MM 31: Mechanical Properties III

Time: Wednesday 17:30–18:30 Location: H 0111

MM 31.1 Wed 17:30 H 0111

Inhomogeneous flow characteristics of bulk metallic glasses — •Alban Dubach, Florian Dalla Torre, and Jörg Löffler — Laboratory of Metal Physics and Technology, Department of Materials, ETH Zurich, Wolfgang-Pauli-Str. 10, 8093 Zurich, Switzerland

In contrast to crystalline metals, which exhibit dislocation mediated deformation, bulk metallic glasses (BMGs) bear a high resistance to plastic flow at low temperatures (T) but viscous like properties close to their glass transition temperature. Both mechanical responses underlie a single mechanism: nucleation and propagation of shear transformation zones (STZs). As opposed to high T deformation at low T is temporarily and spatially restricted within narrow shear bands and therefore difficult to assess experimentally and less well understood.

In this study the inhomogeneous flow kinetics of Zr-based BMGs are investigated at sub-ambient T by strain rate change tests and the temporal and spatial characteristics of shearing are compared with the appearance of shear bands and fracture surfaces. Using the time durations of individual shear events an "apparent viscosity" at the moment of shearing can be estimated. Our results show that serrated flow, typically observed at room temperature, disappears below a critical T or above a critical strain rate, in accordance with a change of the strain rate sensitivity. A constitutive model for inhomogeneous flow in BMGs is presented which describes the deformation behaviour according to a thermally activated (cooperative) motion of STZs, including a time varying state variable representing the local state of relaxation in the shear band.

MM 31.2 Wed 17:45 H 0111

Predicting deformation localisation in cellular materials — •John Dunlop[1], Richard Weinkamer[1], Yves Bréchet[2], and Peter Fratzl[1] — [1]Department of Biomaterials, Max Planck Institute of Colloids and Interfaces, Research Campus Golm, 14424, Potsdam, Germany — [2]Groupe Physique du Métal, SIMAP INPG, Domaine Universitaire de Grenoble, 38402 Saint Martin d'Hères, France

Cellular and porous solids fail under compressive loading through the nucleation and propagation of localised deformation bands throughout the material. In ordered cellular solids such as trabecular bone, wood, as well as in honeycombs and three dimensional periodic lattices localisation or crush bands form in which the localisation plane has a specific orientation with respect to the lattice architecture and the applied load. This has a strong similarity to martensitic phase transformations in atomic crystals which can be described by the propagation of elastic instabilities along particular weak crystallographic directions. The instabilities of atomic crystals were first studied by Born, and there is now a well developed theory available to describe and analyse such structures. In this contribution the lattice dynamics theory is applied to beam lattices of different architectures in order to predict the direction of deformation localisation beam lattices of different architectures in two and three dimensions.

MM 31.3 Wed 18:00 H 0111

Monte Carlo Simulation of Segregation Including Elastic Relaxations — •Rolf Anders and Ferdinand Haider — Universität Augsburg, Institut für Physik

We developed a real space technique which includes local atomic relaxation after each MC step, allowing thus to study processes with strong elastic contributions. The MC step consists of a vacancy jump, exchange of nearest neighbours or atom type change. The activation energy is computed using phenomenological interaction potentials (Lennard-Jones or EAM). After an accepted MC step the atomic coordinates in the vicinity of the modification are relaxed in order to minimise the total energy.

Using this method, segregation to lattice defects was simulated in NiAl and FeNi alloys. In the case of grain boundaries, the temperature dependence of the interfacial excess concentration was studied. It was found to be in good agreement with the Langmuir-McLean theory.

For an edge dislocation, the pinning force due to segregation was calculated. This was accomplished by shifting the concentration profile along the Burgers vector and subsequent relaxation of the lattice.

MM 31.4 Wed 18:15 H 0111

Mechanical properties of Pb-free solder-joints — •Jan Keller[1], Guido Schmitz[1], and Ulrich Wilke[2] — [1]Institut für Materialphysik, WWU Münster, Wilhelm-Klemm-Str.10, 48149 Münster, Germany — [2]Infineon Technologies AG, Max-Planck-Str. 5, 59581 Warstein, Germany

After the prohibition of lead the main focus in packaging technology is to improve the performance of electronic devices. A critical issue is the mechanically stability. From the new relevant lead free solders regarding melting point and wettability, one has to figure out the composition with the best mechanically properties. In this work, we investigate the mechanical strength of $Sn_xAg_yCu_z$-solder between Cu-substrates with different contents of Ag and Cu in Sn. After soldering reactions under reducing atmosphere the solder joints are sheared and stress-strain curves are recorded. Mechanically loaded and unloaded specimens are observed by optical and scanning electron microscopy to determine the fracture structure and the reasons for the failure. The maximum strength, fracture toughness and elongation are related to the observed microstructure.(supported by Infineon Technologies AG)