MM 18: Topical Session Glass Dynamics V

Time: Tuesday 10:15–11:15 Location: H16

Topical Talk MM 18.1 Tue 10:15 H16

The low-frequency vibrational properties of model bulk metallic glasses within the harmonic approximation. — •Peter Derlet[1], Robert Maass[2], and Jörg Löffler[2] — [1]Condensed Matter Theory Group, Paul Scherrer Institut, Switzerland — [2]Laboratory of Metal Physics and Technology, Department of Materials, ETH Zurich, Switzerland

Bulk Metallic Glasses (BMGs) exhibit a rich variety of vibrational properties resulting from the significant topological disorder which occurs at the atomic scale. In the low-frequency regime confined resonant vibrational modes occur that manifest themselves as a Bose peak in the vibrational density of states. However, the precise nature of these modes and how they are influenced by local atomic structure remains unclear. Using standard harmonic analysis, this study investigates various aspects of the problem by diagonalising the Hessian of atomistic BMG structures derived from molecular dynamics simulations via a binary Lennard Jones pair potential. The results are discussed in terms of their possible relation to atomic transition pathways that result in local shear deformation zones - the underlying microscopic process contributing to the plasticity of BMGs.

MM 18.2 Tue 10:45 H16

Relaxation processes in metallic glasses studied by mechanical spectroscopy — •Dennis Bedorf, Moritz Schwabe, Stefan Küchemann, Hannes Wagner, Walter Arnold, and Konrad Samwer — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

We are interested in understanding fundamental relaxation process in glasses, especially in metallic glasses. The use of different mechanical spectroscopy techniques enables us to get an insight of the relaxation processes with a broad range of frequencies. It is also possible to compare the relaxation behavior of samples with length scales from cm down to nm. Annealing experiments reveal reversible relaxations in bulk samples for a temperature regime, where only the β-process is commonly observed [1]. Relevant length scales of dynamic heterogeneities can be obtained from measurements under reduced sample sizes or with local probing techniques. Mechanical loss measurements of thin films indicate a critical length scale of $\approx$ 30 nm for the activation of slow β-processes, while local probing, using an atomic force acoustic microscope (AFAM), demonstrates the heterogeneity of the local indentation modulus.

[1] A. Kahl, T. Koeppe, D. Bedorf, R. Richert, M. L. Lind, M. D. Demetriou, W. L. Johnson, W. Arnold, and K. Samwer, APL, 95, 201903 (2009)

MM 18.3 Tue 11:00 H16

Enthalpy and free volume relaxation in a Zr-Ti-Ni-Cu-Be bulk metallic glass alloy — •Zach Evenson and Ralf Busch — Chair of Metallic Materials, Saarland University, PO Box 151150, 66041 Saarbruecken, Germany

We report on the enthalpy and free volume relaxation kinetics of the $Zr_{44}Ti_{11}Ni_{10}Cu_{10}Be_{25}$ (Vitreloy 1b) bulk metallic glass as measured with dilatometric and calorimetric methods. Using Differential Scanning Calorimetry (DSC) samples are relaxed into the metastable equilibrium liquid at temperatures below the calorimetric glass transition (T_g); the resulting enthalpy recovery ($\Delta H^{recov.}$) is then measured upon re-heating into the supercooled liquid region. It is found that the sample volume also relaxes into a metastable equilibrium liquid state, observed on a long time scale. These volumetric changes are measured isothermally using Thermal Mechanical Analysis (TMA). The total changes in the free volume ($\Delta v_f/v_m$) from the initially glassy state and the equilibrium liquid are calculated during annealing at the same temperatures as in DSC. The equilibrium free volume change is found to relax with a stretched exponential behavior and is best fitted with a Kohlrausch-Williams-Watts (KWW) function with beta-values approaching unity close to the glass transition. The measured values of $\Delta H^{recov.}$ and $\Delta v_f/v_m$ correlate well within the framework of free volume theory and a linear relationship is found between the two.