MM 43: Liquid and Amorphous Metals II - Mechanical properties

Time: Wednesday 11:45–13:00 Location: IFW A

MM 43.1 Wed 11:45 IFW A

FeCoSiBNbCu bulk metallic glass with large compressive deformability studied by time-resolved synchrotron X-ray diffraction — •Mihai Stoica[1,2], Sergio Scudino[1], Jozef Bednarcik[3], Ivan Kaban[1,4], and Jürgen Eckert[1,4] — [1]IFW Dresden, Institute for Complex Materials, Helmholtzstr. 20, D-01069 Dresden, Germany — [2]POLITEHNICA University of Timisoara, P-ta Victoriei 2, Timisoara, Romania — [3]Deutsches Elektronen-Synchrotron (DESY), FS-PE Group, Notkestr. 85, D-22607 Hamburg, Germany — [4]TU Dresden, Institute of Materials Science, D-01062 Dresden, Germany

By adding 0.5 at.% Cu to the strong but brittle $[(Fe_{0.5}Co_{0.5})_{0.75}Si_{0.05}B_{0.20}]_{96}Nb_4$ bulk metallic glass, fully amorphous rods with diameters up to 2 mm were obtained. The monolithic samples with 1 mm diameter revealed a fracture strain of 3.80 % and a maximum stress of 4143 MPa upon compression, together with a slight work-hardening behavior. An estimate of the temperature rise ΔT in the shear plane gives 1039 K, which is large enough to melt a layer of 120 nm. Mechanical tests performed in-situ under synchrotron radiation allowed the calculation of the strain tensor components, using the reciprocal-space data and analyzing the shift of the first (the main) and the second broad peak positions in the X-ray diffraction patterns. The results revealed that each atomic shell may have a different stiffness, which may explain the macroscopic compressive plastic deformation.

MM 43.2 Wed 12:00 IFW A

Diffusion, Structure and Crystallization in a HPT-deformed bulk metallic glass — •Jonas Bünz[1], Koichi Tsuchiya[2], Sergiy Divinsky[1], and Gerhard Wilde[1] — [1]Institut für Materialphysik, WWU Münster, Germany — [2]National Institute of Materials Science, Tsukuba, Japan

Metallic glasses show unique properties compared to their crystalline counterparts, but their applicability is limited by the lack of sufficient plasticity. Stress localization and the associated shear softening strongly weaken the structure, thus leading to the formation of shear bands. The structure of shear bands is still far from being understood. The HPT-technique allows the deformation of glasses with very high strains and thus leads to a rejuvenation of the structure and shear band densities which are obtainable with almost no other experimental technique. Thus, severely deformed glasses can act as a model system for integral testing methods such as calorimetry or diffraction analysis. Due to their extreme sensitiveness to the free volume localization, the diffusion measurements by the radiotracer technique can bring further insight into the structural modifications of shear bands with respect to the amorphous matrix as well as to the conditions of shearing during plastic straining. Here, the results of a combined study of diffusion process, crystallization behaviour and structure evolution in a HPT-deformed Zr-based bulk metallic glass are reported.

MM 43.3 Wed 12:15 IFW A

Mechanical behaviour of CuZr-based bulk metallic glasses and composites — •Benjamin Escher[1,2], Simon Pauly[1], Ivan Kaban[1,2], Uta Kühn[1], and Jürgen Eckert[1,2] — [1]IFW Dresden, Institute for Complex Materials, P.O. Box 270116, 01171 Dresden, Germany — [2]TU Dresden, Institute of Materials Science, 01062 Dresden, Germany

Compared to crystalline alloys, bulk metallic glasses (BMGs) exhibit yield strengths close to the theoretical limit. However, BMGs generally show a low or no plastic strain under either tensile or compressive stresses. This drawback has to be overcome for BMGs to be used as structural material.

The tolerance towards failure of CuZr-based BMGs can be significantly improved by the incorporation of structural heterogeneities such as crystals. The formation of such composites strongly depends on composition and cooling rate.

In the present work we investigated the mechanical properties of CuZr-based bulk metallic glasses and composites with different Al, Ag, Co and Sc additions. The effect of the elements on the thermal behaviour, the corresponding phase evolution and the resulting microstructure is correlated with the deformation behaviour.

It has been found, that the plasticity of the CuZr-X metallic glasses or composites can be significantly enhanced by the addition of proper quantities of the afore mentioned elements by changing the precipitating phase, its volume fraction and distribution.

MM 43.4 Wed 12:30 IFW A

Effect of micro-alloying on the properties of Pd- and Zr-based bulk metallic glasses — •Davide Granata, Erwin Fischer, and Jörg F Löffler — ETH Zürich, Zürich, Schweiz

For applications of bulk metallic glasses (BMGs) it is important to design new glass-forming alloys with improved properties. However, good glass-forming ability and improved mechanical properties, such as high fracture toughness and ductility, appear to be mutually exclusive. It has been shown recently that minor additions of suitable elements significantly alter the resulting properties of BMGs. In this micro-alloying approach slight compositional adjustments on the order of 0.1% generate drastic changes in critical casting thickness and mechanical characteristics. In this context we will discuss the role of fluxing-induced micro-alloying in the case of Pd-based BMGs. The knowledge gained will also be transferred to Zr-based BMGs, which are of greater interest for applications.

MM 43.5 Wed 12:45 IFW A

atomic structures and magnetic properties of FeB-based amorphous alloys — •Guangcun Shan[1,2], Jiliang Zhang[1], and Chan-Hung Shek[1] — [1]Department of Physics and Materials Science, City University of Hong Kong, Hong Kong SAR — [2]Max-Planck-Institut für Chemische Physik fester Stoffe

Several FeB-based amorphous alloys (Fe80B8Si12, Fe71B17Si12 and Fe71B17(Nb4Y4Zr4)) with good mechanical properties and soft magnetic properties have recently been well developed by addition of solute atoms to tune the magnetic properties and glass forming ability (GFA). The atomic structures were revealed by state-of-the-art extended X-ray absorption fine structure spectroscopy (EXAFS) combining with ab initio molecular-dynamics (AIMD) computational techniques. Both AIMD computational results and the EXAFS spectra present clear evidence of a very different chemical and topological short-range order (SRO) around the Fe atom in all the studied samples. The experimental results of nanoindentation, XPS and thermal stability were in good agreement with the EXAFS results. Besides, the magnetic behaviors were discussed in view of the EXAFS results and atomic clusters of the glassy alloys.