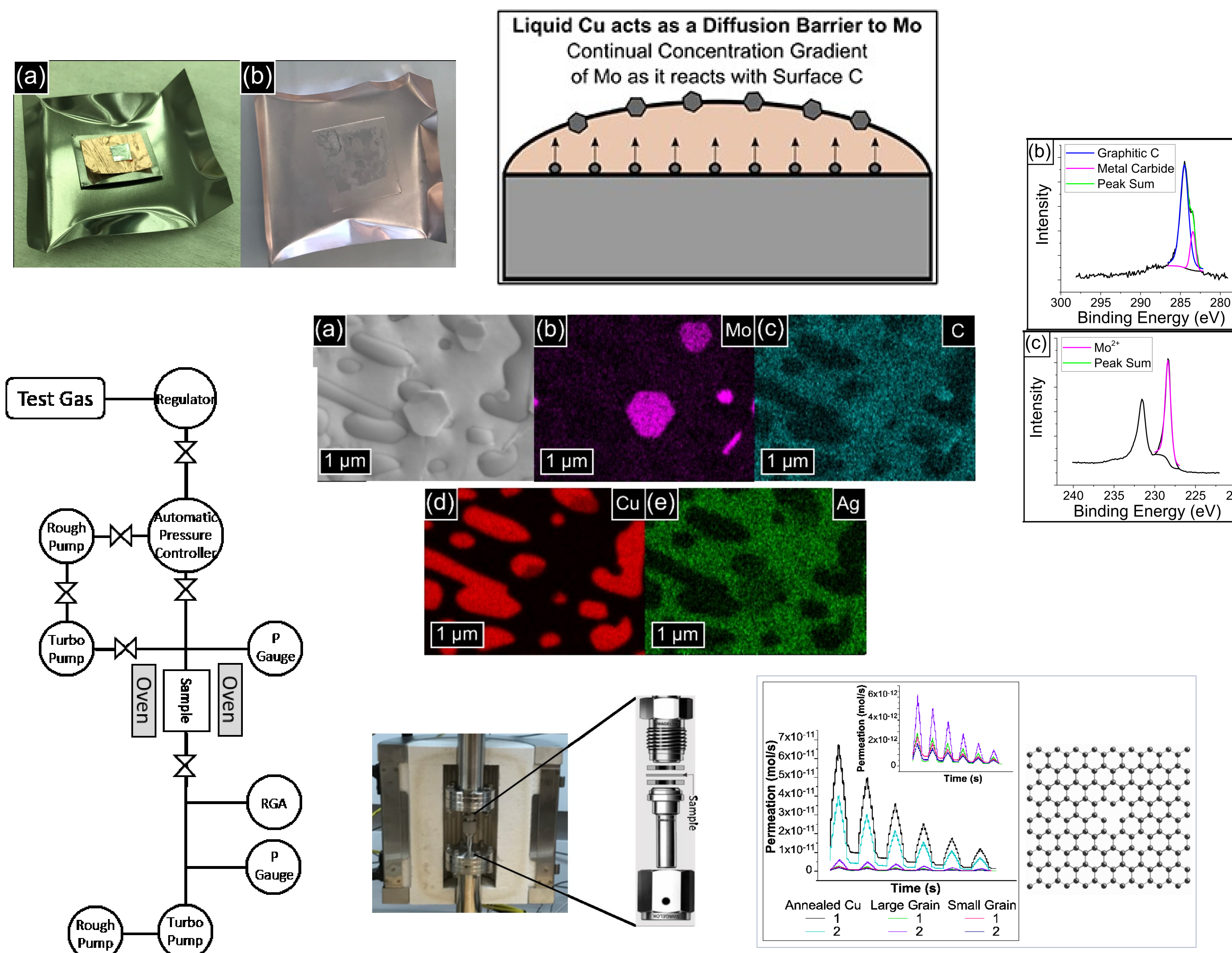
