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Probing Multiple Relaxation Process in Zr-Cu Base Alloy Using Mechanical Spectroscopy

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Abstract : Relaxation dynamics of Zr44Cu40Al8Ag8 bulk metallic glass (BMG) has been probed using dynamic mechanical analyzer. The BMG sample was casted in the form of a plate of dimension 55 mm x 40 mm x 3 mm using tilt casting technique. X-ray diffraction and transmission electron microscope have been used for the microstructural characterization of as-cast BMG. For the mechanical spectroscopy study, samples in the form of a bar of size 55 mm X 2 mm X 3 mm were machined from the BMG plate. The mechanical spectroscopy was performed on dynamic mechanical analyzer (DMA) by 50 mm 3-point bending method in a nitrogen atmosphere. It was observed that two glass transition process were competing in supercooled liquid region around temperature 390°C and 430°C. The supercooled liquid state was completely characterized using DMA and differential scanning calorimeter (DSC). In addition to the main α-relaxation process, presence of β relaxation process around temperature 360°C; below the glass transition temperature was also observed. The β relaxation process could be described by Arrhenius law with the activation energy of 160 kJ/mole. The volume of the flow unit associated with this relaxation process has been estimated. The results from DMA study has been used to characterize the shear transformation zone in terms of activation volume and size. High fragility parameter value of 34 and higher activation volume indicates that this alloy could show good plasticity in supercooled liquid region. The possible mechanism for the relaxation processes has been discussed.

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