Materials Science & Engineering Seminar Series

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A Robust Approach to Handling "Difficult" EBSD Data Sets

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ABSTRACT: Electron back-scatter diffraction (EBSD) is a mature characterization technique that is used extensively in both the materials and geological communities; over the past two decades or so, it has also become one of the core competencies of our MSE department. In this seminar, we will begin by illustrating how the conventional EBSD indexing approach works, and we will illustrate common situations in which the indexing quality leaves much to be desired. Then we describe a physics-based "forward model" that allows us to predict EBSD patterns with substantial accuracy. The availability of such a model leads to a new pattern indexing technique known as "Dictionary Indexing," in which a library (dictionary) of patterns is pre-computed for a uniform sampling of orientation space. Using a numerically efficient similarity metric, the dictionary patterns can then be compared with experimental patterns, and the orientation of the best-matching dictionary pattern is then assigned to the experimental pattern, thereby effectively indexing the pattern without the need for feature extraction. We will show that this leads to a robust indexing technique, capable of handling patterns with low signal-to-noise ratio as well as overlapping patterns near grain and phase boundaries. The most recent implementation of this approach can handle very large data sets, and we illustrate the general capabilities of the technique using a number of examples of increasing size and complexity, culminating in the analysis of a superalloy serial sectioning data set of 117 million EBSD patterns. We will conclude this presentation with a brief description of how this approach can be used for other electron diffraction modalities.

BIOGRAPHY: Professor DeGraef received his BS and MS degrees in physics from the University of Antwerp (Belgium) in 1983, and his Ph.D. in physics from the Catholic University of Leuven (Belgium) in 1989, with a thesis on copper-based shape memory alloys. He then spent three and a half years as a post-doctoral researcher in the Materials Department at the University of California at Santa Barbara before joining Carnegie Mellon in 1993 as an assistant professor. He is currently professor and co-director of the J. Earle and Mary Roberts Materials Characterization Laboratory. Professor DeGraef's research interests lie in the area of microstructural characterization of structural intermetallics and magnetic materials. His current focus is on the development of experimental and modeling techniques for the quantitative study of magnetic domain configurations in a variety of materials, including ferromagnetic shape memory alloys, magnetic thin films, and patterned structures. This study includes a theoretical analysis of the use of shape functions in the computation of shape-dependent material properties. A second research focus is on the acquisition and representation of the three-dimensional character of microstructures. Work in this area includes development of experimental and numerical techniques to extract quantitative3-D data from serial sectioning experiments using a focused ion beam. The generation of accurate forward models for many different characterization modalities is also a topic of current interest.

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