MM 37 Nanostructured Materials I

Time: Thursday 14:45–16:15 Room: IFW D

MM 37.1 Thu 14:45 IFW D

Early stages of Al/Cu thin-film reaction — •Constantin Buzau Ene[1], Guido Schmitz[2], Talaat Al-Kassab[1], and Reiner Kirchheim[1] — [1]Institut für Materialphysik, Georg-August-Universität Göttingen, Friedrich-Hund Platz 1, D-37077, Göttingen, Germany — [2]Institut für Materialphysik, Westf. Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, D-48149 Münster, Germany

Aluminium and Copper are important components of current day metallization of semi-conductor devices, so that their initial reaction is technologically important. Al/Cu/Al triple layers with approximately 10nm single layer thickness were deposited onto needle shaped W tips and analyzed in the early stages of interreaction by means of atom probe tomography (TAP). Owing to the outstanding sensitivity of the method, even minor chemical modifications on the nanometer scale can be detected. After thermal treatments we were able to recognize the formation of the Al_2Cu phase starting after 5 min annealing at 110°C and its parabolic growth as a dense layer to a maximum thickness of 6 nm after 80 min annealing at 110°C. As a particularity of the tip-shaped tungsten tips we observed a remarkable asymmetry in the growth rate of the new phases. The thickness of the reaction product close to the W substrate is approximately 1.5 times thicker than the other one close to the surface. We suggest that this asymmetry is induced by different vacancy annihilation mechanisms at the two Al/Cu interfaces.

MM 37.2 Thu 15:00 IFW D

Pressure temperature phase diagrams of pure and Ag-doped nanocrystalline TiO2 photocatalysts — •Manuela Stir — Institut für theoretische und angewandte Physik, Universität Stuttgart, Pfaffenwaldring 57, D-70569, Stuttgart

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An essential issue in the development and use of nano materials in modern applications is the ability to maintain ultrafine particle sizes within extended temperature pressure ranges. Nanocrystalline titanium dioxide (nc-TiO2) is known as an excellent semiconductor photocatalyst for environmental protection applications such as the decontamination of polluted waste water and air purification. The photocatalytic efficiency of nc-TiO2 depends on its crystal structure and surface morphology and may further be enhanced by adequate metal-doping and by achieving mesoporous surfaces. The use of semiconductor photocatalysts in supported form (pellets or thin-films) eliminates the need for air-bubbling of the contaminated liquid media (to counteract powder sedimentation) and for subsequent complex photocatalyst powder recycling procedures.

MM 37.3 Thu 15:15 IFW D

The role of dislocations during deformation of nanocrystalline metals — •Jürgen Markmann[1,2] and Jörg Weissmüller[1,2] — [1]Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Postfach 3640, 76021 Karlsruhe — [2]Universität des Saarlandes, FR 7.3 Technische Physik, Postfach 151150, 66041 Saarbrücken

During deformation of nanocrystalline metals various deformation mechanisms can be activated. Depending on the applied strain rate and size of the grains grain boundary diffusion, i.e. Coble creep, grain boundary sliding, and even grain rotation contribute to the material transport. Despite the fact that standard dislocation sources of the Frank-Read type in the interior of nano grains cannot be activated before the material fails, it has been shown that dislocations are active in nanocrystalline metals. Here the microstructure of nanocrystalline palladium after a true strain of $\epsilon \approx 0.3$ to 0.7 deformed by cold rolling at strain rates $\dot{\epsilon}$ between $0.08\,s^{-1}$ and $0.3\,s^{-1}$ was investigated. With increasing strain rate the stacking fault density decreases while the number of twins notedly increases as shown by HRTEM images. The number of discovered lattice faults especially after deformation at higher strain rates implies dislocation motion as the main and dominant mechanism of deformation. This means that the number of dislocations is a function of the applied strain rate or stress rather than a function of the strain or total deformation of the material. Furthermore the possibilities of nucleation of dislocations from grain boundaries as proposed by theory and the nucleation of a complete dislocation loop inside the grain are shortly discussed.

