MM 39: Topical session: Interface-Controlled Microstructures: Mechanical Properties and Mechano-Chemical Coupling - Structure and deformation III

Time: Wednesday 10:15–11:15 Location: IFW B

MM 39.1 Wed 10:15 IFW B

Glass formation by severe plastic deformation of crystalline Cu/Zr nano-layers — •Suzhi Li[1], Lars Pastewka[2,3], and Peter Gumbsch[2,3] — [1]Institute of Nanotechnology, Karlsruhe Institute of Technology, 76344 Eggenstein-Leopoldshafen, Germany — [2]Institute for Applied Materials, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany — [3]Fraunhofer Institute for Mechanics of Materials IWM, 79108 Freiburg, Germany

The deformation of crystalline Cu/Zr nano-layers under severe shearing was studied by using molecular dynamics simulations. The whole process can be divided into two distinct stages. The early stage of plasticity is governed by dislocations. The dislocation-interface interaction can induce the interface roughening and slow mechanical mixing around boundaries. As strain is further applied, dislocation activities become less active. Under the large strain, domains are further refined and finally the interfaces are attached locally, where solid-state crystal-to-amorphous transition occurs. The deformation mode then transforms from dislocation plasticity to amorphization. The following deformation is fully localized in the glass transition zone where a strong atomic mixing takes place. The whole crystal-to-amorphous transition process can be characterized by certain Voronoi cells, such as Cu-centered <0 0 12 0>. In addition, the amorphization in thinner layers can be achieved at smaller shear strain. Our work enriches the understanding of amorphization and mechanical alloying in heavily deformation multicomponent systems.

MM 39.2 Wed 10:30 IFW B

Micro-mechanics of amorphous metal/polymer hybrid structures with 3D cellular architectures: size effects, buckling behavior and energy absorption capability — •Maxime Mieszala[1], Laszlo Petho[1], Johann Michler[1], Madoka Hasegawa[1], Jens Bauer[2], Oliver Kraft[2], and Laetitia Philippe[1] — [1]Empa, Materials Science and Technology, Thun, Switzerland — [2]Karlsruhe Institute of Technology, Institute for Applied Materials, Karlsruhe, Germany

By designing advantageous cellular geometries and combining the material size effects at the nanometer scale, lightweight hybrid micro-architectured materials with hierarchical cellular structures and tailored structural properties are achieved. To determine the mechanical performance of polymer cellular nanolattices reinforced with a metal coating, 3D laser lithography and electroless deposition of an amorphous layer of NiB is used to produce metal/polymer hybrid structures. Microcompression experiments show an enhancement of the mechanical properties with the thickness of the NiB layer, suggesting that the deformation mechanism and the buckling behavior are controlled by the size induced brittle-to-ductile transition in the NiB layer. In addition, the energy absorption properties demonstrate the possibility of tuning the energy absorption efficiency with adequate designs.

MM 39.3 Wed 10:45 IFW B

Impact of the composition of Au-Ag alloys on the mechanical properties of dealloyed nanoporous gold — •Birthe Müller[1], Lukas Lührs[1], and Jörg Weissmüller[1,2] — [1]Institute of Materials Physics and Technology, Hamburg University of Technology — [2]Institute of Materials Research, Materials Mechanics, Helmholtz-Zentrum Geesthacht

Nanoporous gold (NPG) made by dealloying can be viewed as a nanofoam that consists of interconnected nanoscale pores and solid "ligaments" that can take the shape of macroscopic bodies. Due to its tunable feature size from a few to a several hundred nanometers and its high chemical stability NPG has proven an attractive model system for various small scale studies. E.g. the mechanical properties of NPG have been the subject of a multitude of studies over many years. Analog to macroscopic metallic foams, results are frequently linked to the solid fraction, ϕ. Focusing on ϕ, the influence of the initial composition of precursor alloy and the manufacturing methods are often neglected.

We present a comparative study on the mechanical properties of NPG using varying initial compositions and different processing procedures. Au_xAg_{100-x} precursors with $x = 20, 25, 30, 35$ were synthesized via electrochemical dealloying in 1 M $HClO_4$ as well as free corrosion in concentrated HNO_3. Using compression tests with single loading and load/unload protocols we investigate the stress-strain behavior, the Young's modulus and the Poisson's ratio. We find significant differences in the mechanical responses that contradict the image of a ϕ controlled behavior.

MM 39.4 Wed 11:00 IFW B

Interfaces and Vortices under High Pressure Torsion — •Roman Kulagin[1], Yulia Ivanisenko[1], Yan Beygelzimer[2], Andrey Mazilkin[1,3], Boris Straumal[1,3], and Horst Hahn[1] — [1]Institute of Nanotechnology, Karlsruhe Institute of Technology, Germany — [2]Donetsk Institute for Physics and Engineering, NASU, Ukraine — [3]Institute of Solid State Physics RAS, Russia

Here we report our results on the behavior of interfaces in the layered metallic samples under high pressure torsion (HPT). We found the development of plastic instabilities in initially flat layers during HPT and the formation of folds and vortices.

These phenomena cannot be explained by the Kelvin-Helmholtz instability mechanism. An important condition to observe the Kelvin-Helmholtz instability is that in the flowing matter the forces of inertia are of the same order of magnitude as the internal forces due to the atomic (or molecular) interactions. In this context in metal under plastic flow a role of such internal forces play forces related to flow stress. However, it is known that at moderate strain rate deformation the forces of inertia are significantly lesser than these associated with flow stress.

Using Finite Element Modeling we show that the formation of vortices during the HPT deformation occurs when the simple shear velocity field is blocked locally within the layers, or at the interfaces. As a result, the rotation of the material takes place on macroscopic level, i.e. the formation of the vortices is observed.