MM 3: Topical Session Bulk Nanostrucured Materials I - Processing

Time: Monday 10:15–11:45 Location: H 0107

Topical Talk MM 3.1 Mon 10:15 H 0107

Generation of nanocomposites and super saturated solid solutions by SPD — •Reinhard Pippan, Andrea Bachmaier, Anton Hohenwarter, and Georg Rathmayr — Erich Schmid Institute of Materials Science, Austrian Academy of Sciences, Jahnstr.12,

Severe plastic deformation (SPD) is a very powerful tool to generate ultrafine grained or nanocrystalline materials. The thermal stability of the SPD processed single phase materials is often low and the refinement is often limited to the 100 nm regime. In order to overcome this drawback we have tried to stabilize the grain structure and to generate even finer nanostructures by second phases. Different types of materials, composites of miscible and immiscible metals, dual phase metallic materials, metal-oxide composites with extreme variations in size and concentration of oxides have been HPT deformed up to very high strains. The microstructural evolution has been examined and the refinement process is analysed. In most cases a bulk nanocomposite or a supersaturated solid solution with nanocrystalline structure or a mixture of them is formed. The fragmentation process as well as the phenomena resulting in a supersaturated solid solution and finally in a saturation will be discussed. Finally, the stability of the different nanostructured is examined and the coarsening phenomena will be considered. Financial support by the FWF Austrian Science Fund is appreciated (project S 10402-N16).

MM 3.2 Mon 10:45 H 0107

The influence of total strain and deformation rate during the ECAP process on the microstructure, microhardness and kinetic properties of nickel — •Gerrit Reglitz[1], Sergiy Divinski[1], Harald Rösner[1], Vladimir Popov[2], Evgeniy Shorokhov[3], and Gerhard Wilde[1] — [1]Institute of Materials Physics, University of Münster, Münster, Germany — [2]Institute of Metal Physics, Russian Academy of Sciences, Ekaterinburg, Russia — [3]All-Russia Research Institute of Technical Physics, Russian Federal Nuclear Center, Snezhinsk, Russia

In the last years ultra-fine grained (UFG) materials produced by severe plastic deformation like equal channel angular pressing (ECAP) or high-pressure torsion became an intensive research topic due to the improved properties which these highly deformed materials offer.

By ECAP it is possible to produce materials with different microstructures through changing the process parameters such as the total introduced strain, the deformation rate or the deformation temperature. In this work the total strain was varied by using different numbers of ECAP passes between 2 and 12, while the deformation rate was varied from $10^{-2}\ s^{-1}$ (standard ECAP) to $10^{4}\ s^{-1}$ (explosive ECAP). The microstructure, microhardness and the kinetic properties of grain boundaries in the different materials are investigated and comparatively discussed.

Support by DFG is gratefully acknowledged.

MM 3.3 Mon 11:00 H 0107

Cu(Bi) alloys processed by Dynamic plastic deformation — •Henning Edelhoff[1], Harald Rösner[1], Matthias Wegner[1], Boris Straumal[2], Zhenbo Wang[3], Ke Lu[3], Sergij Divinski[1], and Gerhard Wilde[1] — [1]Institute of Materials Physics, University of Münster, Münster, Germany — [2]Institute of Solid State Physics, Chernogolovka, Russia — [3]Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences, China

Due to the increased interest in improved materials properties by microstructural refinement numerous synthetic techniques have been developed. One special method of plastic deformation, is the so-called dynamic plastic deformation (DPD) conducted at cryogenic temperatures and high strain rates leading to nanostructured materials. In the case of pure copper, alongside to grain refinement, an increasing tendency of deformation twinning is observed [1]. In this work, the DPD technique is used to deform copper-bismuth alloys with 200 and 1200 ppm bismuth, respectively. The ultrafine grained samples produced by DPD were examined by means of X-ray diffraction analysis, transmission electron microscopy and scanning electron microscopy combined with electron back scatter diffraction. The influence of bismuth on the microstructural refinement was investigated, following a special interest in segregation of bismuth at deformation twin boundaries.

[1] Y.S. Li, N.R. Tao, K. Lu, Acta Mater, 56, 230 (2008)

MM 3.4 Mon 11:15 H 0107

Comparison of the saturation structures of intermetallic alloys subjected to severe plastic deformation — •Christian Rentenberger, Christoph Gammer, David Geist, and Hans-Peter Karnthaler — University of Vienna, Physics of Nanostructured Materials, Boltzmanngasse 5, 1090 Wien, Austria.

Microstructural refinement by severe plastic deformation is a method to achieve novel mechanical properties. Considerable attention has been devoted to pure metals and solid solution alloys but only a few studies have been carried out on intermetallic alloys. The main reason is their high brittleness making them difficult to deform. In the present work based on transmission electron microscopy (TEM) investigations the saturation structures yielded by high pressure torsion deformation of different intermetallic compounds are compared: Ni_3Al ($L1_2$ ordered), Zr_3Al ($L1_2$ ordered) and FeAl (B2 ordered). The structures are studied in three dimensions by using both different sections and novel TEM methods [1]. It is concluded that depending on the type of lattice defects induced by deformation different saturation structures are occurring: a nanocrystalline structure showing the loss of chemical long-range order or an amorphous one with residual nanograins [2,3].

[1] C. Gammer, C. Mangler, H. P. Karnthaler, C. Rentenberger. Micr. Microanal. 17, 866 (2011). [2] C. Mangler, C. Gammer, H. P. Karnthaler, C. Rentenberger, Acta Mater. 58, 5631 (2010). [3] D. Geist, C. Gammer, C. Mangler, C. Rentenberger, H. P. Karnthaler. Phil. Mag. 90, 4635 (2010). This work was supported by the Austrian Science Fund (FWF): [S10403, P22440].

MM 3.5 Mon 11:30 H 0107

Effect of hydrostatic pressure on the microstructure and mechanical properties during and after high pressure torsion — •Erhard Schafler, Roman Schuster, Michael Kerber, and Florian Spieckermann — Universität Wien, Fakultät für Physik, Physik Nanostrukturierter Materialien

The hydrostatic pressure is a general feature of severe plastic deformation (SPD) methods, especially when performing high pressure torsion (HPT). It is essential for achieving the high strains and to introduce the high amount of lattice defects, which are necessary for the fragmentation into an ultra-fine grained matereal. The investigations of HPT-processed Cu and Ni under variation of the hydrostatic pressure revealed marked differences between the in-situ torsional stress (torque measurement) and the post-HPT flow stress of the ultrafine-grained materials. A special experimental procedure was designed to simulate the hydrostatic pressure release, in order to gain insight into the processes behind unloading. Investigations by X-ray line profile analysis and hardness measurement show marked influences of the pressure release on microstructure and strength. While the size of the coherently scattering domains indicate that the fragmentation process is already finished during the HPT-deformation, the dislocation density decreases drastically and the arrangement of the dislocations within the subgrain structure changes to a less stress-intensive one, upon pressure release. In parallel the hardness decreases significantly and confirms the discrepancy between in-situ torque-stress and post-HPT flow stress. Work supported by the Austrian Science Fund, project S 10403