MM 48: Topical session: Dynamics, relaxation and deformation in deeply supercooled metallic liquids and glasses III - plasticity and hetererogeneities

Time: Wednesday 15:45–17:15 Location: IFW A

Topical Talk MM 48.1 Wed 15:45 IFW A

Plastic deformation in amorphous solids: The role of elasticity and spatio-temporal correlations of fluctuations — •Fathollah Varnik and Muhammad Hassani — ICAMS, Ruhr-Universität Bochum, Germany

In view of their broad range of application, deformation behavior amorphous solids is of great practical and theoretical interest. Early experiments on bubble rafts and computer simulations of model glasses has revealed that particles rearrange collectively to accommodate for the globally imposed deformation/stress. Typically, these "shear transformation events" occur within small domains with a linear size of a few particle diameters. Mesoscopic elasto-plastic models highlight the role of system spanning elastic propagators for localized plastic deformation and shear banding. Recent experiments and simulations of hard sphere glasses underline the possible role of anisotropic correlations of plastic activity for shear banding. Microscopic theories, on the other hand, emphasize the role of local structure for the response to an externally imposed shear or stress. In this talk, we review these ideas, with a special emphasize on spatio-temporal correlations of plastic activity and its possible role for shear localization. The role of the fluctuations of the local structure, local forces and correlations thereof is also highlighted.

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MM 48.2 Wed 16:15 IFW A

Local mechanical properties of ultrastable metallic glass — •Thomas Dziuba, Yuansu Luo, and Konrad Samwer — I. Phys. Intitut, Univ. Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

The recent discovery of so called ultrastable metallic glasses led to great opportunities for experimental examinations which may not only give insight to the physical properties of such glasses but also to the glass-forming process in general [1]. In this context, the talk will give an overview on our experimental work using vapor deposition to create different ultrastable CuZr-glasses. Especially the use of Atomic-Force-Acoustic-Microscopy (AFAM) makes the measurement of elastic properties on a nanometer-scale possible. Comparisons with ordinary glassy systems and crystalline material reveal the energetic state during the formation of the solid and line up perfectly with theoretical considerations and simulations. Therefore, information about the behavior of systems in the context of the potential energy landscape (PEL) could be derived and will be presented. Also, the influence of temperature and deposition rates on the formation of different phases in the solid was evaluated by using XRD-techniques. Here the goal is not only to understand the nature of ultrastable metallic glasses but additionally to gain the ability to tune such materials for optimal mechanical properties.

Acknowledgement: DFG-FG 1394 PI

[1] H. B. Yu, Y. Luo and K. Samwer: Ultrastable Metallic Glass. In: Adv. Mater. 25, 5904-5908 (2013)

MM 48.3 Wed 16:30 IFW A

Interface controlled plasticity in metallic crystal-glass composites — Constanze Kalcher, Tobias Brink, Omar Adjaoud, and •Karsten Albe — Technische Universität Darmstadt, FB 11, FG Materialmodellierung, Jovanka-Bontschits-Str. 2, 64287 Darmstadt

The mechanical properties of metallic glasses can be modified by secondary phases. In the current contribution we study how the creep and deformation behavior of a metallic glass is altered by the presence of secondary crystalline and glassy phases. By means of molecular dynamics simulations, we show that not only the mechanical properties of the phase fractions but also interfaces affect the mechanical response of a Cu-Zr glass composite. We study various topologies and phase fractions and propose an explanation in terms of interface orientations and a resulting Schmid-like law. We finally show that it is possible to enhance the mechanical properties of nanoglasses by reinforcing their glassy interfaces.

MM 48.4 Wed 16:45 IFW A

Deformation and relaxation of AlYFe metallic glass ribbons — •Marius Gerlitz, Rene Hubek, Martin Peterlechner, and Gerhard Wilde — Institute of Materials Physics, University of Münster, Germany

Metallic glasses and their deformation behavior are in the focus of current research. Plastic deformation of amorphous structures causes localized shear zones, so called shear bands. However, it is not fully understood to which extend the matrix carries deformation and alters its characteristics upon plastic deformation. Inherent thermal vibrations of atoms are sensitive to their mechanical coupling, thus, specific heat measurements at low temperatures are an excellent tool to analyze fundamental properties of vibrational modes. In the present work, an AlYFe glass was chosen as a model system to analyze the influence of deformation on excess contributions to the specific heat at low temperatures, known as Boson peak. Specimen-states were examined including heat capacity measurements via a 2-Tau-Method subsequent to characterization through x-ray-diffraction and calorimetric measurements. Results are discussed in comparison to the available literature on the Boson peak of metallic glasses. Specifically it was found that the relaxation behavior of metallic glasses is enhanced by the presence of shear bands. Due to the limited volume of shear bands, it is concluded that the mostly undeformed matrix additionally contributes to the relaxation.

MM 48.5 Wed 17:00 IFW A

Micro-alloying of Gd to a PdNiP-based bulk metallic glass — •Christian Buchholz, Niklas Nollmann, Harald Rösner, and Gerhard Wilde — Institut für Materialphysik, WWU Münster, Münster, Deutschland

Bulk metallic glasses (BMGs) are well known for their high hardness but also to exhibit almost no ductility when reaching the end of the elastic deformation range. It has been recently shown [N. Nollmann et al., Scripta Mater. (2015), http://dx.doi.org/10.1016/j.scriptamat.2015.08.030] that micro-alloying applied to $Pd_{40}Ni_{40}P_{20}$ by adding small amounts of Co or Fe (around 1 at%) can strongly improve or worsen the mechanical properties. Here we present new results obtained after adding Gd to $Pd_{40}Ni_{40}P_{20}$. Similar to Co, Gd also enhances the ductility of the produced BMG. However, the phase transformation from the undercooled liquid to the crystalline state is also strongly affected by the Gd addition, resulting in a highly unusual crystallization kinetics. The results and consequences are discussed.