MM 4: Topical session: Dynamics, relaxation and deformation in deeply supercooled metallic liquids and glasses I - Structural Transitions

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

Topical Talk MM 4.1 Mon 10:15 IFW A

Structural transition upon vitrification in viscous metallic liquids — •Andreas Meyer — Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt, Köln

We investigate vitrification of bulk-glass forming Zr-Ni-Cu-Ti-Be and Zr-Cu-Ni-Al-Nb liquids from the equilibrium melt to the glass transition in-situ with container-less processing. Electrostatic levitation gives access to the measurement of temperature, density and in combination with X-ray diffraction to the total structure factor. Free radiation cooling of the sample allows the measurement of the specific heat over constant emissivity of the sample, which exhibits a pronounced peak in the deeply undecooled melt. This comes along with a change in the temperature dependence of the position of the first sharp diffraction peak, whereas the thermal expansion of the sample does not exhibit a detectable change over the entire temperature range. In addition, indirect information on the specific heat of the sample is obtained by precise measurement of the required heating laser power. All measurements reveal a consistent onset of changes in the total structure factor and the specific heat with no detectable cooling rate dependence. Results are discussed in the context of liquid-liquid phase transitions and the mode coupling theory of the liquid to glass transition.

MM 4.2 Mon 10:45 IFW A

Identifying structural changes in the medium range order of metallic glasses by Fluctuation Electron Microscopy (FEM) — •Dominik Tönnies, Lin Tian, and Cynthia A. Volkert — Institute of Materials Physics, University of Göttingen, Germany

The structural heterogeneity of a metallic glass (MG) is known to have tremendous impact on many important properties of the system, such as the mechanical performance and the formation of shear bands. While it is commonly understood how to *qualitatively* alter the structure by thermal and mechanical treatments, it is still extremely difficult to *precisely quantify* the subtle changes in the real-space order induced by structural alterations. For the characterization of medium range order (MRO) of an amorphous system, the method of Fluctuation Electron Microscopy (FEM) has been found useful in the past. In this method, very small volumes of the MG structure are probed by an electron beam in the Transmission Electron Microscope (TEM). Information about changes in the MRO is subsequently inferred from pixel variances of diffraction patterns taken at many different sample sites. We have used this technique to characterize the structure of a $Pd_{77.5}Cu_6Si_{16.5}$ MG at different structural states induced by thermal annealing, cooling to cryogenic temperatures, and mechanical rejuvenation. The results will be compared with nanoindentation pop-in studies to understand the influence of structure on the onset of mechanical deformation.

MM 4.3 Mon 11:00 IFW A

Signature of the atomic structure in the thermophysical properties of flint and metallic glasses — •Simon Hechler[1], Isabella Gallino[1], Moritz Stolpe[1], Frank-Thomas Lentes[2], and Ralf Busch[1] — [1]University of the Saarland, 66123 Saarbrücken, Germany — [2]Schott AG, 55122 Mainz, Germany

Flint glasses are silicates with large lead oxide content. From the experimental point of view, these glasses are the ideal network glass formers to compare metallic glasses with as they exhibit comparable glass transition temperatures. Metallic glasses are multicomponent atomic glass formers. The structure of these two types of glasses is completely different. Flint glasses build networks by connecting silicon and lead over bridging oxygen atoms with covalent or even ionic bondings. Metallic glasses have non-directional metallic bonds and a less ordered clustered structure. The differences in the structure of these materials manifests in their thermophysical properties like the specific heat capacity and viscosity. For understanding the structure property relationship in glasses, three flint glasses with different lead content are investigated in terms of specific heat capacity and viscosity and compared to metallic glass formers.

MM 4.4 Mon 11:15 IFW A

Structural reordering in CuZr-based metallic glass via short term sub-Tg annealing — •Baran Sarac[1], Andrea Bernasconi[2], Jonathan Wright[3], Mihai Stoica[4], and Jürgen Eckert[1] — [1]Erich Schmid Institute of Materials Science, OeAW, Leoben, Austria — [2]Dept. of Chemistry University of Pavia, Pavia, Italy — [3]ESRF-The European Synchrotron, Grenoble, France — [4]ETH Zurich, Department of Materials, Zürich, Switzerland

This work highlights the structural reordering and nanocrystallization behaviour of a recently in-house developed Cu46Zr44Al8Hf2 bulk metallic glass upon short term sub-glass transition annealing. This special type of heat treatment process generated work hardening confirmed by three-point bend tests. Structural reordering is investigated via high energy synchrotron X-ray diffraction ($\lambda = 0.01239$ nm), and compare the results with the structural modifications obtained from transmission electron microscopy (TEM) and conventional X-ray diffraction with Co Kα radiation ($\lambda = 0.01789$ nm). 2D diffraction image displays remarkable diffraction spots from different phases, where the total structure factor S(Q) tends to decrease upon heat treatment. Real-space pair distribution function (PDF) analysis reveals the peak shifts and thereby, changes within the short- to medium-range ordering. The changes in the average coordination number and distances between atom pairs upon annealing is studied from the first coordination shell of the radial distribution function (RDF), where the Gaussian fitting provided us the dominant atom pairs within the as-cast state and the annealed metallic glass.