MM 8: Liquid and Amorphous Metals II: Structure Formation in Metallic Glasses

Time: Monday 11:45–13:00 Location: H 0107

MM 8.1 Mon 11:45 H 0107

On the path from disorder to long-range order in condensed matter — •Peter Häussler — Chemnitz University of Technology, Institute of Physics, 09107 Chemnitz

We well know how molecules form, but we are still lacking a deep understanding how long-range structural order is arising. Liquid and amorphous systems are predetermined to solve this situation. Both are following the completely disordered state and are precursors of the crystals. They should still show individual features of the elements involved, but should also show features of ordering. The emergence of medium-range order, as well as the correlated emergence and evolution of physical properties are in the focus of our research.

After the preparation of very different amorphous thin films we studied their structure and electronic transport properties over a large range of temperature and composition. In this contribution we will report on several involved scenarios, as well as new techniques to analyze the data, in particular the structural ones. We will report on pure elements, binary as well as ternary inorganic alloys, irrespective whether they are insulating or stay metallic. Our description will be the most simple to imagine, will deal with a few global species only, which themselves consist of collectively acting subspecies. Along this line we are able to reduce the tremendous number of parameters to describe e.g. 10^{23} individual atoms/ions to a few parameters only. Accordingly, we are able to understand the major structure-forming effects.

MM 8.2 Mon 12:00 H 0107

Non-isothermal crystallization kinetics of metallic glass by differential fast scanning calorimetry — •Bin Yang[1], Yulai Gao[2], and Christoph Schick[1] — [1]AG Polymer Physics, Institute of Physics, University of Rostock, Germany — [2]School of Materials Science and Engineering, Shanghai University, Shanghai, P.R. China

The thermal stability and the kinetic fragility of Al86Ni6Y4.5Co2La1.5 (%wt.) metallic glass were investigated by ultra-fast non-isothermal thermal analysis. The differential fast scanning calorimeter (DFSC) traces revealed that the material undergoes a three-stage crystallization for heating rates ranged from 5 to 40,000 K/s. Combining DSC and DFSC, the kinetics of the glass transition and crystallization of Al86Ni6Y4.5Co2La1.5 metallic glass was investigated. The kissinger plot can express the temperature dependence of growth rate of this metallic glass. Furthermore, the kinetic fragility for Al86Ni6Y4.5Co2La1.5 metallic glasses is evaluated. Depending on the fragility index, this metallic glass is a liquid of very high fragility, similar to several organics.

MM 8.3 Mon 12:15 H 0107

Effect of minor additions on the structure and dynamics of binary Zr-Cu melts — •Zach Evenson, Fan Yang, Dirk Holland-Moritz, and Andreas Meyer — Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt (DLR), 51147 Köln

The formation of bulk metallic glasses can be greatly enhanced through the minor addition of another element, although the underlying physical mechanisms remain largely unknown and often speculative. It has been suggested that minor additions can lead to a more sluggish melt kinetics as well as thermodynamically suppress competing crystal phases. However, very few studies are actually carried out in the melt to directly test these assumptions. We report on the effect of minor additions of Al and Ti on the structure, dynamics and glass-forming ability of binary Zr-Cu liquids. In order to accurately investigate the physical properties of chemically reactive metallic melts and gain access to the metastable undercooled liquid, we employed electrostatic levitation (ESL) as a versatile containerless processing technique. Investigations of a $Zr_{50}Cu_{50}$ liquid with minor additions of only 4 at.% Al or Ti reveal a complex interplay between structure and dynamics as a result of chemical short-range order, extending beyond simple considerations based on free volume or atomic packing. The impact of minor additions on the glass-forming ability of this system is discussed in terms of non-ideal interactions between the melt constituents.

MM 8.4 Mon 12:30 H 0107

Effects of hydrogen-microalloying on the properties of bulk metallic glasses — •Davide Granata, Erwin Fischer, and Jörg F. Löffler — Laboratory of Metal Physics and Technology, Department of Materials, ETH Zurich, Switzerland.

Microalloying, i.e. the addition of small amounts of alloying elements, has been found to be a viable tool to significantly improve the glass-forming ability (GFA) of metallic systems. In this work we identified hydrogen to be an ideal microalloying element to simultaneously improve the GFA and mechanical properties of bulk metallic glasses (BMGs). We processed various BMGs under a hydrogen-containing atmosphere and thus directly introduced hydrogen as an alloying partner to the resulting glass structure. Using this hydrogen-microalloying approach we found a simultaneous enhancement of the attainable critical casting thickness and malleability. The effectiveness of this processing route depends on how strongly hydrogen is incorporated into the microstructure and thus how strongly hydrogen (out-)diffusion can be suppressed. Based on these results, we will also discuss implications for future BMG design.

MM 8.5 Mon 12:45 H 0107

Influence of micro alloying on the bulk metallic glass former PdNiP — •Niklas Nollmann, Isabelle Binkowski, Harald Rösner, and Gerhard Wilde — Westfälische Wilhelms-Universität, Münster

When describing the deformation of bulk metallic glasses (BMGs), two different modes have to be distinguished. For high temperatures and low stresses homogeneous flow occurs, whereas for low temperatures and high stresses the flow becomes inhomogeneous. During inhomogeneous deformation of metallic glasses (e.g. in compression or bending) the strain is localized in thin regions, the so-called shear bands. In general, bulk metallic glasses show almost no ductility during plastic deformation. For instance, in compression tests BMGs fail catastrophically mostly at the location of one shear band that is typically inclined at about 45 degrees with respect to the load axis. The investigated PdNiP glass features a high ductility in bending compared to different metallic glasses. By the use of micro alloying, the mechanical properties of metallic glasses can be influenced. In our investigation, we demonstrate that the ductility in bending and compression of the PdNiP bulk metallic glass can be altered by adding small amounts of a differing element. Whereas cobalt additions improve the ability of plastic deformation, an iron addition leads to an almost complete loss of ductility. The results are discussed concerning the possible interrelation between minor alloying and plasticity enhancement.