MM 39: Liquid and Amorphous Metals I - Shearbands

Time: Wednesday 10:15–11:30 Location: IFW A

MM 39.1 Wed 10:15 IFW A

Kinetics of single shear bands in Zr-based bulk metallic glasses — •Peter Thurnheer[1], Robert Maass[2], Stefan Pogatscher[1], Alireza Saeed-Akbari[1], and Jörg F. Löffler[1] — [1]Laboratory of Metal Physics and Technology, Department of Materials, ETH Zürich, 8093 Zürich, Switzerland — [2]Nanoskalige Materialien, Institut für Materialphysik, Georg-August Universität Göttingen, 37077 Göttingen, Germany

Mechanical properties of bulk metallic glasses are generally assessed by compression testing. However, quantities such as plasticity or the material's ability to strain-harden are often modified by geometric effects. These include initiation of constrained shear bands at sample corners and shear-band arrest at contact points between emerging shear-offsets and the cross-heads of the machine. To study freely propagating shear bands, the compression samples are equipped with a small notch, which promote the initiation of a single, major shear band well off the sample corners. In this work, we present results on the compositional dependence of single-shear-band dynamics for a set of Zr-based bulk metallic glasses, and review recent theories and experiments on shear-band propagation modes.

MM 39.2 Wed 10:30 IFW A

Mechanical analysis of amorphous solids with large amplitude oscillatory spectroscopy (LAOS) — •Stefanie Finkhäuser[1], Ranko Richert[2], Carsten Mahn[1], and Konrad Samwer[1] — [1]1.Physikalisches Institut, Georg-August Universität Göttingen — [2]Department of Chemistry & Biochemistry, Arizona State University

In the presence of mechanical fields, glassy materials are known to reveal many interesting phenomena. One of them is a crossover from a linear behavior in stress-strain dependency to a nonlinear behavior. To investigate this crossover in detail, we use dynamic mechanical excitation with large amplitudes. The sample is excited with a sinusoidal stress whose amplitude is large enough to lead to nonlinear strain-responses. The Fourier-analysis of these nonlinear responses contains higher harmonic contributions. These can give further insight into interactions among local plastic events, which lead to the nonlinear response. By switching between large amplitudes and small amplitudes which give a linear strain-response, the time dependence of these interactions is investigated. We will show results on PMMA and bulk metallic glasses.

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MM 39.3 Wed 10:45 IFW A

Diffusion in shear bands of a Pd40Ni40P20 bulk metallic glass — •Isabelle Binkowski, Sergiy V. Divinski, and Gerhard Wilde — 1- Institut für Materialphysik, Universität Münster, Wilhelm-Klemm-Str. 10, D-48149 Münster, Germany

Bulk metallic glasses feature beneficial properties which are promising for applications, because of which they have received increasing attention. Metallic glasses exhibit mechanical properties such as high strength and hardness, however, this advantage is impeded by the fact that their plasticity appears to be extremely limited. The plastic deformation is localized in thin regions, called shear bands, with widths from 10nm to 50 nm, whose extension lead to catastrophic failure. Despite their obvious importance, there exist several open issues concerning the initiation, propagation, kinetics and general comprehension of shear banding. In the present study, the characteristics of shear bands in a Pd40Ni40P20 bulk metallic glass are investigated more precisely utilizing the radiotracer technique to measure atomic transport in shear bands. Additionally, combining these experimental results with calorimetric measurements should get insight into the time-dependence and the impact of structural changes on diffusion.

MM 39.4 Wed 11:00 IFW A

Elastic Susceptibility measurements of Zr-based Bulk Metallic Glass at Ultra Low Temperatures — •Marius Hempel, Andreas Reiser, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, Im Neuenheimer Feld 227, 69120 Heidelberg

Many low temperature properties of glasses can be described by the standard tunnelling model. Dielectric and metallic glasses in the superconducting state far below T_C ought to yield similar results since their behaviour is solely governed by interactions between tunnelling systems and phonons in the absence of conduction electrons. We present experimental results of both temperature and frequency dependence of the internal friction and sound velocity of the bulk metallic glass $Zr_{55}Cu_{30}Al_{10}Ni_5$ which differ systematically from predictions. In particular, the observed temperature dependency of the internal friction is significantly weaker than predicted by the standard tunnelling model, but agrees reasonably well with the behaviour of thin ribbon samples of metallic glasses reported by other authors.

MM 39.5 Wed 11:15 IFW A

Boson peak in the heat capacity of severely deformed metallic glass — Jonas Bünz[1], •Tobias Brink[2], Koichi Tsuchiya[3], Gerhard Wilde[1], and Karsten Albe[2] — [1]Institut für Materialphysik, Westfälische Wilhelms-Universität Münster, Germany — [2]Institut für Materialwissenschaft, Technische Universität Darmstadt, Germany — [3]National Institute of Materials Science, Sengen, Tsukuba, Japan

Heat capacity measurements on amorphous materials reveal an additional contribution to the low temperature heat capacity compared to crystalline materials. This so called boson peak, which is due to additional vibrational modes, appears as an excess heat capacity compared to the Debye T^3-law. We show the influence of deformation and annealing on the boson peak of Cu-Zr-based metallic glass using differential scanning calorimetry. To elucidate the origin of the changes of boson peak intensity, we utilize molecular dynamics computer simulations and the harmonic approximation. The results indicate that the emergence of shear bands and their gradual relaxation upon annealing strongly influence the intensity of the boson peak for the whole sample. Moreover, the annealing experiments also give new insights into the thermal relaxation behavior of shear bands in metallic glasses.