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MONTE CARLO SIMULATION OF SPATIAL RESOLUTION FOR ELECTRON BACKSCATTERED DIFFRACTION (EBSD) WITH APPLICATION TO TWO-PHASE MATERIALS

S. X. Ren, E. A. Kenik, and K. B. Alexander

Metals and Ceramics Division, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831

The study of texture and grain boundary misorientation in multiphase materials has been greatly benefited from the recent automation of the electron back-scattered diffraction (EBSD) technique[1]. With this technique, each phase in a multiphase material can be individually sampled and analyzed. This is of great significance and interest in the study of thin films, inclusions and multiphase alloys. Spatial resolution, which depends on experimental conditions such as beam energy and specimen tilt, and the material being studied, is critical in order to determine the orientation of different phases in multiphase materials.

The Monte Carlo (MC) method has been effectively used to investigate spatial resolution in single phase materials[2]. In this paper, the MC simulation is modified and applied to two-phase geometries. For a bulk two phase (Al/Au) specimen, the coordinate system was defined such that the x-axis was normal to the electron beam and the interface, y-axis parallel to the interface and coplanar to the beam direction, and z-axis perpendicular to the specimen surface which was tilted 70^0, as shown in Fig. 1. By moving the beam across the interface, the backscattered electron (BSE) yield was calculated and plotted in Fig. 2, in which the BSE signals exiting from both phases extended -600 nm from the interface for the Al and +300 nm from the Au. Furthermore, the simulated BSE trajectories observed from the y-direction with the beam impinging at three selected points (a)-100 nm (in Al), (b)+100 nm (in Au) and (c)+200 nm from the interface are plotted in Fig. 3. Obviously, the BSE penetrated much deeper and wider in the Al than in the Au before they escaped from the surface, indicating the spatial resolution was higher for the Au. To quantitatively determine the spatial resolution for comparison to experimental measurements, careful consideration of some other experimental conditions such as detector energy sensitivity, BSE energy and spatial distribution etc. is required as well[2].

The MC model was also applied to a 750 nm thick Au film on a SiO_2 substrate. BSE trajectories observed from the x-direction for Au/SiO_2 with a beam accelerated at (a) 20 keV and (b) 10 keV are plotted in Fig. 4. At 20 keV, both the Au film and SiO_2 substrate contributed to the BSE generation, whereas at 10 keV BSE were only from the Au film alone. By selecting an appropriate accelerating voltage using MC technique, it is possible to ensure that BSE arises only from the area of interest. On the other hand, compromises will be involved in achieving both high quality EBSD patterns and high spatial resolution.

References

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2. S.X. Ren et al., submitted to *Microscopy and Microanalysis*, March 1997.
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