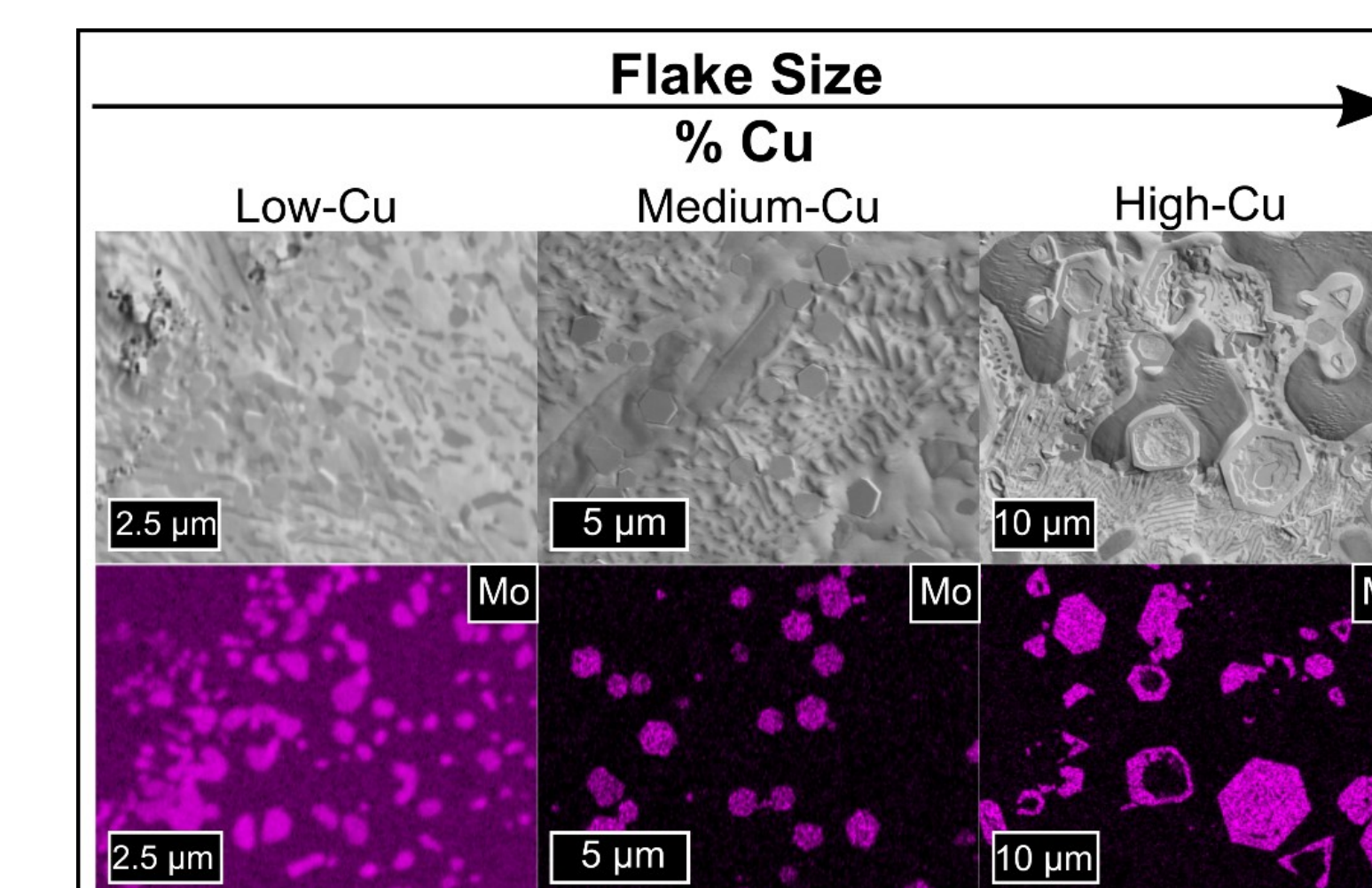


