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Integrated Electron Backscatter Diffraction and X-Ray Energy Dispersive Spectroscopy in the Scanning Electron Microscope

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X-Ray Energy Dispersive Spectroscopy (XEDS) is a well-established technique for characterizing the chemical composition of materials. Electron Backscatter Diffraction (EBSD) is becoming relatively common as well in materials science characterization facilities. EBSD is helpful for identifying phases [1-2] and spatial mapping of crystallographic orientation in polycrystals [3]. Combining XEDS with EBSD improves both phase identification as well as the orientation mapping.

The combination of XEDS and EBSD for phase identification is well documented. Combining the chemical composition information provided by XEDS with the crystallographic structure information derived for EBSD patterns enables phases to be identified at SEM resolutions. The limiting factor in the resolution is the interaction volume for X-Rays. The general procedure is to first locate the beam on a specific feature of interest in the microstructure. Second, obtain an XEDS spectrum and identify the elements present from the spectrum. These elements are then used as a filter on a crystallographic database to select a set of candidate phases. An EBSD pattern is then obtained and crystallographic information extracted from the pattern. This is used as a second level filter to further pare down the list of candidate phases. This is often enough to uniquely identify the phase.

Less utilized is the simultaneous collection of XEDS data during a typical automated EBSD scan. Integrating XEDS data with EBSD data provides a means for studying the effects of local texture on local variations in chemical composition as well as the converse – the role chemistry plays in texture evolution. Combing XEDS with EBSD can also provide a dramatic improvement in the reliability of the orientation mapping results in materials with multiple phases [4]. One of the key elements to orientation mapping of multiphase materials is the ability to differentiate between phases. This is fairly reliable between phases with dissimilar structure, e.g. the alpha and beta phases in titanium, which are hexagonal and alpha respectively. However, when the phases are similar in structure – as in alpha Titanium, which is hexagonal, and Alumina, which is trigonal –reliably differentiating the phases from individual EBSD patterns is difficult. Without being able to reliably differentiate between the phases, the orientation results are compromised. However, by using the chemistry as a filter prior to the EBSD analysis enables the phases to be differentiated relatively easily. The general procedure is to simultaneously collect XEDS and EBSD data, extract the critical parameters from these data and record these parameters to file. This procedure is followed for each point in the scan. After the data is collected, the EDS data can be used to identify the potential phase or phases at each point and the indexing of the EBSD pattern performed using the recorded data. This can be done in an automated fashion using cluster analysis

[1] B. L. Adams, S. I. Wright and K. Kunze, Met. Trans. 24 (1993) 819.
[2] J. R. Michael and R. P. Goehner, MSA Bulletin 23 (1993) 168.
[3] J.R. Michael, Electron Backscatter Diffraction in Materials Science. Eds. A. J. Schwartz, M. Kumar and B. L. Adams. Kluwer Academic/Plenum Publishers, New York (2000) 75.
[4] M. M. Nowell and S. I. Wright, J. Microscopy 213 (2004) 296.

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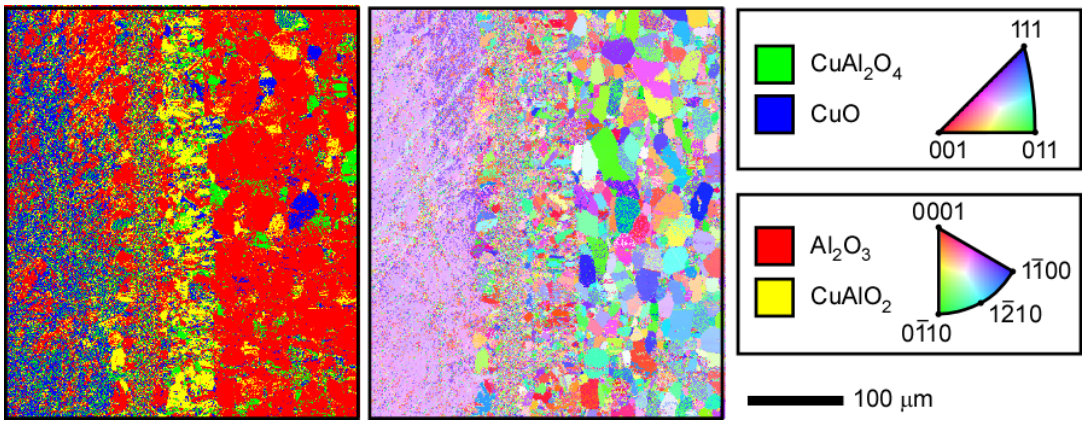

FIG. 1. Phase and orientation map generated from automated EBSD measurements. The phases are determined by automated inspection of the patterns during an automated EBSD scan. The sample is a reaction zone between alumina and copper oxide.

