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Fabrication and Characterization of Nanostructured CuAg (Ag-40at%Cu)

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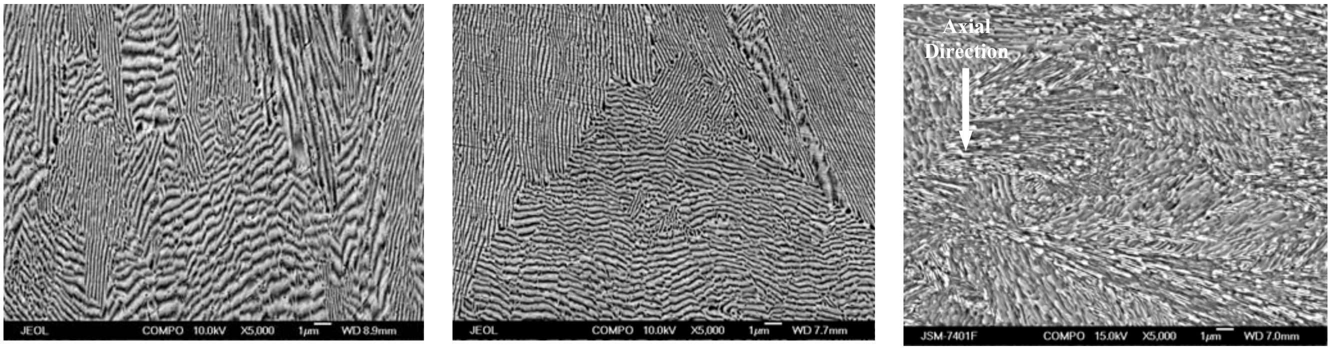
The demanding scientific research requires that magnets are stronger and larger than those currently in use. However, the efficiency and operations of the magnets are hindered by various limitations. One of the limitations is the performance of the conductor materials in the magnets [1]. Micro-composite conductors have the potential to break this limitation. One of such micro-composites is Cu-Ag, which has the potential to provide nanostructured composite by both casting and deformations [2]. This research is to investigate the evolution of microstructure and texture in a eutectic Cu-Ag.

The nominal composition of the composite used in this investigation is Ag-40at%Cu. The ingots were obtained as cast or directional solidified via a flux-melting technique. The ingots were then cold deformed by equal channel angular extrusion (ECAE), swaging and drawing in order to refine the microstructures. The accumulated strain was 2 ($\varepsilon = 2$) for the ECAE deformed samples and was 2.8 for swaged and drawn samples. Samples were sectioned in both cross-section and longitudinal directions at various strains throughout the forming process. The sectioned CuAg samples were polished, etched and examined with a JSM7401F Field Emission Scanning Electron Microscopy (FESEM).

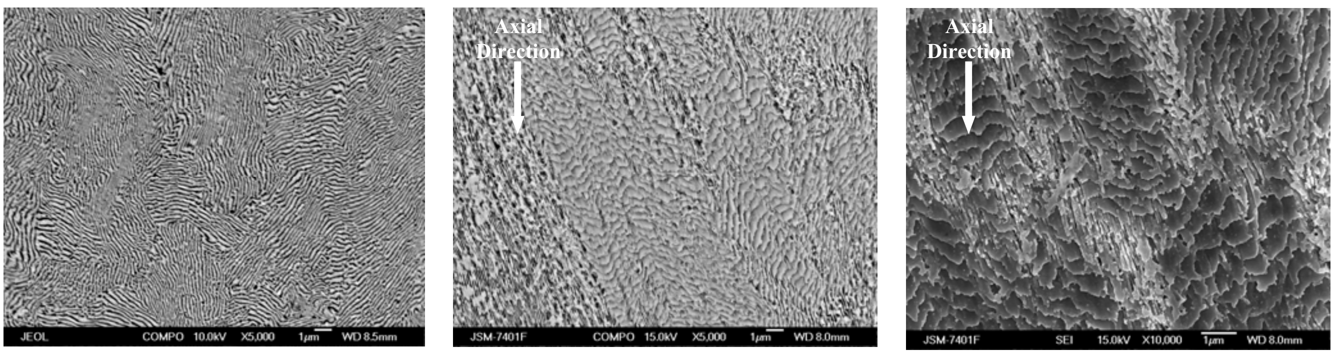
Figure 1 compares the microstructure of the composites fabricated by (a) casting and (b) directional solidification. Directional solidification appears to produce more refined and homogeneous microstructure than that produced by casting. In some of the areas, the directional solidification indeed produces textures in the materials. Such textures introduce anisotropic mechanical and physical properties to the composites. The cross-section image of EACE sample presented in figure 2a shows that deformation produces finer microstructure when compared to either directional solidified (Fig. 1b) or cast samples (Fig. 1a). Furthermore, EACE appears to introduce local orientation changes within a nodular, as shown in Figure 2c in a large magnification image. However, swaging and drawing refine the microstructure in a much efficient manner than EACE, if one compares figures 2 and 3. The material shown in figure 3a was swaged to a strain of 1.2, which is smaller than that in the sample shown in figure 2. Swaging achieves finer structure than EACE if the samples are examined in a longitudinal direction. Drawing refines the microstructure to a nanoscale, as demonstrated in Figures 3 b&c.

