Controlled-environment Preparation Hub for Cryo-Atom Probe Tomography

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Abstract: Three-dimensional atomic-scale materials analyses by atom-probe tomography (APT) of liquid, reactive, or heat sensitive materials require preparation and transfer of samples in a controlled inert-gas, vacuum, and/or cryogenic environment. With support from ARO-DURIP and ONR-DURIP equipment grants, we are implementing a versatile specimen preparation and specimen transfer hub permitting multi-modal specimen preparation workflows, which include a dedicated inert-gas glove box with cryo-wells and ports for cryo-vacuum specimen transfer to compatible characterization and processing systems, e.g., cryo-FIB/SEM, cryo-APT, with extensibility to, e.g., correlated-light and electron microscopy (CLEM). Our system will be available for imaging and analyses of different material types and research fields, including thin-films and electronic materials: hydrogen embrittlement and corrosion, frozen-hydrated specimens, Li-ion electrodes and electrolytic materials or catalytic nanoparticles, to name a few. Specifically, cryo-APT is expected to reveal local compositions and nanostructures at an atomic or molecular levels in electrochemical reactions, where freezing samples arrests ions, which are highly mobile, or where reactions progress rapidly at ambient conditions, or in an aqueous environment. We will discuss basic principles, the required instrumentation and possibilities for implementation available, as well as current and future applications of cryo-APT.

Biographical Sketch:

Dr. Dieter Isheim is a research associate professor of materials science and engineering at Northwestern University and has been managing the Northwestern University Center for Atom-Probe Tomography (NUCAPT) since its founding in 2004. After receiving a doctorate in physics and physical metallurgy from the University of Göttingen, Germany, in 1995, he joined Northwestern University for postdoctoral studies in 1996 and was reappointed at Northwestern in the rank of research faculty in 2002. Dr. Isheim received the Champion H. Mathewson Award of the Mineral, Metals & Materials Society in 2016. Dr. Isheim's research interests include phase transformations in solids, structure and local composition of interfaces in materials, and structure-properties relationships of nano-structured materials. He specializes in high-resolution atomic-scale materials characterization and analysis, with a focus on atom-probe tomography, and has published more than 150 research papers.