Characterization and performance of metal matrix nanocomposites fabricated by high shear solidification

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Metal matrix composites (MMCs) can be tailored to produce various combinations of stiffness and strength and have found a wide range of applications where existing materials are not suitable for use in automotive and aerospace industries and many other areas. A key challenge for fabricating nanoparticle reinforced MMCs is to overcome the strong tendency of particle agglomeration. The present work was carried out to investigate the effect of high shear treatment on the microstructure and mechanical performance in the fabrication of magnesium and aluminum alloy matrix particulate nanocomposites. In particular, the impact of high shear treatment on reinforcing particle distribution and consequently microstructure and mechanical performance was examined. An Mg-2Zn-0.5Ca alloy and commercially pure aluminum were selected as the matrix alloys. Hydroxyapatite nanoparticles (~50nm, spherical, 1-5wt%) were added to the magnesium alloy as reinforcing elements and alumina nanoparticles (~30nm, spherical, 1-3wt%) to aluminum. The high shear treatment was employed after the admission of reinforcing particles by mechanical stir and performed with a rotor-stator device at a speed of ~5000rpm. Microstructure and particle distribution was characterized using optical and electron microscopy assisted with EDAX and EBSD techniques. Mechanical performance was assessed by standard compression and tensile testing. Experimental results showed that the high shear treatment effectively reduced particle agglomeration for both Mg/HA and Al/Al_2O_3 nanocomposites and enhanced both yield strength and ultimate strength without a significant reduction in ductility. The mechanical performance was further improved upon plastic deformation by hot extrusion and cold rolling respectively.

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