doi:10.1017/S1431927610054450
Microsc. Microanal. 16 (Suppl 2), 2010

Application of Ion Cross Section Polishing: Comparison with Abrasive Polishing

Byungmin Ahn* and Steven R. Nutt*

*Department of Chemical Engineering and Materials Science, University of Southern California, Los Angeles, CA 90089-0241

The cross-sectional ion polishing method utilizes a low voltage Ar ion beam (< 5kV) to polish and etch materials, eliminating the need for mechanical polishing. The ion-polished surface enables unambiguous SEM observation of microstructure, defects, and voids which are not obscured by artifacts often present in sections prepared by abrasive polishing. In this study, applications of the ion polishing technique are presented and compared with sections prepared by abrasive polishing.

Figure 1 shows SE micrographs of a two-phase Zn-22%Al eutectoid alloy processed by high pressure torsion, one of the severe plastic deformation techniques to produce ultrafine grained microstructure. Generally, TEM is used to investigate ultrafine grain structures, whereas SEM is usually not appropriate for revealing grain boundaries because of the surface strains introduced by abrasive polishing methods. In practice, however, TEM imaging typically provides a limited field of view within the material, and thus extensive observations are required to provide an accurate evaluation of the global microstructure. In contrast, ion-polished surfaces provide a clear view of the global microstructure, including grain boundaries and phase boundaries with enhanced orientation contrast, as shown in Fig. 1, a comparison of abrasive-polished and ion-polished sections [1].

Figure 2 shows LV-BSE micrographs of an uncoated cross section of a glass fiber-epoxy composite. The sample was subjected to fatigue loading prior to sectioning to detect and identify the nature of defects and damage. As shown in Fig. 2(a), abrasive polishing causes severe cracking of the brittle glass fibers, and there is noticeable surface relief as a result of matrix recession. Fine features in the matrix, such as cracks and voids, are poorly resolved because of apparent smearing. In contrast, the ion-polished section preserves the glass fibers, reveals fine details of crack path and branching, as well as matrix porosity (Fig. 2(b)).

Figure 3 shows LV-BSE micrographs of an uncoated cross section of a fiber-reinforced hybrid syntactic foam containing heat-expandable PVC and glass microspheres. The porous structure is inherently delicate, and includes multiple components of disparate hardnesses and polishing characteristics [2]. Conventional abrasive polishing methods yielded little microstructural information, as shown in Fig. 3(a). The microsphere structures were severely damaged and distorted by abrasive polishing, and microstructural analysis was not possible. However, the ion-polished cross section in Fig. 3(b) clearly reveals details of the foam structure. The polymer and glass microspheres (round) and the fibers are clearly visible, and some slumping of the polymer microspheres has occurred because of overheating during foam expansion. Broad beam ion polishing preserves microstructural integrity and is a useful alternative to abrasive polishing, particularly when working with delicate structure, such as porous materials or composite materials with components of disparate polishing characteristics.

Reference

[1] M. Kawasaki, B. Ahn and T.G. Langdon, *Acta Mater.* 58 (2010) 919.
[2] Y-J. Huang, C-H. Wang, Y-L. Huang, G. Guo and S.R. Nutt, *Polym. Compos.* 31 (2010) 256.
[3] The authors are grateful to JEOL USA, Inc. for providing access to the SM-09010 cross-section polisher.

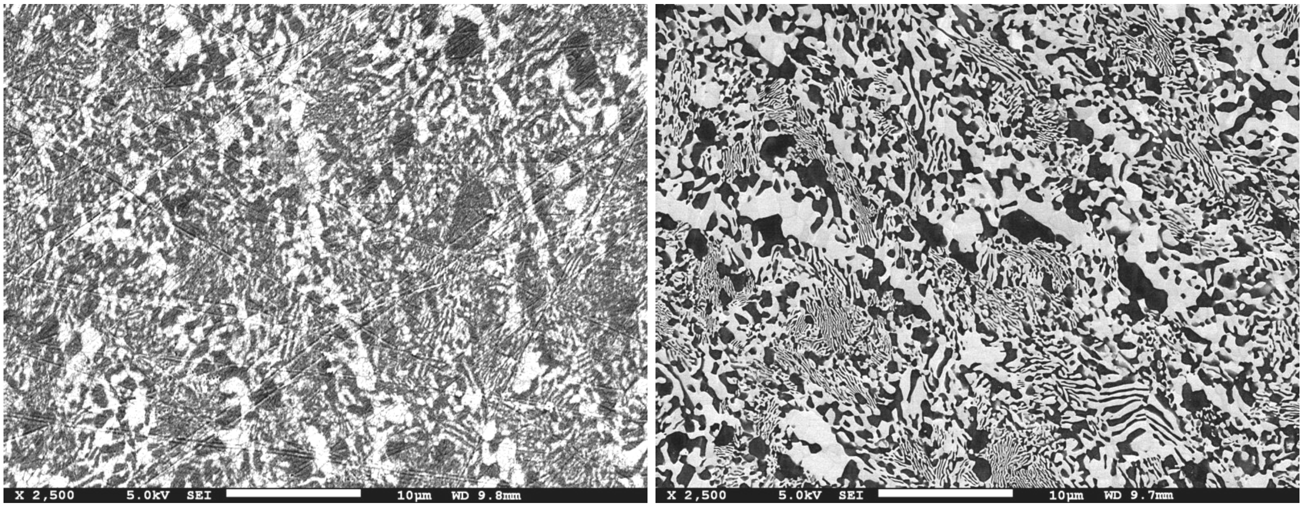

Fig. 1. SE images of Zn-22%Al alloy prepared by (a) mechanical polishing and (b) ion polishing.