References:
[1] K. Han et al., Material Science and Engineering, A267, (1999) 99-114.
[2] K. Han, A. A. Vasquez, Y. Xin, and P.N. Kalu, Acta Materiala, 51, 767-780 (2003)



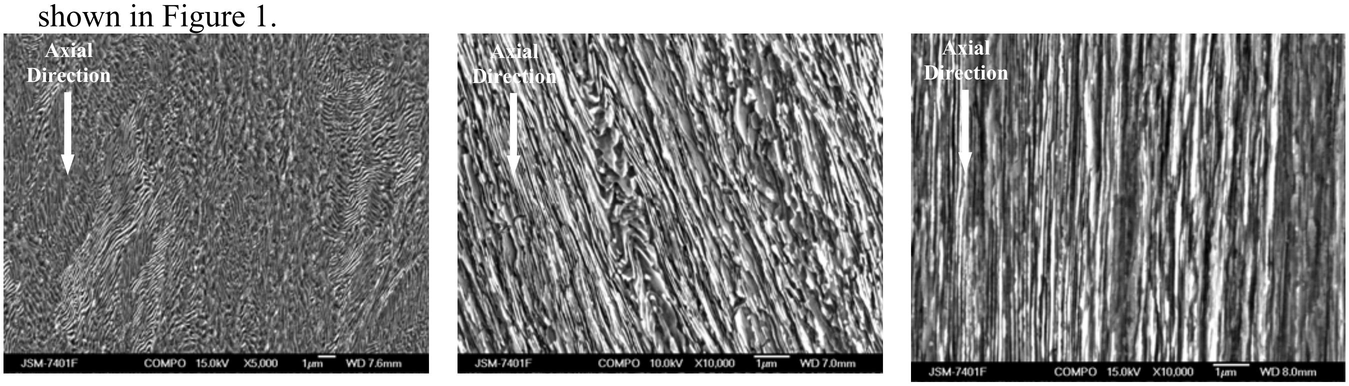
a. b. c.

Figure 1: SEM images of the composites solidified by different techniques: (a) cross-section image of cast sample; (b) cross-section image of directional solidified sample and (c) longitudinal image of directional solidified sample. The images have same magnification and demonstrate that the directional solidified sample produces finer microstructure.



a. b. c.

Figure 2: SEM images of the composites deformed by EACE to a strain of 2: (a) cross-section image; (b) longitudinal direction image and (c) longitudinal direction image in a large magnification. The images of Figures 2(a) and 2(b) have the same magnification as those shown in Figure 1.



a. b. c.

Figure 3: SEM images of the composites deformed by different techniques: (a) longitudinal direction image of cast sample swaged to a strain of 1.2. The images are in a same magnification as shown in Figure 1.

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