3rd Semester report

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PhD Program: Materials Physics

Supervisor: Dr. Zsolt Kovács

Ph.D. Thesis title: Defect evolution during plastic deformation in crystalline and amorphous solids

Introduction:

Bulk metallic glasses (BMG) are achieving noticeable interest recently due to their disordered amorphous structure and special mechanical properties like high strength, good corrosion resistance and large elastic strain. These materials gave a critical cooling rates low enough to allow formation of amorphous structure in thick layers. The disadvantage is their poor macroscopic plasticity and brittleness. High-pressure torsion (HPT) deformation is a special plastic deformation method, which applies strong constraints along the sample surface that can induce significant plasticity in metallic glasses. This Ph.D. work focuses on the characteristics of the as-cast, deformed BMG samples. Presently, we investigate the plasticity and other mechanical properties of a Cu-Zr-Al BMG using different techniques which is summarized as follows.

Description of research work carried out in current semester:

In this semester which is practically my first semester at ELTE these works carried out:

1. We fabricated micro-pillars with different diameters on as-cast and HPT deformed (N=5, P=8 GPa) samples Then we did micro-compression tests with acoustic emission measurements on them using an in-situ indenter in the SEM. The fabricated and compressed pillars are shown in Figure 1.

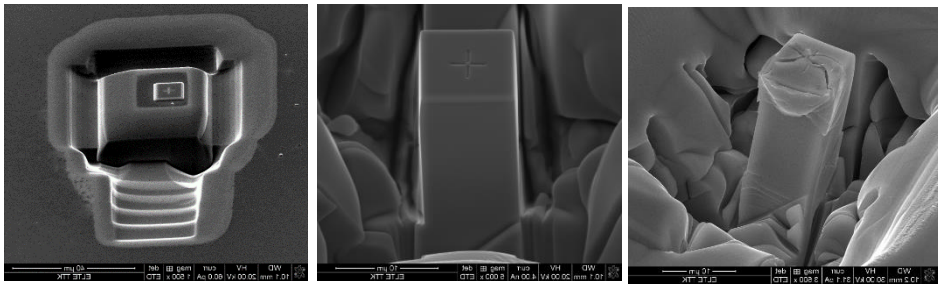

Figure 1. Early milling, finished and compressed pillars (left to right)

The experimental results obtained from the stress-strain curve shown in Figure 2. indicate a size effect and appearance of shear bands. For the smaller pillars in both as-cast and

deformed sample, the serrations are more apparent and for the bigger pillars we end up with a big drop.

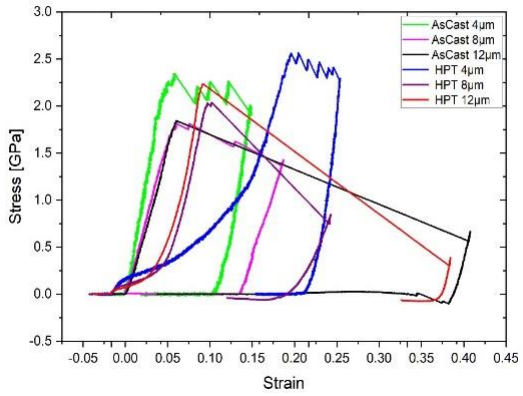

Figure 2. Stress strain curve

Furthermore, the AE signals were also recorded during the compression test. We are still working on the analysis of the AE events and the SEM images to find the correlation between different parameters.

2. Also differential scanning calorimetry (DSC) measurement was done on as-cast $Cu_{38}Zr_{54}Al_8$ metallic glass at different rates, namely, 5-10-20-40-80 K/min. As it is shown in Figure 3 (left) the glass transition and crystallization temperatures have a shift by increasing the rate due to the thermal activation of the processes. Isothermal DSC on the as-cast sample at different temperatures, namely, 710-720-730 K also show the same feature for the first crystallization peak.

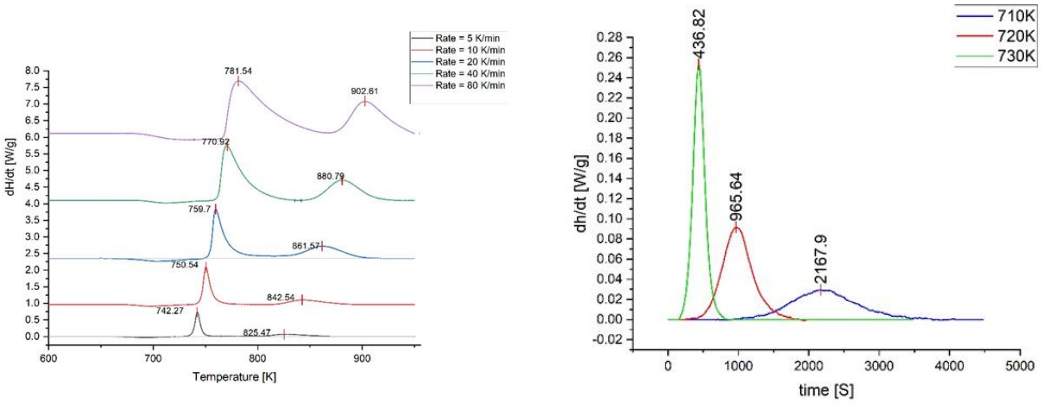

Figure 3. DSC measurements at different rates(left), isothermal DSC at different temperatures (right)

We followed the structural changes of the different thermal events by XRD measurement on the same alloy.

Publications:

1. Lajos Daróczi, Tarek Yousif Elrasasi, Talaye Arjmandabasi, László Zoltán Tóth, Bence Veres and Dezső László Beke, *Change of Acoustic Emission Characteristics during Temperature Induced Transition from Twinning to Dislocation Slip under Compression in Polycrystalline SN*, Materials, 2022, 15(1), 224; *https://doi.org/10.3390/ma15010224.*

Studies in current semester:

Subject code	**Subject name, Lecturer**	**Cr.**	**Req.**	**Class per week (T/P/L)**
FIZ/KUT-S3	Guided research work, Groma István Dr., Kürti Jenő Dr., Nguyen Quang Chinh Dr., Petrovay Kristóf Dr., Trócsányi Zoltán Dr.	18	report	
FIZ/1/037E	Amorphous alloys, Révész Ádám Dr.	6	exam	2/0/0
FIZ/1/016E	Physical materials science II., Kovács Zsolt Dr.	6	exam	2/0/0

Teaching activity in current semester:

Single crystal X-ray diffraction lab (Laue lab) in Laboratory for structural investigation techniques: 4 hours/week