Materials Science & Engineering Seminar Series

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presents

Understanding structure-property relationships of materials using atom probe tomography and correlative microscopy

Dr. Arun Devaraj
Physical and Computational Sciences Directorate,
Pacific Northwest National Laboratory, Richland, WA, USA, 99354

ABSTRACT: Understanding the structure-property relationships in materials is crucial for developing new materials with improved performance criteria for a variety of engineering applications. Driven by the demand for new materials, new microstructural characterization methods are being devised and existing microscopy methods are entering new frontiers on a continuous basis. In this talk, a few specific examples will be presented of discovering structure-property relationships using advanced characterization methods such as atom probe tomography (APT) and electron microscopy for nanocomposite soft magnetic materials, advanced lightweight vehicle structural materials, and high performance energy materials. Nanocomposite soft magnetic materials exhibit high magnetization and low coercivity for applications in power electronics, motors, and sensors. Results of linking local composition measurements of annealed nanocomposites from APT with observed magnetic properties of the material structure will be presented [1]. In the field of advanced lightweight vehicle structural materials, which are of significant interest to the U.S. Department of Energy (DOE), an example of a new low cost nanostructured beta titanium alloy (Ti-1Al-8V-5Fe) will be presented, where multiscale characterization by scanning electron microscopy (SEM), transmission electron microscopy (TEM), and APT helped correlate excellent tensile properties with the unique hierarchical nanostructure of the alloy [2]. Advanced energy materials, specifically high voltage and high capacity electrode materials for Li-ion batteries, are also of significant interest to DOE. To develop new batteries with improved performance, it is very important to correlate the electrochemical performance of battery materials with their nanostructure, which in turn can be influenced by the synthesis methods and by electrochemical cycling. Results of a multimodal chemical imaging approach using APT and scanning TEM–energy-dispersive x-ray spectroscopy that provides new insights on capacity decay mechanisms will also be presented [3]. Together these examples will highlight the role of advanced microstructural characterization in enhancing design of new materials for many different critical engineering applications.

BIOGRAPHY: Dr. Arun Devaraj is a senior research scientist in the Physical and Computational Sciences Directorate of Pacific Northwest National Laboratory. He received his Ph.D. in Material Science and Engineering from the University of North Texas in 2011. Before his graduate studies he worked as a process R&D engineer at an integrated steel plant, Essar Steel Ltd., Surat, India. He completed his undergraduate degree in Metallurgical Engineering at Malaviya National Institute of Technology, Jaipur, India. His research interest is in understanding microstructure-property relationships in a variety of materials including automotive structural materials, magnetic materials, energy materials, nuclear materials, and natural biomaterials using APT, in addition to correlating with SEM, FIB, TEM, x-ray spectroscopy, and x-ray diffraction at various DOE synchrotron facilities. Dr. Devaraj has more than 40 publications and has been the lead organizer of APT focus topic sessions at American Vacuum Society national meetings and serving as leader in the Microscopy Society of America Atom Probe Focused Interest Group.

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