Dynamic Compression Behavior of Zirconium and Iron-Based Bulk Metallic Glasses

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ABSTRACT

In the present study, the Split-Hopkinson Pressure Bar (SHPB) was employed to perform high strain-rate compression tests on a Zr-based bulk metallic glass (Liquidmetal) with length-to-diameter (L/D) ratios varying from 0.5 to 2.0 and for both as-cast (i.e., fully amorphous) and annealed conditions. Ultra-high-speed photography, scanning electron microscopy, and optical microscopy were utilized to examine the macroscopic and microscopic fracture surfaces. These fracture surfaces and the corresponding stress-strain curves exhibited no evidence of stress concentrations. SHPB tests were also performed on an Fe-based BMG (SAM 1651) that shows promise due to its higher hardness.

INTRODUCTION

OBJECTIVES

- Amorphous LM-1
  - Effects of L/D ratio, shear banding, flow/fracture behavior
  - Annealed LM-1
  - Promote fragmentation
  - Fe-based BMG (SAM 1651)
  - Exceptional hardness (13 GPa), more extensive fragmentation

The as-cast LM-1 fails via shear band formation and slip; the annealed LM-1 fails via extensive fragmentation. A new experimental design has been developed to provide a uniform stress state in the specimen.

SUMMARY

- The as-cast LM-1 fails via shear band formation and slip; the annealed LM-1 fails via extensive fragmentation.
- Finite element simulations show a non-uniform stress state due to stress concentrations at specimen-bar interface.
- A new experimental design has been developed to provide a uniform stress state in the specimen.
  - Failure occurs in the gauge section of the specimen.
  - Equilibrium conditions are not compromised because of new inserts.
  - Strain gage experiments reveal constant stress-rate and no effect of L/D ratio on peak stress of LM-1.
  - Stress from transmitted signal and specimen strain gage are similar.
  - Stress from reflected signal and specimen strain gage are not similar.
  - Due to deformation of the new inserts.

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REFERENCES