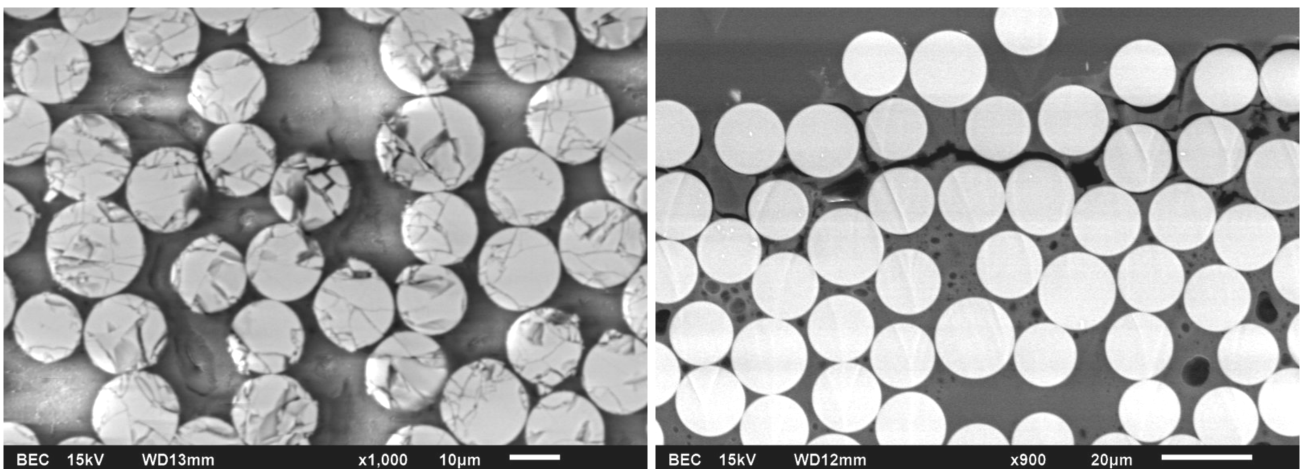

Fig. 2. LV-BSE images of glass fiber-epoxy composite prepared by (a) mechanical polishing and (b) ion polishing.

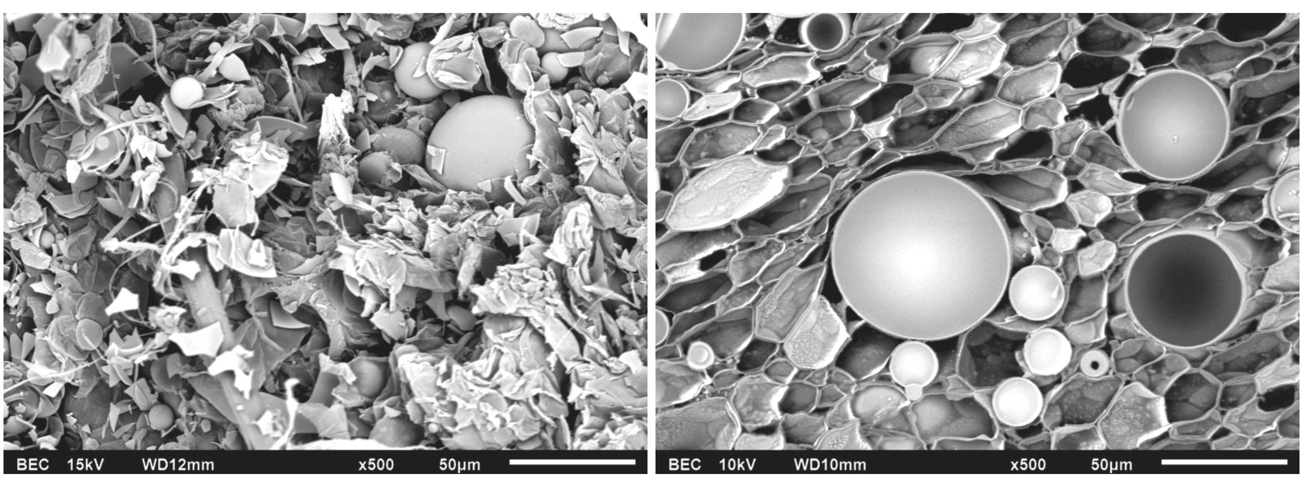

Fig. 3. LV-BSE images of fiber-reinforced syntactic foam prepared by (a) mechanical polishing and (b) ion polishing.

https://doi.org/10.1017/S1431927610054450 Published online by Cambridge University Press