DOI: 10.1017/S1431927603440142
Microsc Microanal 9(Suppl 2), 2003

Comparison of Dislocation Substructures in Friction-Stir Welded Cast Aluminum 359+20% SiC Metal-Matrix Composite

A. R. Rivera, G. Fernandez, K. Soto, and L. E. Murr

Department of Metallurgical and Materials Engineering, The University of Texas at El Paso, El Paso, TX 79968

The friction-stir welding (FSW) process, or in fact friction-stir processing (FSP), involves severe plastic deformation. There is no melting of the work piece in either operation and processing occurs in the solid state. The mechanism accommodating this superplastic deformation involves dynamic recrystallization which produces a characteristically equiaxed fine-grain (< 10 μm) structure, with a low dislocation density [1-3]. Li, et al [4] also observed complex networks of helical dislocations and dislocation loops associated with fine precipitates in the recrystallized grains of the weld zone for the FSW of aluminum 6061 to aluminum 2024. These helical dislocation substructures were characterized in part by the elevated weld zone temperatures (~0.8 T_M) promoting dislocation climb.

The present study examined the dislocation substructures in the weld zone for a cast aluminum 359 + 20 volume percent SiC-metal-matrix composite (MMC). Shindo, et al. [5] have previously shown that this MMC undergoes some SiC particle attrition; with the initial, mean particle size of 4.1 μm being reduced by roughly 25% in the FSW zone. As a consequence of this attrition, a range of smaller SiC fragments was produced in the recrystallized weld zone.

Figure 1 compares the MMC microstructures in the base or work-piece material and the center of the FSW zone after welding at a tool rotation speed of 1000 rpm and a traverse speed of 11 mm/s. There is little perceptible difference between the SiC particle size and distribution between the base and weld zone and the grain size. Figure 2 compares the typical base and FSW zone center dislocation substructure. The base microstructure varied somewhat from regions of very high dislocation density to low dislocation density, with some dislocation loops as shown in Fig. 2(a) (arrows). There is generally a higher dislocation loop density within the FSW zone as shown in Fig. 2(b); these seem to be associated with the very small SiC particles (arrows in Fig. 2 (b)), and the elevated temperature deformation promoting dislocation climb. The occurrence of dislocation loops in the FSW zone is an indication of deformation after recrystallization and the role played by the SiC particles in loop production; similar to that played by precipitates in prior FSW observations [4,6].

References

[1] C. G. Rhodes et al., *Scripta Mater.* 36 (1997) 69.
[2] G. Liu et al., *Scripta Mater.* 37 (1997) 355.
[3] L. E. Murr et al., *Mater. Res. Innovations* 1 (1998) 211.
[4] Ying Li et al., *Mater. Sci. Engng.* A271 (1999) 213.
[5] D. J. Shindo et al., *J. Mater. Sci.* 37 (23) (2002) 4999.
[6] This research was supported by a U.S. DoE Grant DE-FC04-01AL67097
(Amendment No. A0001) and a Mr. & Mrs. MacIntosh Murchison Endowment at UTEP.

