MM 43: Liquid and Amorphous Metals II

Time: Thursday 16:00–17:45 Location: IFW A

MM 43.1 Thu 16:00 IFW A

serrated flow behavior in bulk metallic glasses — •gang wang, norbert mattern, and jürgen eckert — Institute of complex materials, IFW-Dresden, 01069 Dresden, Germany

Plastic deformation of bulk metallic glasses (BMGs) is a complex inhomogeneous process characterized by avalanches in the motion of shear bands. In the present study, based on the CuZr-based BMG, we investigate the serrated flow behavior in the plastic deformation stage. We statistically analyze the serrated stress-strain behavior of BMGs with different plastic deformation ability. The cumulative possibility distribution of the elastic energy density follows the Weibull distribution. Accompanying with the compression tests, we measured the atomic-scale strain during the serrated flow stage by x-ray synchrotron radiation at room temperature. High resolution strain scanning reveals the relationship between the macroscopic serrated flow and the atomic-scale elasto-plastic deformation. Based on the potential energy landscape (PEL) theory of ductile glasses, we attempt to construct a clear physic image of the origination of the plastic deformation in glassy phase, i.e. the evolution from the disorder atomic cluster, to shear transforming zone (STZ) formation, to shear bands origination and then to the shear slip occurring.

MM 43.2 Thu 16:15 IFW A

Dynamics of shear localization and stress relaxation in amorphous $Cu_{50}Ti_{50}$ — •Max Neudecker and S. G. Mayr — I. Physikalisches Institut, Georg-August-Universitaet Goettingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Dynamic heterogeneities of atomic mobility in metallic glasses are investigated for the model glass $Cu_{50}Ti_{50}$ with the help of classical molecular dynamics computer simulations. By rapid quenching from melt at various cooling rates (comprising 5 orders of magnitude), differently relaxed amorphous cells are prepared. During subsequent shearing, we observe a series of highly localized shear events, termed shear transformation zones (STZs). Detailed analysis focuses on geometrical shape and size of STZs, mechanical stress dynamics and correlations of mobility with local properties. We identify a local stress bias as physical origin of STZ formation during during low temperature deformation. Further investigations concern the characterization and analysis of heterogeneous mobility and stress dynamics during shearing at higher temperatures.

[1] M. Neudecker and S. G. Mayr, Acta Materialia, in press (2008)
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MM 43.3 Thu 16:30 IFW A

Temperature and kinetics of shear band propagation in amorphous metals — •Florian H. Dalla Torre, David Klaumünzer, Alban Dubach, and Jörg F. Löffler — Laboratory of Metal Physics and Technology, Department of Materials, ETH Zurich, Wolfgang-Pauli-Str. 10, 8093 Zurich, Switzerland

Deformation in bulk metallic glasses (BMGs) far below their glass transition temperature is known to be spatially inhomogeneous and restricted to narrow nanometer-sized shear bands. In this study the shear band characteristics of Zr-based BMGs has been investigated as function of strain rate and temperature. To capture discrete shear events precisely a dedicated acoustic emission spectrometer has been used in-situ during deformation testing, which allows for extremely high data acquisition rates of the order of MHz. Preliminary results of evaluating the viscosity within shear bands during deformation suggest that the local temperatures are of the same order of magnitude as those measured during homogeneous deformation close to the glass transition temperature. Acoustic emission results indicate that irreversible deformation starts well before reaching the elastic limit and that the Kaiser effect known to crystalline metals is present also in amorphous metals. It is shown that serrated flow and the associated stress drops are a function of temperature and strain rate. The time periods for a shear band to be activated increases with decreasing temperature from milliseconds at ambient temperatures to seconds at temperatures of 200 K.

MM 43.4 Thu 16:45 IFW A

Modelling the mechanical properties of bulk metallic glasses with nanoscale precipitates — •Yvonne Ritter and Karsten Albe — Institut f. Materialwissenschaft, TU Darmstadt, Petersenstr. 23, D-64287 Darmstadt

Bulk metallic glasses exhibit unique mechanical properties as compared to conventional crystalline metals. Large elastic strains and specific strengths exceeding the strength of crystalline alloys by more than 100% illustrate the high potential for structural applications. On the other hand, metallic glasses have a relatively low tensile ductility and fail catastrophically when reaching the flow stress. Nanoscale precipitates in the glassy matrix were found to improve the plasticity of BMGs. The underlying mechanisms, however, that lead to the improved deformation bahavior have not yet been exposed. In this study, we investigate the role of structural inhomogeneities in CuZr by means of molecular dynamics simulations. Nanoprecipates of crystalline Cu and CuZr as well as amorphous precipitates with varying composition are investigated and their influence on the materials behavior under tensile load and shear is investigated.