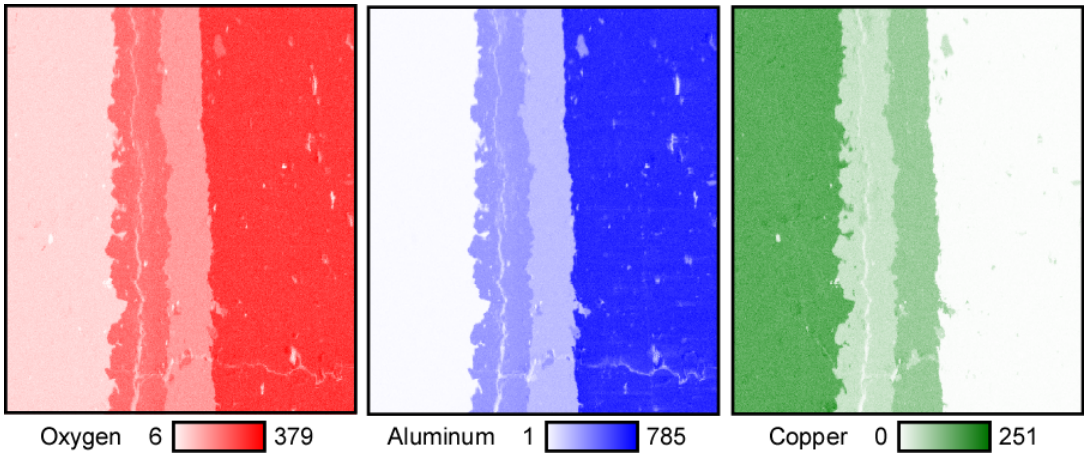

FIG. 2. Elemental maps generated from XEDS measurements obtained simultaneously with the EBSD measurements shown in figure 1.

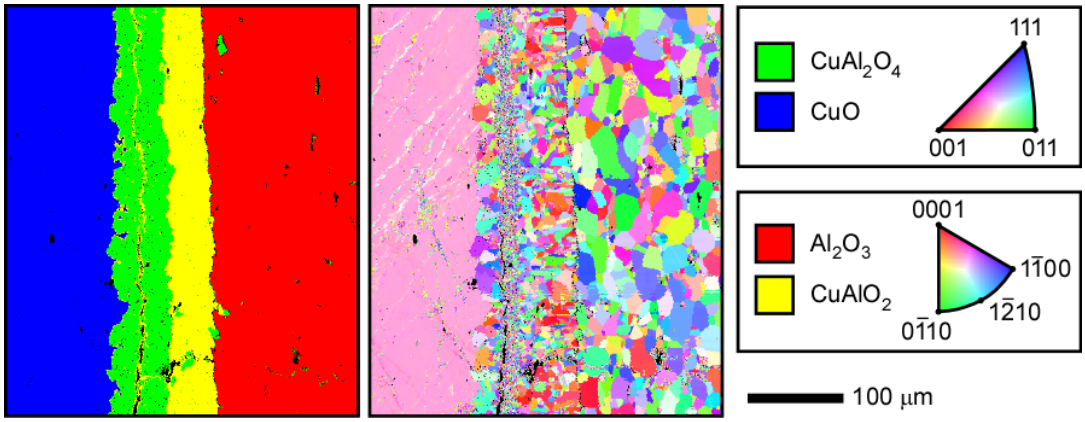

FIG. 3. Phase map and orientation maps generated from the combined XEDS/EBSD measurements. The XEDS data is used as a filter prior to indexing the EBSD pattern data. A phase or phases are assigned to each cluster found using cluster analysis. If multiple phases are assigned to a given cluster, EBSD is used for further phase differentiation among the constituent points of the cluster.

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