4th 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 as-cast and 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 these works carried out:

1. In the previous semester we fabricated micro-pillars with different diameters on as-cast and HPT deformed (N=5, P=8 GPa) samples of $Cu_{38}Zr_{54}Al_8$ BMG and the micro-compression tests with acoustic emission measurements was carried out with an in-situ indenter in the SEM. In this semester, we have worked more on the correlation between different parameters, like energy distribution function which can be seen in Figure.1. Also since there was a big difference between the elastic modulus obtained in our experiment compare to the literature, we are working on the calibration to find the reason for this change.

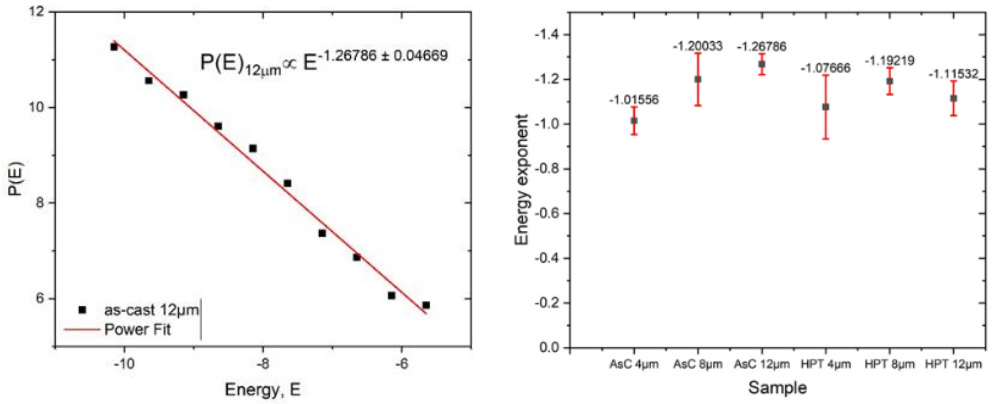

Figure 1. Energy distribution function (left) and energy exponents for all samples (right)

2. Moreover, partial isothermal annealing was done on the samples. Measured linear heating calorimetric thermograms after various t_{iso} pre-annealing times (at 7 different times between 1000s-3400s) taken at T_{iso} = 710 K. As seen in figure 2, The observed decrease of the first transformation temperature is associated with a reduced supercooled liquid range, which might correspond to a slight compositional modification of the residual amorphous component. On the figure 3. The crystalline mean size was also calculated using XRD patterns which shows the growth throughout the overall crystallization process, see figure 3.

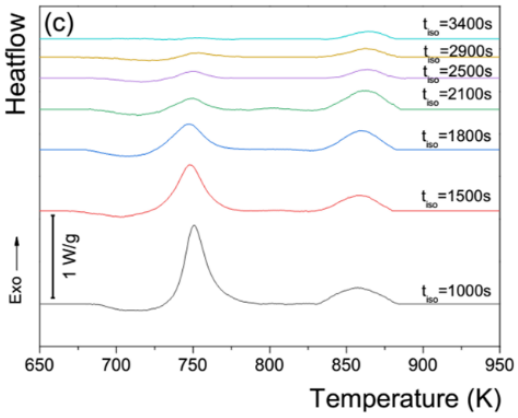

Figure 2. partial isothermal annealing of the samples

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

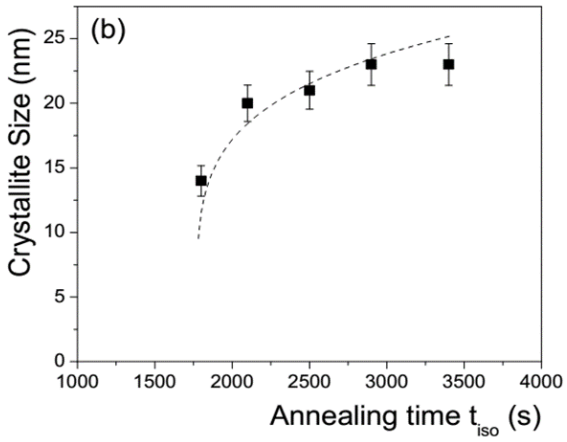

Figure 3. Mean crystalline size of the samples

3. Modulated thermal analysis was also investigated. (Figure 4). The curves indicate the presence of extra defects in the glassy state for the compressed sample and a more ordered (severely sheared) glassy structure for the severe plastic deformed glass.

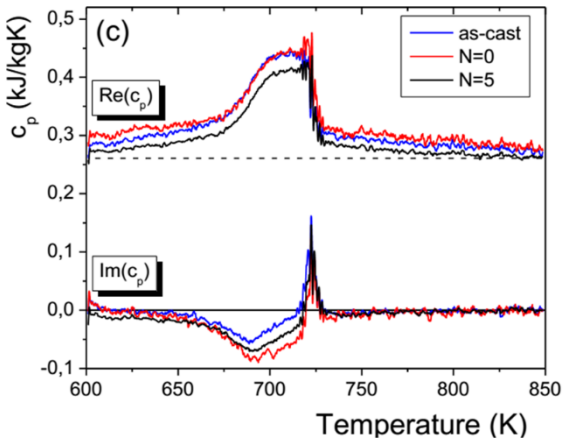

Figure 4. Modulated thermal analysis curves of as cast and deformed samples(N=0,5)

Submitted Paper: (Journal of Thermal Analysis and Calorimetry)

1. Ádám Révész, Talaye Arjmandabasi, Erhard Schafler, David J. Browne, Zsolt Kovács, *Comprehensive thermal analysis of a high stability Cu-Zr-Al bulk metallic glass subjected to high-pressure torsion*

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-S4	Guided research work, Groma István Dr., Kürti Jenő Dr., Nguyen Quang Chinh Dr., Petrovay Kristóf Dr., Trócsányi Zoltán Dr.	18	report	
FIZ/1/025E	Lattice defects II. Gubicza Jenő Dr.	6	exam	2/0/0
FIZ/1/015E	Physical materials science I. Kovács Zsolt Dr.	6	exam	2/0/0