MM 43.5 Thu 17:00 IFW A

Deformation-induced martensitic transformation in Cu-Zr-Al(Ti) bulk metallic glass composites — •Ram Bachchan Kumar, Simon Pauly, Jayanta Das, and Jürgen Eckert — Institut für Komplexe Materialien, IFW Dresden

Plastic deformation of Cu-Zr-(Al, Ti) bulk metallic glass (BMG) composites induces a martensitic phase transformation from the B2 to the B19* CuZr phase. Addition of Ti to binary Cu-Zr increases the temperature above which the B2 CuZr phase becomes stable. This affects the phase formation upon quenching in Cu-Zr-Ti BMG composites. The deformation-induced martensitic transformation is believed to cause the strong work hardening and to contribute to the large compressive deformability with plastic strains up to 15%.

MM 43.6 Thu 17:15 IFW A

Elastostatic preloading of bulk metallic glasses — •Denise Beitelschmidt[1], Sergio Scudino[1], Uta Kühn[1], and Jürgen Eckert[1,2] — [1]IFW Dresden, Institut für Komplexe Materialien, Helmholtzstrasse 20, D-01069 Dresden — [2]TU Dresden, Institut für Werkstoffwissenschaft, D-01062 Dresden

Many bulk metallic glasses (BMG) show excellent elastic properties but their plastic behaviour is poor at room temperature. However recently, it has been reported that elastostatic compression below the yielding point can be used to enhance the plasticity of BMGs. In this work, the effect of preloading in the elastic regime on the structure and mechanical behaviour of different BMGs is investigated. Different alloys are tested with regard to their changing mechanical properties: as-cast and after preloading. Rods have been cast by different mould-casting techniques and were studied concerning their as-cast structural properties. Those as-cast samples have been preloaded for different periods and loads in the elastic regime and the effect on room-temperature plastic deformation has been investigated. Possible structure variation (e.g., SRO, atomic packing etc.) and creation of free volume as a result of preloading have been analyzed by XRD, DSC, density measurements and ultrasonic investigations. The results will be discussed with already published results from other groups to clarify the mechanisms of structural changes by preloading below yield strength.

MM 43.7 Thu 17:30 IFW A

Synthesis and mechanical properties of Al-based alloys prepared by hot extrusion and spark plasma sintering of gas atomized powders — •Kumar Babu Surreddi[1], Hoang Viet Nguyen[2], Miroslava Sakaliyska[1], Fahad Ali[1], Sergio Scudino[1], Vikas C Srivastava[3,4], Volker Uhlenwinkel[3], Ji-Soon Kim[2], Daniel J Sordelet[5], and Jürgen Eckert[1,6] — [1]IFW Dresden, Institut für Komplexe Materialien, Dresden, Germany — [2]Research Center for Machine Parts and Materials Processing, University of Ulsan, Ulsan, Republic of Korea — [3]Institut für Werkstofftechnik, Universität Bremen, Bremen, Germany — [4]Metal Extraction & Forming Division, National Metallurgical Laboratory, Jamshedpur, India — [5]Materials and Engineering Physics Program, Ames Laboratory (USDOE), Iowa State University, Ames, Iowa — [6]TU Dresden, Institut für Werkstoffwissenschaft, Dresden, Germany

Bulk nanocrystalline and ultrafine-grained Al-based specimens were prepared by in-situ devitrification and consolidation of gas atomized glassy powders. Consolidation was carried out at different temperatures by hot extrusion as well as by spark plasma sintering (SPS). Both techniques lead to highly dense bulk specimens with a microstructure consisting of an fcc-Al phase together with several intermetallic compounds. The consolidated materials display high compression strength, which depends on the consolidation technique, together with large plastic deformation. These results indicate that the mechanical properties of the samples can be tuned within a wide range of strength and ductility as a function of the consolidation technique and parameters used.