Materials characterization for a new millennium: spectrum-imaging with automated analysis

Ian M. Anderson
Metals & Ceramics Division
Oak Ridge National Laboratory, Oak Ridge TN

Spectrum-imaging – where a full spectrum is acquired at each pixel in a two-dimensional array – provides a method for chemical characterization of a microstructure in a comprehensive fashion. However, spectrum-images are typically large raw data files: tens of megabytes today and potentially gigabytes in the near future. In order to access the advantages of spectrum-imaging, effective "data mining" methods must be developed to extract the relevant information – typically a fraction of a megabyte – from these large raw data files. This talk will describe a method under development at Oak Ridge National Laboratory that provides robust, objective and quantitative analysis of these large data files. The results of the analysis are an RGB image of the specimen, which identifies all chemically distinct features of the microstructure by a different color, plus the spectra that correspond to these microstructural features. These results are extracted without any a priori input, eliminating operator bias; ongoing research efforts focus on displaying the RGB image and corresponding spectra automatically following spectrum image acquisition. Applications will be presented that illustrate the versatility of the analysis method, including low-voltage energy-dispersive X-ray spectrometry (LV-EDS) of semiconductors, atom location by channeling-enhanced microanalysis (ALCHEMI) of ordered intermetallics, electron energy-loss (EELS) spectrum profiles of intergranular films in silicon nitride, and scanning transmission X-ray microscopy (STXM) of multiphase polymers.

Research at the Oak Ridge National Laboratory SHaRE User Facility was sponsored by the Division of Materials Sciences, U.S. Department of Energy, under contract DE-AC05-96OR22464 with Lockheed Martin Energy Research Corporation.