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Influence of particulate reinforcement on microstructure evolution and tensile properties of in-situ polymer derived MMC by friction stir processing

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Abstract

The authors recently reported a novel in-situ method of fabricating nano-polymer derived metal matrix composite (PD-MMC) by friction stir processing (FSP) and addressed the issues of tool wear and particle agglomeration. In the present work, the microstructural evolution and tensile properties of the processed composite are reported. The microstructure during FSP evolved by discontinuous dynamic recrystallization. In the composite, fine ceramic particles pin the grain boundaries, preventing grain growth resulting in a fine grain (2 μm) structure being retained. FSPed Cu (processed with the same process parameters as that of the composite) exhibited a grain size of 100 μm compared to 400 μm in the base Cu. The composite microstructure was characterized by equiaxed grains with narrow grain size distribution and a high fraction (> 80%) of high angle grain boundaries. The combined effect of grain refinement and ceramic particle incorporation lead to a twofold improvement in the proof stress of the composite (201MPa compared to 98 MPa of base copper). The ultimate tensile strength improved by 33% and there was small drop in the ductility of the composite when compared to base Cu. Kocks-Mecking plot of the composite showed stage III of work hardening.

Keywords: In-situ composite; Grain refinement; Microstructure; Mechanical characterization; Friction stir processing.