INVESTIGATION OF LOAD-TRANSFER IN Ta-REINFORCED BULK METALLIC GLASSES USING HIGH-ENERGY X-RAY DIFFRACTION

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Bulk metallic glasses (BMGs) have recently gained popularity due to the development of new alloys that yield a glassy structure even with “conventional” metal processing such as casting. The unique properties of BMGs potentially place them among significant engineering materials: very high strength (1.9 GPa) and fracture toughness (40-55 MPa.m$^{1/2}$), a near theoretical specific strength, excellent wear and corrosion resistance, and a high elastic strain limit (up to 2%). However, BMGs tend to fail catastrophically in tension due to shear band formation. Addition of a reinforcing second phase has been shown to improve the tensile properties of BMGs both by inhibiting shear band movement and by load transfer to the stiffer reinforcement.

To determine the in-situ behavior of the reinforcement under applied stress, a BMG composite reinforced with Ta particulates was investigated at the Advanced Photon Source, Argonne National Laboratory. Using a 65 keV X-ray beam in transmission mode, Ta Debye rings were recorded on a two-dimensional detector. Slight deformation of the ring to ellipses gives Ta lattice strain data in directions parallel and perpendicular to the loading axis. The elastic load transfer, and after Ta yielding, the plastic load transfer from the matrix to the particles was observed in a series of experiments where the compressive stress was increased from 0 to 1,000 MPa. Also, constant stress experiments were conducted at 1,000 and 1,250 MPa, where the Ta strain was measured as a function of holding time to determine the amount of room-temperature relaxation leading to time-dependent load-transfer. The results will be presented to interpret the effect of the reinforcement behavior on the overall composite performance.