MM 29: Nanostructured Materials II

Time: Wednesday 12:00–13:00 Location: H16

MM 29.1 Wed 12:00 H16

Diffusion-induced recrystallization in Ni/Pd bi-layers — •Michael Kasprzak, Dietmar Baither, and Guido Schmitz — Institut für Materialphysik, WWU Münster, Germany

In size-mismatched thin film interdiffusion couples Diffusion-Induced Recrystallisation (DIR) appears instead of the conventional continuous Fickian atomic transport. The new grains formed during this process reveal characteristic composition levels which are so far not understood.

We study this effect in sputter-deposited Ni/Pd films in order to derive a physical interpretation of the preferred compositions. After heat treatment, transmission electron microscopy, energy dispersive X-ray spectroscopy and X-ray diffractometry show that new grains are indeed formed inside the diffusion zone. Characteristic concentration levels for Ni/Pd are derived from XRD data.

A thermo-mechanic model is presented, which determines the thermo-elastic driving force to grain boundary migration. The model assumes that the gradients of Gibbs free energy of the new grain volume behind and of stressed matrix ahead of the moving grain boundary are equal in local equilibrium. This allows the determination of composition and stress in front of the boundary. Remarkably, just those grains which reveal a composition leading to the maximum possible stress in front of the moving grain boundary dominate the diffusion zone by fastest growth. According to our measurements these stresses are rather high, close to the theoretical maximum strength of the material.

MM 29.2 Wed 12:15 H16

Mechanical testing of infiltrated nanoporous gold — •Eike Epler[1], Burkhard Roos[1], Marcus Jahn[1], Lorenz Holzer[2], and Cynthia A. Volkert[1] — [1]Institut für Materialphysik, Uni Göttingen, Germany — [2]EMPA, Dübendorf, Switzerland

Recently, nanoporous (np) metal foams have attracted a lot of interest because of their unusual mechanical, electrical, chemical, and optical properties. The very high strength of np Au foams has been the topic of numerous studies and is attributed to a length scale effect, although the exact strengthening mechanisms are not known. Unfortunately, np Au also shows a very low fracture toughness, comparable to that of concrete. In our investigations, we copy nature and combine a brittle material, in this case the np foam, with a ductile material, in this case a polymer, with the goal of achieving a strong and tough composite. Open cell np gold with a relative density of 30% and ligament diameters of around 30nm has been infiltrated with two types of polymers and the elastic modulus, yield strength and fracture toughness of the composite have been measured using micro-mechanical testing methods in the nanoindenter. Results are compared to the uninfiltrated np structure and the bulk material. Additionally, it is possible to fabricate high quality SEM and TEM samples from the infiltrated material with focused ion beam machining, which was not possible in the uninfiltrated foam due to redeposition. The microscopy allows the defect content and foam morphology before and after deformation to be investigated and reveals that nano-twins play an important role in deformation.

MM 29.3 Wed 12:30 H16

X-ray diffraction studies on pore condensates in silica nanochannels: The interplay of sorption strains, capillary condensation and capillary sublimation phenomena — •Daniel Rau[1], Patrick Huber[1], Sebastian Mörz[1], Wolfram Leitenberger[2], and Rolf Pelster[1] — [1]Universität des Saarlandes, Saarbrücken, Germany — [2]Universität Potsdam, Germany

We present investigations on the interplay of capillary condensation, capillary sublimation and sorption strains in molecular assemblies confined in template-grown silica nanochannels (SBA-15). The influence of the spatial restriction on the structure of the pore-condensates as well as the influence of the pore-condensate on the structure of the nanochannel array are investigated by wide- and small-angle x-ray scattering techniques.

MM 29.4 Wed 12:45 H16

Electrochemical tuning of the electrical resistance of nanoporous gold prepared by dealloying — Patrick Wahl[1], •Thomas Traussnig[1], Hai-Jun Jin[2], Stephan Landgraf[3], Jörg Weissmüller[2], and Roland Würschum[1] — [1]Inst. f. Materialphysik, TU Graz, Graz, Austria — [2]Inst. f. Nanotechnologie, Karlsruher Institut für Technologie, Karlsruhe, Germany — [3]Inst. f. Physikal. u. Theoret. Chemie, TU Graz, Graz, Austria

Electric field-induced tuning of material properties is usually restricted to nonmetals such as semiconductors and piezoelectric ceramics. Studies on the property tuning (e.g., resistance tuning [1,2]) of metals have been initiated making use of nanocomposites of porous nanophase metals and liquid electrolytes. Triggered by recent findings that the surface stress-charge response of nanoporous gold sensitively depends on adsorbed oxygen [3], the variation of the electrical resistance of nanoporous gold upon electrochemical charging in an aqueous electrolyte is studied. Nanoporous gold is prepared by dealloying. Reversible variations of the resistance up to ca. 50% occur due to the formation of an electro-chemical double layer and the chemical interaction of the electrolyte with the surface (primarily the reversible adsorption of OH/O and desorption of O). The charge-induced variation of the resistance in the various electrochemical regimes is discussed.

[1] M. Sagmeister et al., Phys. Rev. Lett. 96 (2006) 156601; [2] A.K. Mishra et al., J. Appl. Phys. 103 (2008) 094308; [3] Hai-Jun Jin et al., Surface Science 602 (2008) 3588. Financial support by the FWF Austrian Science Fund is appreciated (project S10405-N16).