MM 11: Nanostructured Materials III

Time: Monday 14:45–16:15 Location: H 0107

MM 11.1 Mon 14:45 H 0107

Deformation of Metals at Small Length Scales — •Cynthia Volkert — Institut für Materialphysik, Georg-August-Universität Göttingen

"Smaller is stronger", at least for most metals. When either the sample size or grain size of a metal is decreased below one micrometer, the underlying mechanisms for deformation are changed and almost all mechanical properties - strength in particular - are influenced. Without these effects, many technologies such as microelectronic devices or hard disks would not work. In this presentation, an overview will be given of the observations, proposed mechanisms, and open questions for size effects in metal deformation. In particular, new results from uni-axial compression tests on focused ion beam machined, sub-micron columns confirm the "smaller is stronger" trend, but also challenge the existing models. The models will be critically compared and an outlook of what can be achieved by tailoring length scales in various materials will be presented.

MM 11.2 Mon 15:00 H 0107

Texture and mechanical anisotropy of ultrafine-grained Al alloys produced by accumulative roll bonding — •Juliane Hüttenrauch[1], Werner Skrotzki[1], Carl-Georg Oertel[1], Heinz-Günter Brokmeier[2], Heinz Werner Höppel[3], and Irena Topic[3] — [1]Institut für Strukturphysik, Technische Universität Dresden — [2]GKSS Forschungszentrum, Geesthacht — [3]Lehrstuhl Allgemeine Werkstoffwissenschaften, Universität Erlangen- Nürnberg

The texture of ultrafine-grained Al alloys produced by accumulative roll bonding (ARB) has been measured by neutron diffraction. The starting texture consists of a strong cube component. During ARB this texture breaks down and a texture typical for rolling of face-centred cubic metals with high stacking fault energy develops. The texture after 8 ARB cycles is characterized by the beta-fibre with the Cu component dominating. Moreover, the rotated cube component forms. This component is typical for simple shear which during rolling takes place in the surface layer of the sheets. Based on the Lankford parameter measured the mechanical anisotropy of the advanced metal sheets will be discussed.

MM 11.3 Mon 15:15 H 0107

Strain rate sensitivity of ultrafine-grained Al and Al-Mg-alloys — •Andreas Böhner[1], Johannes May[1], Aferdita Vevecka-Priftaj[2], Heinz Werner Höppel[1], and Mathias Göken[1] — [1]Institute I: General Materials Properties, Department of Materials Science and Engineering, University of Erlangen-Nürnberg, Germany — [2]Department of Physics, Polytechnic University of Tirana, Albania

Nanocrystalline or ultrafine-grained (UFG) metals are known to exhibit very high strength paired with high ductility. In this context, strain rate sensitivity (SRS) is regarded to be the main issue to explain this behaviour. Bulk UFG metals can be achieved by Equal Channel Angular Pressing (ECAP), where the material is deformed by repeated shear deformation. In this contribution, detailed investigations of the SRS of technically pure Al, AlMg and a technologically relevant Al-Mg-alloy (AA6061) were performed. For the precipitation hardenable AA6061-alloy a solution treated and a peak aged state were investigated. The SRS was determined by strain rate jump compression tests which were performed in a temperature range from room temperature (RT) up to 250 °C. It could be shown that an UFG microstructure significantly enhances the SRS, especially at elevated temperatures. The influences of precipitations, microstructure and number of ECAP passes on the SRS and the mechanical properties are also discussed.

MM 11.4 Mon 15:30 H 0107

Influence of high pressure torsion on precipitation in Al-Cu-Mg alloys studied by positron annihilation spectroscopy. — •Wolfgang Lechner[1], Werner Puff[1], Michael Zehetbauer[2], Erhard Schafler[2], and Roland Würschum[1] — [1]Institut für Materialphysik, Technische Universität Graz, Petersgasse 16, 8010 Graz, Austria — [2]Fakultät für Physik, Forschungsgruppe Physik Nanostrukturierter Materialien, Universität Wien, Boltzmanngasse 5, Universität Wien, 1090 Wien, Austria

High pressure torsion (HPT) may open up an efficient way to refine precipations of supersaturated solutions. In the present work, the influence of HPT on the precipitation in Al-Cu-Mg alloys and on the evolution of the precipitates with subsequent annealing is studied by positron annihilation spectroscopy. HPT is observed to give rise to a fragmentation of metastable nanoscaled precipitates which have formed upon pre-annealing at 200°C (3 hours). Positron lifetime spectroscopy in combination with coincident Doppler broadening of the positron-electron annihilation enables a specific and chemical sensitive distinction between interfacial vacancy-type defects associated with precipitates and the vacancy-type lattice defects formed upon high pressure torsion. Different aging behaviour is observed for undeformed and HPT-deformed samples. Financial support from the Austrian Science Found (FWF) under contracts P18111-N02 and P17095-N02 is gratefully acknowledged.

MM 11.5 Mon 15:45 H 0107

Grain boundary radiotracer diffusion of Ni in ultra-fine grained Cu–1wt.% Pb alloy produced by ECAP — •Jens Ribbe[1], Guido Schmitz[1], Juri Estrin[2], and Sergiy Divinski[1] — [1]Institut für Materialphysik, Universität Münster, Wilhelm-Klemm-Str. 10, D-48149 Münster, Germany — [2]Department of Materials Engineering, Monash University, Clayton, Australia

Severe plastic deformation is a promising technique for producing materials with a high hardness and sufficient ductility. Kinetic properties of internal interfaces in such materials with an ultra fine grained microstructure represent one of central issues. The radiotracer technique is applied for measuring Ni grain boundary diffusion in ultra fine grained pure copper materials with different nominal purities and in the Cu–1wt.%Pb alloy produced by equal channel angular pressing (ECAP). The stability of the structure of the nanostructured material was studied by focused ion beam.

The interface diffusion was investigated in the temperature interval from 300 to 520K under the Harrison C type kinetic conditions. Two distinct short-circuit diffusion paths were observed in all materials studied. The first (relatively slower) path corresponds unambiguously to general high-angle grain boundaries with diffusivities which are quite similar to those in their coarse-grained counterparts. The second path is characterized by even higher diffusivities. The measured data favour a one-dimensional but not planar nature of the second diffusion path in the Cu–1wt.%Pb alloy.

MM 11.6 Mon 16:00 H 0107

Three-dimensional tomographic EBSD measurements of the crystal topology in heavily deformed ultra fine grained pure Cu and Cu-0.17wt%Zr obtained from ECAP and HPT — •Anahita Khorashadizadeh, Myrjam Winning, and Dierk Raabe — Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf, Germany

Obtaining knowledge on the grain boundary topology in three dimensions is of great importance as it controls the recrystallization and grain growth behaviour of polycrystalline materials. In this study, the three dimensional distribution of grain boundaries and the grain topology of the as-deformed condition have been investigated using three-dimensional orientation microscopy (3D electron backscattering diffraction, EBSD) measurements in ultra fine grained pure Cu and Cu-0.17wt%Zr. Two different methods of severe plastic deformation were used to produce the ultra fine grained structures: equal-channel angular pressing (ECAP) and high pressure torsion (HPT). The experiments are conducted using a dual-beam system for 3D-EBSD. The approach is realized by a combination of a focused ion beam (FIB) unit for serial sectioning with high-resolution field emission scanning electron microscopy equipped with EBSD. The work demonstrates that the new 3D EBSD-FIB technique provides a new level of microstructure information that cannot be achieved by conventional 2D-EBSD analysis. Such information is of great importance in studying metallurgical behaviours which depend on the 3D grain boundary topology (such as grain growth, recrystallization).