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International Conference on

Nanomaterials and Nanochemistry

November 29-30, 2017 | Atlanta, USA

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A novel *in-situ* polymer derived nano ceramic mmc by friction stir processing

Friction stir processing (FSP) is a solid-state technique used for material processing. Tool wear and the agglomeration of ceramic particles have been serious issues in FSP of metal matrix composites. In the present research, FSP has been employed to disperse the nanoscale particles of a polymer-derived silicon carbonitride (SiCN) ceramic phase into copper by an *in-situ* process. SiCN cross linked polymer particles were incorporated using multi-pass FSP into pure copper to form bulk particulate metal matrix composites. The polymer was then converted into ceramic through an *in-situ* pyrolysis process and dispersed by FSP. Multi-pass processing was carried out to remove porosity from the samples and also for the uniform dispersion of polymer derived ceramic particles. Microstructural observations carried out using Field Emission Scanning Electron Microscopy (FE-SEM) and Transmission Electron Microscopy (TEM) of the composite indicated a uniform distribution of ~100 nm size particles of the ceramic phase in the copper matrix after FSP. The microstructure during FSP evolved by discontinuous dynamic recrystallization. In the composite, fine ceramic particles pinned 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 nanocomposite exhibits a five-fold increase in microhardness (260HV100) which is attributed to the nano scale dispersion of ceramic particles. A mechanism of shear has been proposed for the fracturing of PDC particles during multi-pass FSP. The combined effect of grain refinement and nano polymer derived ceramic particle incorporation lead to a two-fold improvement in the proof stress of the composite (201 MPa compared to 98 MPa of base copper). The ultimate tensile strength improved by 33% and there was negligible drop in the ductility of the composite when compared to base Cu. Kocks-Mecking plot of the nano composite showed stage III of work hardening.

Speaker Biography

Dr. Ajay Kumar P is currently working as a Post-Doctoral Researcher (Research Associate) at the College of Engineering and Applied Science, University of Wisconsin-Milwaukee (UWM) USA working in the area of developing metal matrix composite program. Mainly he is working in the area of Advanced Surface Alloying of Plain Carbon Steel to Stainless Steel Compositions during Manufacturing to improve Corrosion Resistance of Components used in the Water Industry, Novel Surface Microstructure and Low-Cost Surface treatments to reduce drag, Energy Consumption, and Corrosion in Water Transport Systems, Waste Materials Reinforced Metal Matrix Composites for Reducing Embodied Energy and Emissions, Graphene Based MMCs.

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