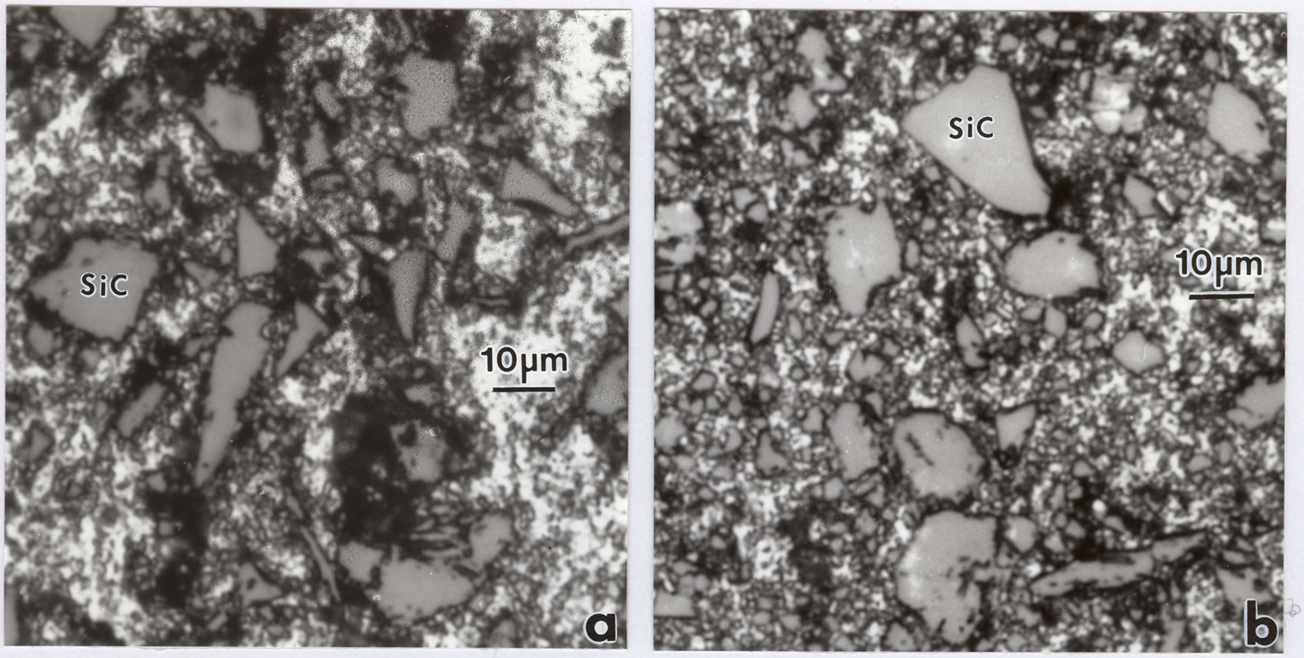

FIG. 1. Comparison of the MMC base (a) with the weld zone center (b).

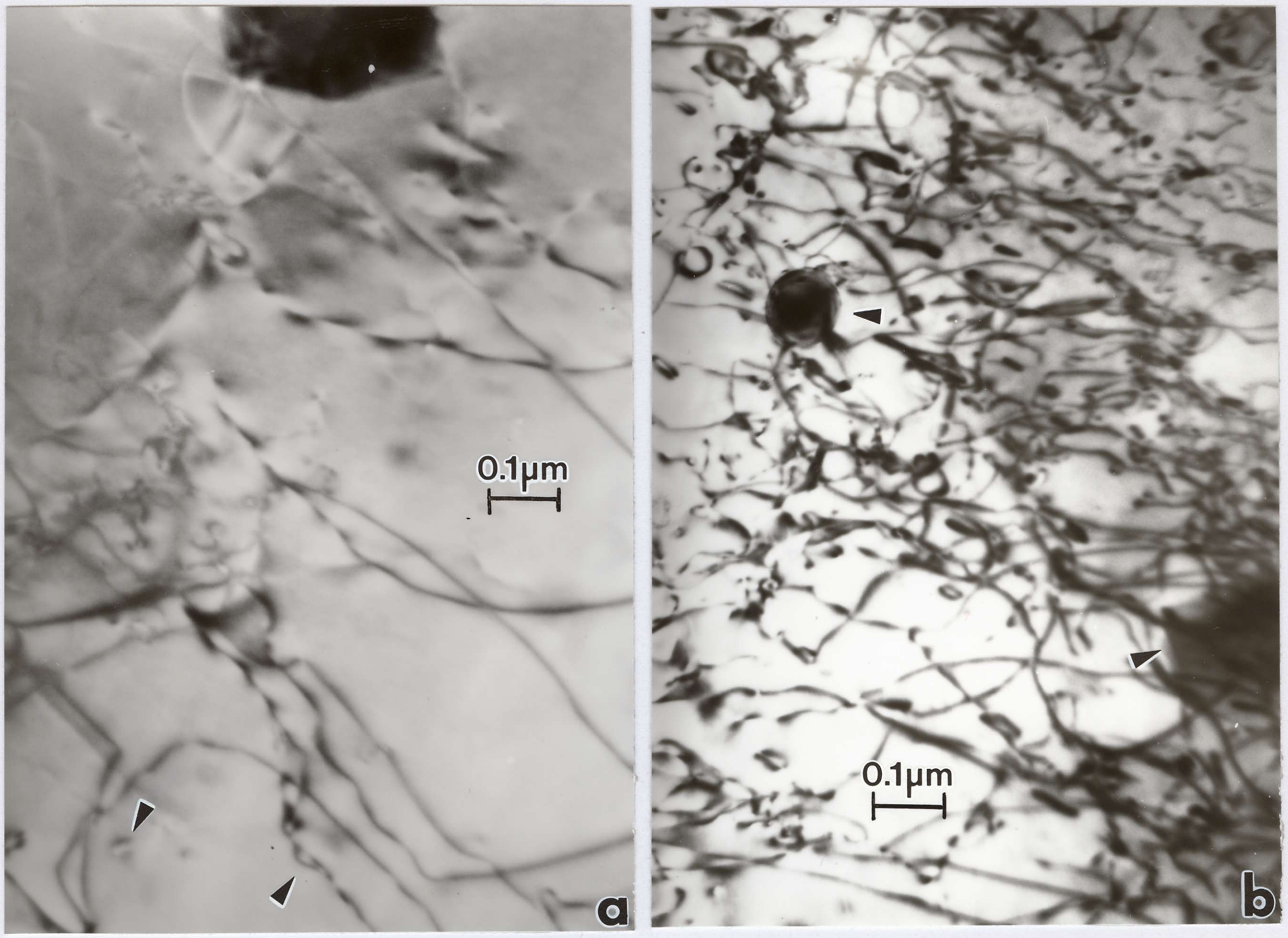

FIG. 2. Comparison of dislocation substructures in the MMC base (a) with the weld zone center (b). Note propensity of dislocation loops in (b).

https://doi.org/10.1017/S1431927603440142 Published online by Cambridge University Press