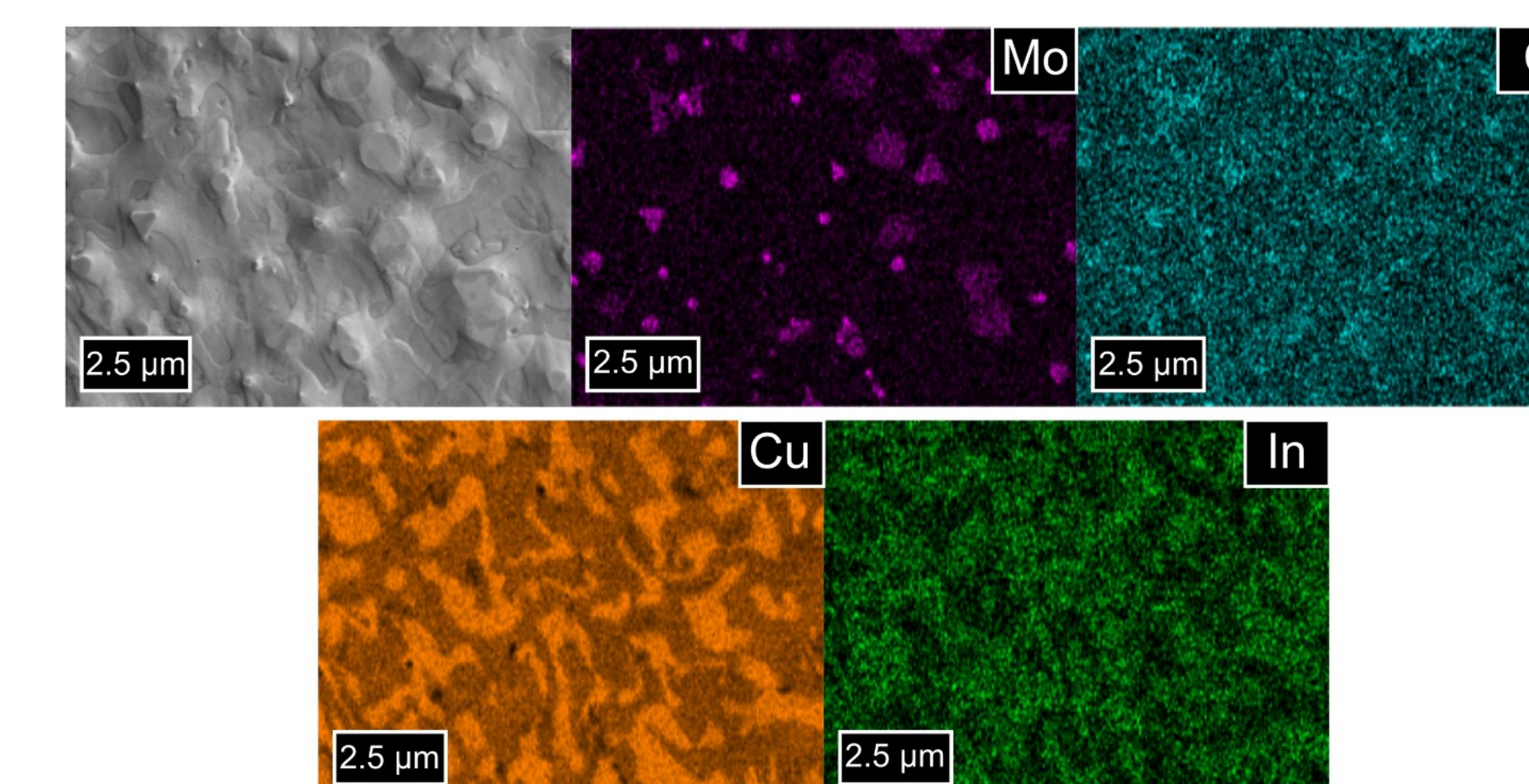
Figure 3 a) Raw permeation data measured on Cu and graphene coated Cu and b) C vacancy in a graphene lattice

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## Results



**Figure 2:** SEM images and EDS maps comparing the Mo<sub>2</sub>C flake sizes on Low-, Medium-, and High-Cu, Ag-Cu alloys grown at 1000 °C.



**Figure 3:** Mo<sub>2</sub>C synthesis on an In-Cu alloy substrate at 800 °C.



**Figure 4:** Comparison of the permeation data between the annealed Cu and graphene coated Cu. The PRF at 624 K is ~28