MM 11: Liquid and Amorphous Metals III

Time: Monday 15:45–17:15 Location: IFW D

MM 11.1 Mon 15:45 IFW D

Stick-Slip Instabilities in a Zr-based Bulk Metallic Glass — •David Klaumünzer, Robert Maass, Peter Thurnheer, and Jörg F Löffler — Laboratory of Metal Physics and Technology, ETH Zurich, Zurich, Switzerland

At temperatures well below the glass transition, plastic deformation of bulk metallic glasses is characterised by a strong degree of flow localisation and the formation of narrow shear bands. The mechanism by which shear bands form and operate remains subject of debate. We can show that serrated flow observed during compression testing of bulk metallic glasses is remarkably similar to other stick-slip systems. While a common property of these systems seems to be their disordered nature, they essentially bridge a wide range of underlying dimensions, from macroscopic to atomic length scales. The dynamics of individual slip events in a Zr-based metallic glass can be captured by time-resolved compression testing. A careful analysis reveals a wide distribution of event duration in agreement with chaotic dynamical behaviour. A correlation between event amplitude and duration can be established. The results are discussed by applying conventional stick-slip theory to the inhomogeneous deformation behaviour of metallic glasses.

MM 11.2 Mon 16:00 IFW D

A fundamental new approach on structure formation — •Peter Häussler — Chemnitz University of Technology, Institute of Physics, 09107 Chemnitz, Germany

Whereas the formation of molecules is well understood the formation of crystalline matter is not. Liquid and amorphous systems are somewhere inbetween. The number of atoms is already huge and hence Schrödingers equation is unable to treat them properly. Thermodynamics fails too due to its incompleteness: the lack of momentum and angular momentum, indispensable incredients of any description of structure formation.

Liquid and amorphous systems are by no mean really disordered, instead show well defined structural order. We show for all the liquid elements along the Periodic Table, known to us, that their structural features are formed under the influence of resonances between global subsystems as there are the Fermi gas of the electrons as one, and the forming static structure as the other one. Both mutually adjust and trigger medium-ranging spherical-periodic order (SPO) in the mean around any atom. The fundamental processes causing this feature may once help us to understand better the formation of long-ranging crystalline order, nucleation and growth. We present a new analysis of all the structural data, discuss the resonance interaction based on momentum exchange as the driving effect which causes bonding as well as anti-bonding states between the global subsystems. We discuss the importance of entropy creation when the total system finally occupies the bonding state.

MM 11.3 Mon 16:15 IFW D

On physical properties and atomic structure of Al-Pd alloys — •Nan Jiang and Peter Häussler — Chemnitz University of Technology, Institute of Physics, 09107 Chemnitz, Germany

In recent years we reported on an electronic influence on phase stability of all the Al-3d-TM alloys (TM: Sc, ..., Cu). The electronic influence is based on an internal exchange of momentum between global subsystems, namely the electronic system and the forming static structure. Both systems come into resonance to each other. The resonance is enhanced by a hybridization effect between the Al-p- and the empty TM-d-states causing a reduced effective electron density of the total system. Structure formation, phase stability and the evolution of electronic transport properties were found to be strongly related. In the present contribution we start to replace the 3d-TM elements by the 4d-TM.

For thin films of amorphous AlPd alloys, deposited at a temperature around 4 K, the resistivity and the thermopower have been measured from 4 K to 345 K, the atomic structure after annealing to room-temperature by TEM. The thermal stability is largest around 30-40 at%Pd and hence supports our assumption of hybridization of Al-3p electrons with the Pd-4d-states. Comparing the position K_{pe} of the first peak in $S(K)$, the structure factor, with $2k_{\mathrm{F}}$, the diameter of the Fermi sphere, we extract another composition around 60 at%Pd, where again there is an electronic stabilizing effect, but now without hybridization.

MM 11.4 Mon 16:30 IFW D

Relaxation kinetics of a AuCuAgSi bulk metallic glass — •Jonas Bünz and Gerhard Wilde — Institut für Materialphysik, WWU Münster

Au-based bulk metallic glasses that were recently discovered belong to the metallic glasses that provide the highest kinetic stability against devitrification. Additionally, and in contrast to earlier types of metallic glasses with high stability, the glass transition occurs at rather low temperatures around 100°C. This allows the determination of the temperature dependence of the relaxation time directly with microcalorimetry for a Au50Cu25.5Ag7.5Si17 bulk metallic glass with very high accuracy. The availability of both relaxation data for enthalpy and volume and thermodynamic data for this specific system allows comparing different models for the structural relaxation on the basis of experimental data.

MM 11.5 Mon 16:45 IFW D

Einfluss von Silber und Bismut auf die Viskosität des flüssigen Zinns — •Andriy Yakymovych, Yuriy Plevachuk und Vasyl Sklyarchuk — Institut für Metallphysik, Nationale Ivan-Franko-Universität, Lviv, Ukraine

Blei und bleihaltige Legierungen gehören zu den gefährlichsten Chemikalien für Menschen. Ein von Verfahren bleihaltiger Materialer zu vermeiden, ist neue Lotmaterialien zu finden. Die Kräfte, welche die Struktur im festen Zustand, auch im flüssigen Zustand wirksam sind. Diese Arbeit wird die Forschungsergebnisse der Viskosität, wie eine von strukturell sensibler Eigenschaft, bleifreie Lotmaterialien (Systeme Sn-Ag und Sn-Bi-Ag) präsentiert. Die Wichtigkeit der Forschung ist die Auswirkungen von Silber und Bismut auf die Zähigkeit des Zinn zu untersuchen.

Die Viskosität von Sn, SnxAg100-x und (SnxAg100-x)90Bi10 war mit dem Torsionsviskosimeter gemessen. Die Viskositätzunahme durch zweites Element ist beobachtet. Auf andere Seite auf Isotherme ist geringe Absteigeffekt beobachtet, was ist typisch für eutektische Legierungssystemen.

MM 11.6 Mon 17:00 IFW D

Surface Tension and Reactive Wetting in Solder Connections — •Andre Wedi and Guido Schmitz — Institut für Materialphysik, Westf. Wilhelms-Universität, Wilhelm-Klemm-Strasse 10, 48149 Münster, Germany

Wetting is an important pre-requisite of a reliable solder connection. However, it is only an indirect measure for the important specific energy of the reactive interface between solder and base metallization. In order to quantify this energy, we measured wetting angles of solder drops as well as surface tension of SnPb solders under systematic variation of composition and gaseous flux at different reflow temperatures. For the latter, we used the sessile drop method placing a solder drop on a glas substrate. From the two independent data sets, the important energy of the reactive interface is evaluated based on Young's equation. Remarkably, although both, the tension between the solder and flux and the wetting angle, reveal significant dependence on solder composition. So the adhesion energy reveals distinguished plateaus which are related to different reaction products in contact to the solder. TEM analysis and calculations of phase stabilities show that there is no Cu6Sn5 for high lead concentrations. The experiments confirm a model of reactive wetting by Eustathopoulos[1].

[1]N. Eustathopoulos; Current Opinion in Solid State and Materials Science, 9 (2005) 152-160.