MM 56: Liquid and Amorphous Metals IV

Time: Thursday 11:30–13:00 Location: IFW A

MM 56.1 Thu 11:30 IFW A

Scenarios of structure stabilization in amorphous AlMnCu — •Syed Sajid Ali Gillani and Peter Häussler — Chemnitz University of Technology, Institute of Physis, 09107 Chemnitz, Germany

Structural studies of binary amorphous AlMn and AlCu and two different cuts through the ternary AlMnCu show purely amorphous regions, those with additional quasi-crystalline features, as well as those with nano-crystalline inclusions. Our analysis focuses on global resonance effects between two global subsystems, the Fermi gas as one and the static structure as the other one. The global resonances in this case are self-organizing via the exchange of a characteristic momentum, supported by density anomalies, hybridization effects and phase separations. For both, the binary a-AlMn as well as the binary a-AlCu systems, the corresponding structure factors $S(K)$ show the resonance peaks at $K_{\mathrm{pe}} = 2k_{\mathrm{F}}$. They correspond in r-space to a spherical-periodic atomic order. The self-organizing processes are limited since e.g. hybridization needs minimal as well as maximal contents of transition metals (here Mn) and changes if we replace the Mn. To go more into details, we go along two cuts through the ternary AlMnCu and so are able to cross the several limits at different compositions. Amorphous AlMnCu seems to be a model system for a deeper understanding of those effects. For one cut we start at a-$Al_{50}Mn_{50}$ and add Cu. A second cut starts from a-$Al_{60}Cu_{40}$, keeps the Cu-content constant and varies both, the Al- as well as the Mn-content. We report on the results.

MM 56.2 Thu 11:45 IFW A

Investigations of temperature-time-transformation behavior of bulk glass forming alloys — •Stefanie Koch[1,2], Dieter M. Herlach[1,2], and Markus Rettenmayr[3] — [1]Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt, 51170 Köln, Germany — [2]Institut für Experimentalphysik IV, Ruhr-Universität Bochum, 44780 Bochum, Germany — [3]Otto-Schott-Institut für Materialforschung, Friedrich-Schiller-Universität Jena, 07743 Jena, Germany

Isothermal crystallization studies were performed on Zr-based bulk glass forming alloys in the undercooled liquid region between the glass transition and liquidus temperature. The resulting temperature-time-transformation (TTT) diagram for crystallization is used to identify the primary factors influencing their glass-forming ability.

To prevent heterogeneous nucleation on container walls, levitation techniques are used. In this work electrostatic levitation (ESL) is used to melt and undercool samples. Containerless processing is an effective tool for undercooling melts far below their equilibrium melting temperatures. In case of ESL samples in a diameter of 3mm are processed in ultra-high vacuum.

At first an effect of the temperature from which the melt is cooled is observed on the crystallization behavior for Zr-based bulk metallic glasses. A critical temperature is found above which there is an increase in the undercooling and the crystallization time. To determine the TTT diagram, isothermal experiments were performed.

This work is supported by DLR Space Management.

MM 56.3 Thu 12:00 IFW A

Indication for a liquid-liquid phase transition during ultrafast heating of metallic glasses — •Stefan Küchemann[1], Norbert Mattern[2], and Konrad Samwer[1] — [1]1. Physikalisches Institut, Georg-August-Universität Göttingen, 37077 Göttingen, Germany — [2]Leibniz Institut für Festkörper- und Werkstoffprüfung Dresden, 01171 Dresden, Germany

Although the origin of the dramatic change of the dynamics in the supercooled liquid region of metallic glasses has been studied since many years, there is still no conclusive explanation for this behavior. The incipient crystallization process limits the number of possible techniques which can be used to study the supercooled liquid region of metallic glasses. In this contribution, we used an ultrafast capacitor discharge in order to heat up metallic glasses homogeneously above the glass transition temperature with typical heating rates of the order of 106 K/s [1]. For our measurements, we used melt-spun ribbons of nominal composition of Zr65Cu27.5Al7.5. At high temperatures, we studied the specific heat as well as structural changes during the crystallization at different temperatures. Therefore, X-ray measurements have been performed at P07 beamline of PETRA III at DESY. A newly developed chopper system has been used in order to enhance the temporal resolution of the 2D detector from 15 Hz up to 195 Hz. The observations will be discussed in the framework of a liquid-liquid phase transition. Financial support by DFG within SFB 602 is gratefully acknowledged.