MM 37.4 Thu 15:30 IFW D

Thermal Stability of a Nanocrystalline Cobalt-Phosphorous Alloy — •Catharina Wille[1], Taláat Al-Kassab[1], Reiner Kirchheim[1], Melina da Silva[2], and Uta Klement[2] — [1]Georg-August-Universität Göttingen, Institut für Materialphysik, Friedrich-Hund-Platz 1, D-37077 Göttingen — [2]Chalmers University of Technology, Department of Materials and Manufacturing Technology, SE-41296 Göteborg, Sweden

Nano-crystalline Co-2.3at%P layers with a thickness of 200 μm and an average grain size of 12 nm were prepared by means of the pulsed current electro-deposition. These specimens were investigated both in the as prepared state and after different heat treatments by utilizing different analysis techniques such as Field Ion Microscopy (FIM), Tomographic Atom Probe (TAP), Transmission Electron Microscopy (TEM), Differential Scanning Calorimetry (DSC), X-Ray Diffraction (XRD).

The results reveal a high P-segregation at the grain boundaries already in the as prepared state. Between 723 and 753K, the allotropic phase transformation (hcp-Co to fcc-Co) sets in and abnormal grain growth is observed. The onset of abnormal grain growth at 673K is accompanied by the precipitation of the CoP-phase, whereas the formation of the equilibrium Co_2P-phase is not detected. For most of the neighboring grain boundaries, the level of P was depleted insofar as no significant excess segregation was detected.

Between 723 and 743K normal grain growth occurs. Thus the thermal stability of this alloy can be mainly attributed to the reduction of grain-boundary energy by P-segregation.

MM 37.5 Thu 15:45 IFW D

Self deformation during dealloying of silver-gold alloys — •Smrutiranjan Parida[1], Dominik Kramer[1], and Joerg Weissmueller[1,2] — [1]Forschungszentrum Karlsruhe, Institut für Nanotechnologi, Karlsruhe — [2]Universität des Saarlandes, Fachrichtung Technische Physik, Saarbrücken

Dealloying or selective dissolution is an important route to prepare nanoporous metals and alloys. We present a study of the dealloying process in silver-gold alloys, which uses SEM, TEM and XRD investigations of the obtained porous metals and measurements of the lateral shrinkage of the sample during dealloying by insitu dilatometry. This shrinkage, which depends on the dissolution rate (hence on dealloying potential) and the composition of the alloy, has not been reported before. The volume of the sample reduces by up to 30% during dealloying, although our measurements show that the original crystal lattice of the alloy is conserved. This result can not be explained with the existing model or with elastic lattice strain or with lattice parameter differences. Therefore, we suggest plastic deformation to explain the observation, which is consistent with the high defect concentration in dealloyed structure as observed by TEM. Several possible mechanisms to nucleate the defects during dealloying are discussed.

MM 37.6 Thu 16:00 IFW D

Characterization of the Microstructure and Texture of Nanostructured Electrodeposited CoNi by use of Electron Backscatter Diffraction (EBSD) — •Alice Bastos, Stefan Zaefferer, and Dierk Raabe — Max-Planck-Institut für eisenforschung, Max-Planck-Strasse 1, D-40237 Duesseldorf

A Co-20at%Ni polycrystal produced by electrodeposition has been investigated in planar and cross sections using orientation microscopy in a high resolution scanning electron microscope and focused ion beam microscope. The local crystallographic texture, grain size, amount of phases, and grain boundary character were characterized by electron backscatter diffraction (EBSD). This technique appears to be ideal for accomplishing a detailed microstructure characterization, particularly regarding the crystallographic character of the boundaries, which plays a special role in such nanostructured materials. Exploring the limits of the spatial resolution of the EBSD we present a detailed study of the microstructure and facilitate in this way the understanding its complexity. Additionally a combination of EBSD technique with a serial section method using a focused ion beam microscope (3D-EBSD) was applied in order to study the boundary character throughout the thickness of