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Processing and Characterization of Aluminum Matrix Composite Reinforced with Amorphous $Zr_{37.5}Cu_{18.67}Al_{43.98}$ Phase

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Abstract : The amorphous reinforcements (metallic glasses) can be considered as promising options for reinforcing light-weight aluminum and its alloys. By using the proper type of reinforcement, one can overcome to drawbacks such as interfacial de-cohesion and undesirable reactions which can be created at ceramic particle and metallic matrix interface. In this work, the Zr-based amorphous phase was produced via mechanical milling of elemental powders. Based on Miedema semi-empirical Model and diagrams for formation enthalpies and/or Gibbs free energies of Zr-Cu amorphous phase in comparison with the crystalline phase, the glass formability range was predicted. The composite was produced using the powder mixture of the aluminum and metallic glass and spark plasma sintering (SPS) at the temperature slightly above the glass transition Tg of the metallic glass particles. The selected temperature and rapid sintering route were suitable for consolidation of an aluminum matrix without crystallization of amorphous phase. To characterize amorphous phase formation, X-ray diffraction (XRD) phase analyses were performed on powder mixture after specified intervals of milling. The microstructure of the composite was studied by optical and scanning electron microscope (SEM). Uniaxial compression tests were carried out on composite specimens with the dimension of 4 mm long and a cross-section of 2 □ 2mm2. The micrographs indicated an appropriate reinforcement distribution in the metallic matrix. The comparison of stress–strain curves of the consolidated composite and the non-reinforced Al matrix alloy in compression showed that the enhancement of yield strength and mechanical strength are combined with an appreciable plastic strain at fracture. It can be concluded that metallic glasses (amorphous phases) are alternative reinforcement material for lightweight metal matrix composites capable of producing high strength and adequate ductility. However, this is in the expense of minor density increase.

Keywords : aluminum matrix composite, amorphous phase, mechanical alloying, spark plasma sintering
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