MM 20: Liquid and Amorphous Metals III: Deformation of Metallic Glasses

Time: Tuesday 10:15–11:30 Location: H 0107

MM 20.1 Tue 10:15 H 0107

Potential energy landscape of deformed Cu-Zr based metallic glasses — •Tobias Brink and Karsten Albe — Fachgebiet Materialmodellierung, Institut für Materialwissenschaft, Technische Universität Darmstadt, Germany

Metallic glasses are usually described in terms of a potential energy landscape which consists of large megabasins that contain small local minima with low barriers between them. In this work, we explore the potential energy landscape of Cu-Zr glasses of varying composition using an adaptive kinetic Monte Carlo method with high temperature molecular dynamics saddle-point search. We examine the evolution of the potential energy landscape under applied strain and identify transient structural excitations as well as stress-activated plastic events (shear transformation zones). We make a distinction between these events and classify them in terms of their barriers and structural changes. Using this data, we gain quantitative insights into the microscopic processes of plastic deformation in metallic glasses, which ultimately lead to the percolation of a shear band.

MM 20.2 Tue 10:30 H 0107

Avalanches dynamics and microstructure evolution of the glassy Cu50Zr50 system by means of Molecular Dynamic Simulations. — •Alexandra Lagogianni and Konrad Samwer — 1. Physikalisches Institut, Universität Göttingen, Germany

Several experimental studies revealed the presence of avalanches/stress drops in the plastic regime of BMGs, [1-3] upon mechanical deformation, and their direct correlation with the formation and arrest of single shear bands. Aiming to gain a deeper insight of this phenomenon on a smaller length scale we employed molecular dynamic simulations of an amorphous CuZr system under tension. Different strain rates were tested at room and glass transition temperature and the distribution of stress drops sizes were statistically analysed. In agreement with the experimental findings it came out that the serrated flow takes place even from the very beginning of the elastic region while the possible alterations that occur in the microstructure of the system were exhaustively studied. The present simulation results provide a theoritical confirmation of the experimental findings and a deeper and qualitative understanding of the origin of avalanches in a metallic glass.

MM 20.3 Tue 10:45 H 0107

Investigation of kinetics and strain fields in shear bands of a Pd40Ni40P20 bulk metallic glass — •Isabelle Binkowski, Sergiy Divinski, and Gerhard Wilde — 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 reached 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. At temperatures well below the glass transition, the plastic deformation is localized in thin regions, called shear bands, with widths from 5 nm to 50 nm, whose continued activation leads to a catastrophic failure. In the area of research on shear bands, several important questions are still open, as e.g. concerning the initiation, propagation, kinetics of shear banding as well as concerning the intrinsic properties of these thin plate-like regions. In the present study, the mechanism of shear banding in a Pd40Ni40P20 bulk metallic glass was investigated in detail. The investigation focuses on the kinetic and structural properties of the shear bands in this highly stable bulk metallic glass by the use of various experimental techniques.

MM 20.4 Tue 11:00 H 0107

Crossover from random three-dimensional avalanches to correlated nano shear bands in metallic glasses — •Carlos Herrero-Gómez, Jon-Olaf Krisponeit, Sebastian Pitikaris, Karina E.Avila, Stefan Küchemann, Antje Krüger, and Konrad Samwer — University of Goettingen,Goettingen, Germany

Bulk metallic glasses respond with elastic and/or plastic deformation to applied mechanical stresses. Such deformation do not have a smooth dependence with the applied stress but take place via jerky jumps, which are often referred as Crackling Noise [1] . We report a statistical analysis of the crackling noise in metallic glasses for creep measurements. Such analysis shows the existence of a crossover which seems to indicate a change in the process of deformation [2]. Although the microscopic theory of deformation remains an open task, this crossover seems to indicate a transition in the plastic deformation behavior from the three-dimensional random activity of Shear Transformation Zones to a two-dimensional nano-shear band sliding. Financial support by the EU Marie Curie Grant 60780 within the VitriMetTech Initial Training Network is thankfully acknowledged.

[1] Dahmen, Karin Ben-Zion, Yehuda Uhl, Jonathan. Micromechanical Model for Deformation in Solids with Universal Predictions for Stress-Strain Curves and Slip Avalanches. Phs Rev Let.102,17, 175501 (2009)

[2] Krisponeit, J.O et al. Crossover from random three-dimensional avalanches to correlated nano shear bands in metallic glasses. Nat. Commun. 5:3616 (2014)

MM 20.5 Tue 11:15 H 0107

Evolution of crystallite size, lattice parameter and internal strain in Al precipitates during high energy ball milling of partly amorphous Al87Ni8La5 alloy — •Matthias Dittrich[1,2] and Gerhard Schumacher[1] — [1]Helmholtz-Zentrum Berlin, Mikrostruktur und Eigenspannungsanalyse — [2]jetzt: Bundesanstalt für Materialforschung und -Prüfung Berlin

The effects of plastic deformation by ball milling on the structure of a partly amorphous Al87Ni8La5 alloy were investigated by X-ray diffractometry. Lattice parameter, crystallite size and lattice strain of the fcc-Al precipitates were determined by Rietveld refinement, double-Voigt approach and Williamson-Hall plots. The changes in lattice parameter of fcc-Al nano-precipitates during ball milling are ascribed to the uptake of Ni. The crystallite size decreases as a function of the milling time from about 100 nm in the as- atomized state to about 14 nm after 1440 min of ball milling time. A model based on shear deformation of precipitates in the amorphous phase is used to describe quantitatively the decrease in crystallite size and change in lattice parameter.