MM 20: Topical Session Bulk Nanostrucured Materials IV - Microstructure and Characterization II

Time: Tuesday 10:15–11:30 Location: H 0107

Topical Talk MM 20.1 Tue 10:15 H 0107

Stabilisation of nanocrystalline materials by defects — •Harald Rösner — Institut für Materialphysik, Westfälische Wilhelms-Universität Münster, Germany

The stability of nanocrystalline materials is an important issue and of technological interest. Grain growth occurs in polycrystalline materials to reduce the grain boundary area and hence the total energy of the system. Therefore, the high density of interfaces in nanocrystalline materials is likely to provide a significant driving force for grain growth. However, grain growth can be suppressed by the presence of either impurities or defects. In this talk a comprehensive study of defect-stabilized nanocrystalline Pd using aberration-corrected transmission electron microscopy is presented. Local strains were quantified at grain interiors and interfaces (grain/twin boundaries, triple/quadruple junctions) using the geometric phase analysis; a technique that allows calculation of the in-plane components of the strain tensor. The results obtained suggest that rotational defects play a significant role as stabilising elements for nanocrystalline structures.

MM 20.2 Tue 10:45 H 0107

Quantitative grain size and twin density analysis by TEM-OIM measurements for tensile testing of nanocrystalline Pd — •Aaron Kobler[1,2], Anna Castrup[1,2], Christian Kübel[1], and Horst Hahn[1,2] — [1]Institute of Nanotechnology (INT/KIT), Eggenstein, Germany — [2]Joint Research Laboratory Nanomaterials (KIT and TUD), Darmstadt, Germany

To study the deformation mechanisms in nanocrystalline (nc) Pd, we performed tensile tests on magnetron sputtered thin films in combination with orientation imaging (OIM) analysis in a TEM. TEM-OIM is a new technique that fills the gap of EBSD measurements for grain sizes below 30-50 nm. We have implemented the OIM (NanoMegas) on a FEI Tecnai F20 in micro-probe (up) STEM mode, that allows us to acquire (fast) STEM reference images. Once an OIM map is acquired, the grain size and twin density is evaluated using Mtex. The main advantage of this approach is a much better identification of grains and sub-grains and the detection of all twin boundaries within the area of interest. The thin films were magnetron sputtered onto Kapton films to avoid strain localization using conditions previously identified to minimize growth induced residual stress. Subsequently, the films were individually deformed in tension up to 0%, 2%, 3,5%, 5% and 10% and prepared for TEM imaging. Our evaluation based on the BF/DF-TEM and OIM reveals qualitatively similar results and show that the grain size and the twin density both increase continuously with increasing strain. However, the absolute twin density observed by OIM is significantly higher compared to DF-TEM as almost all twins are detected.

MM 20.3 Tue 11:00 H 0107

Electron microscopic studies of Ni_3Ge deformed by high pressure torsion — •Andreas Grill, Hans-Peter Karnthaler, and Christian Rentenberger — University of Vienna, Physics of Nanostructured Materials, Boltzmanngasse 5, 1090 Wien, Austria

Nanocrystalline $L1_2$ ordered intermetallics processed by high pressure torsion (HPT) show improved mechanical properties [1]. The persistance of larger grains oriented for multiple slip embedded in the nanocrystalline structure indicates that highly symmetric orientations are less favourable to form nanograins [2]. To study the evolution process of nanocrystallization as a function of orientation single crystalline $L1_2$ ordered Ni_3Ge of two different initial orientations was deformed by HPT. The structure of the samples was investigated by electron microscopy methods. At low numbers of turns electron backscatter diffraction of the cross section of the HPT discs shows homogeneous fragmentation. At higher numbers of turns bands are formed inhomogeneously. They cross the fragmented matrix and accumulate near the top and bottom surfaces. Transmission electron microscopy studies show that the bands consist of elongated nanograins whereas the neighbouring regions are fragmented crystallographically by a high density of defects accumulating on highly activated {111} glide planes. Finally, in the present case the different orientations seem to have little influence on the deformation structures.

[1] K. Tsuchiya, O. Ciuca. Mat. Sci. For. 667-669, 17 (2011). [2] C. Rentenberger, H. P. Karnthaler. Int. J. Mat. Res. 98, 4 (2007). This work was supported by the Austrian Science Fund (FWF): [P22440].

MM 20.4 Tue 11:15 H 0107

Texture evolution in NiAl deformed by high pressure torsion — •Christine Tränkner[1], Robert Chulist[1], Werner Skrotzki[1], Benoit Beausir[2], Thomas Lippmann[3], Jelena Horky[4], and Michael Zehetbauer[4] — [1]Institut für Strukturphysik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Laboratoire d'Etude des Microstructures et de Mécanique des Matériaux (LEM3), Université Paul-Verlaine de Metz, Metz-57012, France — [3]Institut für Werkstoffforschung, Helmholtz-Zentrum Geesthacht, 21502 Geesthacht, Germany — [4]Fakultät für Physik, Universität Wien, Austria

Small discs of polycrystalline NiAl were deformed by high pressure torsion at temperatures from room temperature up to 500°C and pressures ranging from 2 to 8 GPa. In this way, very high local shear strains at the edge of the samples of about 70 could be achieved. Local textures were measured by high-energy synchrotron radiation at several positions from the centre to the edge of the samples. Due to increasing shear strain along this line a texture gradient is observed. The texture also changes with processing temperature and pressure. Type and intensity of texture will be discussed with respect to slip system activity and recrystallization.