MM 38: Nanostructured Materials V

Time: Thursday 11:45–13:00 Location: H 0111

MM 38.1 Thu 11:45 H 0111

Single crystalline metal nanowires with high aspect ratio — •Achim Walter Hassel and Srdjan Milenkovic — Max-Planck-Institut für Eisenforschung, Düsseldorf, Germany

Directional solidification of eutectics with an asymmetric composition is a route to metallic nanowires. This coupled growth yields a single crystalline matrix with embedded single crystalline nanowires, all being aligned parallel to each other. Differential electrochemical processing allows a partial, local or entire release of the wires with an aspect ratio of over 1000. Various metals can be used such as the refractory metals Re, Mo and W or the noble metals Au and Cu. Both, diameter and length can be controlled by the processing parameters in a wide range. Prototypes for further investigations and applications will be shown.

MM 38.2 Thu 12:00 H 0111

The influence of ion irradiation on bimetallic nanoparticles — •Darius Pohl[1], Elias Mohn[1], Jürgen Fassbender[2], Karsten Albe[3], Ludwig Schultz[1], and Bernd Rellinghaus[1] — [1]IFW Dresden, D-01171 Dresden, Germany — [2]Forschungszentrum Rossendorf, D-01314 Dresden, Germany — [3]TU Darmstadt, D-64287, Germany

FePt nanoparticles with mean diameters of about 5 nm and a narrow particle size distribution are prepared through inert gas condensation. Since as-deposited particles usually exhibit the metastable disordered and soft magnetic A1 phase or even other structural motifs such as icosahedral or decahedral multiply twinned structures, additional annealing steps are required to transform these particles into the $L1_0$ phase.

In order to gain more insight into the phase stability of the various crystal structures observed in FePt nanoparticles we have investigated, how ion irradiation influences these structures. Comparable studies were conducted on particles of CuAu, the phase diagram of which is very alike that of FePt. In the present study, gas-phase prepared single crystalline and multiply twinned FePt and CuAu nanoparticles are irradiated with ions of different noble gases and different energy. It is shown that the He^+ ion irradiation promotes the de-twinning of the bimetallic nanoparticles and the formation of single crystalline A1 phase particles. A comparison of the experiments on CuAu nanoparticles with the results of molecular dynamic simulations will be presented. The effect of the energy difference between the different morphologies for both the ordered and disordered structures is discussed.

MM 38.3 Thu 12:15 H 0111

Sintering of Metallic Nanoparticles — •Ralf Meyer and Peter Entel — Theoretische Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

With the growing interest in the production of nanoparticles with well defined physical properties for novel technological applications, the sintering of nanoparticles has become an increasingly important subject. In this work, the sintering of metallic nanoparticles is studied at temperatures of 800 and 1000 K over periods of up to 200 ns with the help of molecular-dynamics simulations. Simulations of the sintering of two Ni nanoparticles with diameters of approximately 4 nm show that a small-angle grain boundary with a corresponding (partial) dislocation grid is formed shortly after the particles make contact. The grain boundary remains stable over a period of several nanoseconds, until the dislocations disappear from the system. The disappearance of the disocations leads to a simultaneous rotation of the grains so that a single-crystalline particle is formed. In addition to the simulations of the sintering of two particles, results will be shown of the simulation of the sintering of 300 particles containing several million atoms into a single 40 nm sized particle.

MM 38.4 Thu 12:30 H 0111

Reactive diffusion under elastic stress in nanospheres — •Constantin Buzau Ene[1], Guido Schmitz[2], Carsten Nowak[1], Talaat Al-Kassab[1], and Reiner Kirchheim[1] — [1]Universität Göttingen, Institut für Materialphysik, Friedrich-Hund Platz 1, D-37077 Göttingen — [2]Universität Münster, Institut für Materialphysik, Wilhelm-Klemm-Str.10, D-48149 Münster

A remarkably clear experiment has been designed in order to investigate the influence of stress on reactive diffusion in spherical symmetry. Thin film Al/Cu/Al and Cu/Al/Cu triple layers with approximately 10 nm single layer thickness are deposited on curved substrates of 25 nm radius and investigated by atom probe tomography. The experiments demonstrate that the reaction rate depends significantly on the deposition sequence of the metals. The thickness of the product formed at the interfaces at which Cu is deposited on top of Al is approximately 1.5 to 2 times thicker than that of the opposite stacking sequence. This observation may be explained naturally by Laplace tension of the curved interfaces. By quantitative analysis, the level of induced stress can be determined from the modified growth rates.

MM 38.5 Thu 12:45 H 0111

Twinning during low-temperature deformation of nanocrystalline pulsed-electrodeposited nickel — •Klemens Reuther, Lutz Hollang, and Werner Skrotzki — Institut für Strukturphysik, Technische Universität Dresden, 01062 Dresden

Pure 'nanocrystalline' nickel was produced by pulsed electro-deposition without additives for grain refinement. The average grain size of the material is $d_{EBSD} = 150$ nm and $d_{XRD} = 30$ nm if determined by electron backscatter diffraction (EBSD) and by X-ray diffraction (XRD), respectively. Tensile tests between 4 K and 320 K reveal that the material is ductile in the whole temperature range. Generally, the stress-strain curves are parabolic and the stress reaches its maximum after about two percent plastic strain, with the ultimate stress strongly increasing with decreasing temperature. However, there exists a critical temperature $T_T = 9$ K below which the deformation mode suddenly changes towards twinning if the stress level reaches 2400 MPa. The twinning events are characterized by substantial stress drops accompanied by loud acoustic emissions. The microstructural changes connected with twinning will be discussed on the basis of results obtained by scanning and transmission electron microscopy.