MM 4: Liquid and Amorphous Metals I: Glassy dynamics

Time: Monday 10:15–11:30 Location: H52

MM 4.1 Mon 10:15 H52

Experimental evidence for a dynamical crossover in liquid aluminium — •Franz Demmel[1] and Christoph Morkel[2] — [1]ISIS Facility, Rutherford Appleton Laboratory, Didcot, OX11 0QX, UK — [2]Physikdepartment E21, TU Munchen, 85748 Garching, Germany

The temperature dependence of the dynamic structure factor at next-neighbour distances has been investigated for liquid aluminium [1]. This correlation function is a sensitive parameter for changes in the local environment and its Fourier transform was measured in a coherent quasielastic neutron scattering experiment. The zero frequency amplitude decreases in a nonlinear way and indicates a change in dynamics around 1.4 Tmelting. From that amplitude a generalized viscosity can be derived which is a measure of local stress correlations on next-neighbour distances. The derived generalized longitudinal viscosity shows a changing slope at the same temperature range. At this temperature the freezing out of degrees of freedom for structural relaxation upon cooling sets in which can be understood as a precursor towards the solid state. Thermodynamic calculations for the solid state predicted an upper temperature stability limit for the solid phase which corresponds favourable with our observations. That crossover in dynamics of liquid aluminium shows the same signatures as previously observed in liquid rubidium and lead, indicating a universal character. [1] F. Demmel, A. Fraile, D. Szubrin, W.C. Pilgrim and C. Morkel, J.Phys.: Condens. Matter 27 455102 (2015)

MM 4.2 Mon 10:30 H52

Distinct dynamical regimes in a gold-based metallic glass revealed by X-ray photon correlation spectroscopy (XPCS) — •Simon Hechler[1], Beatrice Ruta[2], Zach Evenson[3], Moritz Stolpe[1], William Hembree[1], Isabella Gallino[1], and Ralf Busch[1] — [1]Lehrstuhl für Metallische Werkstoffe, Universität des Saarlandes, Saarbrücken — [2]ESRF, Grenoble — [3]Heinz Maier-Leibnitz-Zentrum, TU München, Garching

Although structural relaxation is a universal feature of glasses, the atomic-level processes involved still remain a puzzling mystery. XPCS has emerged as a novel technique for studying the microscopic dynamics of non-equilibrium condensed matter, as it enables the investigation of the structural relaxation time by resolving the translational atomic motion in non-equilibrium materials as metallic glasses. Using XPCS experiments, we follow the equilibration from the glass into the supercooled liquid of a gold- based metallic glass. The as-cast alloy shows different dynamical regimes as it approaches the glass transition.At low temperature, the relaxation time appears to be almost temperature independent. Upon heating, closer to the glass transition, the glass shows highly temperature dependent dynamics. In the supercooled liquid region, the material changes the equilibrium dynamics upon cooling to a significantly stronger dynamic behavior, without freezing to a glass. Such crossovers in the dynamics have not been observed in XPCS studies before and suggest the existence of complex structural relaxation mechanisms in this metallic glass forming material.

MM 4.3 Mon 10:45 H52

Atomic-scale structural changes during a liquid-liquid transition in a Zr-based bulk metallic glass forming alloy — •Moritz Stolpe[1], Shuai Wei[2], Isabell Jonas[3], William Hembree[1], Zach Evenson[4], Fan Yang[3], Andreas Meyer[3], and Ralf Busch[1] — [1]Lehrstuhl für Metallische Werkstoffe, Universität des Saarlandes, Saarbrücken — [2]Department of Chemistry and Biochemistry, Arizona State University, Tempe — [3]Institut für Materialphysik im Weltraum, DLR, Köln — [4]Heinz Maier-Leibniz Zentrum, TU München, Garching

Liquid-liquid phase transitions (LLTs) are considered as a possible source to explain anomalous changes in the viscous behavior, a phenomenon known as fragile-strong transition.

Using synchrotron X-ray scattering combined with electrostatic levitation we investigated the structural evolution of Zr-based metallic glass forming alloy from above the liquidus temperature down to the glass transition temperature Tg. Our study reveals a LLT from a less ordered high temperature to a more ordered low temperature phase which, thermodynamically, manifests as a smeared-out peak in the heat capacity. Although no notable density change is observed, marked structural changes in both, short- (SRO) and medium range order (MRO) occur. Our results imply that in particular the structural evolution at MRO is related to the experimentally observed change in the viscous behavior. This is in agreement with the conception that the viscous slowdown is related to an extension of MRO through an aggregation of energetically-preferred atomic clusters.

MM 4.4 Mon 11:00 H52

Thermodynamic Properties of Zr- and Au-based Bulk Metallic Glasses Low Temperatures — •Andreas Reifenberger[1], Mahmoud Abdel-Hafiez[2], Andreas Fleischmann[1], Andreas Reiser[1], and Christian Enss[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, INF 227, 69120 Heidelberg — [2]Physikalisches Institut, Goethe-Universität Frankfurt, Max-von-Laue-Str. 1, 60438 Frankfurt am Main

The origin of low temperature excitations in bulk metallic glasses is still an open question. We report on measurements of both low-temperature specific heat C_p and thermal conductivity κ of two model glasses based on Au and Zr (Au-BMG and Zr-BMG, respectively) in the temperature range from 1K to room temperature. We find pronounced low temperature anomalies in the phononic specific heat C_{ph}, which are attributed to localized harmonic vibration modes. These Einstein modes act as additional scattering centers as can be seen in a plateau region in the thermal conductivity data. Furthermore, we derive the phonon mean free path $l = 3\,\kappa/(C_V\,v)$, finding an overdamped region for temperatures higher than the corresponding Einstein energies. It is noteworthy that the mean free path in the overdamped region is comparable to phonon wavelengths corresponding to the found Einstein energies.

15 min. coffee break