[1] William L. Johnson et al., Science 332, 828 (2011)

MM 56.4 Thu 12:15 IFW A

Thermal Conductivity of Superconducting Bulk Metallic Glasses in the Temperature Range between 6 mK and 300 K — •Daniel Rothfuss[1], Andreas Reiser[1], Andreas Fleischmann[1], Uta Kühn[2], and Christian Enss[1] — [1]Kirchhoff-Institute for Physics, Heidelberg University, INF 227, 69120 Heidelberg — [2]IFW Dresden, Institute for Complex Materials, P.O. Box 270116, 01171 Dresden

Bulk metallic glasses (BMG) are a new and very interesting kind of amorphous materials. Measuring the thermal conductivity provides the possibility to probe the fundamental interactions governing the heat flow in solids. We present the first measurements of the thermal conductivity of two superconducting BMGs in the temperature range from 6 mK to 300 K. Our results show that the thermal conductivity of BMGs can be described by two independent contributions based on conduction electrons and phonons. Above the critical temperature T_{c} the part based on conduction electrons is determined by defect scattering and reduces rapidly below T_{c}. Sufficiently far below T_{c} the thermal conductivity is based on the part of the phonons and can be described by their resonant scattering with tunneling systems. Above T_{c} the contribution of the phonons can be described successfully within a novel model considering not only electrons and phonons but also localized modes as scattering centres. At ultralow temperatures a new contactless measuring technique was used, which is based on optical heating and paramagnetic temperature sensors that are read out by a SQUID magnetometer.

MM 56.5 Thu 12:30 IFW A

Heat flow analysis of amorphous solids using dynamic differential scanning calorimetry (DDSC) — •Birte Riechers[1], Ranko Richert[2], Carsten Mahn[1], and Konrad Samwer[1] — [1]1.Physiklisches Institut, Georg-August-Universität Göttingen, Deutschland — [2]Department of Chemistry and Biochemistry, Arizona State University, USA

Relaxation modes, especially their detailed description and understanding, play a captivating role for physicists working with glassy matter. One of many interesting aspects is the temperature dependence of the relaxation mode distribution, and of their relaxation times, which can be explored by DDSC. Therefore, the heat response of amorphous PdCuSi and PMMA is analyzed by applying a periodic triangular excitation of temperature below the glass transition temperature. Though only odd harmonics contribute to the excitation function, i.e. temperature, also even harmonics are seen in the response function, i.e. heat flow. This non-linear behavior gives information about the energy transfer to excited relaxation modes due to temperature variation. Moreover, the change in specific heat of even harmonics offers insight into temperature dependent relaxation times of excited modes.

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MM 56.6 Thu 12:45 IFW A

High-resolution laser dilatometry applied to volume equilibration phenomena in bulk metallic glasses — •Martin Luckabauer[1], Uta Kühn[2], Jürgen Eckert[2], and Wolfgang Sprengel[1] — [1]Institut für Materialphysik, Technische Universität Graz, Austria — [2]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, Germany

The slowing down of molecular or atomic motion occurring at the calorimetrically determined glass transition temperature T_{g} upon cooling complicates the access of kinetic processes at lower temperatures. However, possible changes around or below T_{g} regarding the structural dynamics are believed to yield key parameters in understanding the glass transition. In this talk some insight on how to examine the equilibration processes in the far sub- T_{g} regime will be given applying the method of high-resolution laser dilatometry. This technique involves contactless measurements with a 2-beam Michelson laserinterferometer capable of accessing volume equilibration time constants of up to $1{\cdot}10^6$ s with a length change resolution of up to 10 nm. In addition the dynamical change of the instantaneous thermal expansion coefficient during volume equilibration can be studied simultaneously. Experimental results regarding changes in the volume equilibration processes upon approaching the glass transition from lower temperatures are presented. Moreover, the possibility of using the thermal expansion coefficient as an indication of the equilibration state of the material is discussed. Financial support by the Austrian Science Fund (FWF) is appreciated (project P22645-N20).