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Evaluation of the microstructure and mechanical properties of WC particle reinforced aluminum matrix composites fabricated by friction stir processing

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Abstract

Tungsten carbide (WC) is an attractive reinforcing material for aluminum and its alloys. However, it is technically challenging to fabricate WC particle reinforced aluminum matrix composites (AMCs) with homogeneous distribution of WC particles by liquid state processing techniques because of large density gradient. The present work aim to produce WC particle reinforced aluminum matrix composites (AMCs) through friction stir processing (FSP) and analyze the effect of its volume fraction on the microstructural features and the mechanical behavior of the developed AMCs. Microstructural evaluation was conducted on the cross-sections of the samples by optical microscopy (OM), scanning electron microscopy (SEM) and electron backscattered diffraction (EBSD). Microhardness testing was conducted across the cross-sections of FSPed samples to obtain hardness profiles and tensile test was conducted on as-received Al and FSPed samples. The fabricated AMCs exhibited the homogeneous distribution of WC particle with no obvious particle clustering in the stir zone, irrespective of position and WC particle volume fraction. Excellent WC/Al interfacial bonding was obtained in all FSPed AMCs with obviously refined grains. The average size of WC particles after FSP was slightly reduced with the increased volume fraction. It was also found that increasing the volume fraction of WC particles favored the grain refinement, improved the hardness and strength, but decreased the ductility. This improvement in the hardness and strength was attributed to the grain refinement strengthening and homogeneous distribution of WC particles.The decreased ductility resulted from the introduction of more WC particles. Increasing the volume fraction of WC particles caused the nature of fracture to move towards brittle nature.

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