World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:11, No:10, 2017

Crystalline Particles Dispersed Cu-Based Metallic Glassy Composites Fabricated by Spark Plasma Sintering

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Abstract : Bulk metallic glasses exhibit several superior properties, compared to their corresponding crystalline counterpart, such as high strength, high elastic limit or good corrosion resistance. Therefore they can be considered as good candidates for structural applications in many sectors. However, they are generally brittle and do not exhibit plastic deformation at room temperature. These materials are mainly obtained by rapid cooling from a liquid state to prevent crystallization, which limits their size. To overcome these two drawbacks: fragility and limited dimensions, composite metallic glass matrix reinforced by a second phase whose role is to slow crack growth are developed. Concerning the limited size of the pieces, the proposed solution is to get the material from amorphous powders by densifying under load. In this study, Cu50Zr45Al5 bulk metallic glassy matrix composites (MGMCs) containing different volume fraction (Vf) of Zr crystalline particles were manufactured by spark plasma sintering (SPS). Microstructure, thermal stability and mechanical properties of the MGMCs were investigated. Matrix of the composites remains a fully amorphous phase after consolidation at 420°C under 600 MPa. A good dispersion of the particles in the glassy matrix is obtained. Results show that the compressive strength decreases with Vf : 1670 MPa (Vf=0%) to 1300MPa (Vf=30%), the elastic modulus decreases but only slighty respectively 97.3GPa and 94.5 GPa and plasticity is improved from 0 to 4%. Fractographic investigation indicates a good bonding between amorphous and crystalline particles. In conclusion, present study has demonstrated that SPS method is useful for the synthesis of the bulk glassy composites. Large controlled microstructure specimens with interesting ductility can be obtained compared with others methods.

Keywords : composite, mechanical properties, metallic glasses, spark plasma sintering
Conference Title : ICMASNM 2017 : International Conference on Metastable, Amorphous Solid and Nanostructured Materials
Conference Location : New York, United States
Conference Dates : October 05-06, 2017