MM 40: Nanomaterials III

Time: Thursday 16:15–17:30 Location: IFW B

MM 40.1 Thu 16:15 IFW B

Continuous recrystallization and mechanical properties of a C45 steel after high pressure torsion — •Mike Haddad[1,2], JiangLi Ning[2], Ute Hörmann[3], Maxim Murashkin[4], Yulia Ivanisenko[2], and Hans Fecht[1,2] — [1]Institute of Micro and Nanomaterials, University of Ulm, Ulm, Gemany — [2]Institute of Nanotechnology, Karlsruhe Institut of Technology, Karlsruhe, Germany — [3]Central Facility for Electron Microscopy, University of Ulm, Ulm, Germany — [4]IPAM, Ufa State Aviation Technical University, Ufa, Russia

An initial microstructure of C45 steel (Fe, 0.42-0.5% C, 0.5-0.8% Mn, <0.4% Si, <0.045% S, 0.045% P * All in wt%) was modified from ferritic-pearlitic to bainitic through heating at 900°C for 1 hour and quenching in a lead bath at 500°C for 30 min. The steel was processed by High Pressure Torsion (HPT) at room temperature for 3 and 5 rotations, which led to an ultrafine or nano-scale grained structure. Then the material was annealed at 400°C and 450°C for two hours, respectively. TEM observation showed that continuous recrystallization occurred during the annealing. The yield strength and elongation after annealing at 400°C and 450°C were 1277 MPa, 3%, and 1100 MPa, 11%, respectively. Compared with the mechanical properties before annealing, it was revealed that the continuous recrystallization during annealing led to an enhancement of the ductility, but without sacrificing much of the strength.

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MM 40.2 Thu 16:30 IFW B

Martensitic transformation of nanostructured NiTi made by crystallization of a deformation induced amorphous phase — •Martin Peterlechner[1], Christoph Gammer[2], Gerhard Wilde[1], and Thomas Waitz[2] — [1]Institut für Materialphysik, Universität Münster, 48149 Münster — [2]Physik nanostrukturierter Materialien, Fakultät für Physik, Universität Wien, 1090 Wien

Nanocrystalline NiTi shape memory alloys with a tailored grain size are of interest for applications. In this work, bulk nanostructured NiTi was processed by nanocrystallization of an intermediate amorphous phase made by repeated cold rolling (RCR). The structures and their phase stability were studied using transmission electron microscopy and calorimetry. RCR deformation causes grain refinement and amorphization; at high deformation degrees an almost completely amorphous phase is achieved. Upon heating nanocrystallization occurs. Combinations of the deformation degree and annealing condition allow to control the final grain size. Grains are stable up to ~370°C where grain growth occurs. The occurring martensitic phase transformation was analyzed using calorimetry, showing that the grain size strongly impacts the transformation path and temperatures. The transformation from the B2 austenite to the B19' martensite occurs via the intermediate R-phase. The effect of the grain size on the transformation temperature of the R-phase is small; this is in contrast to the transformation to the B19' martensite, which strongly depends on the grain size. With decreasing grain size, both the forward transformation (from B2 to B19') and the reverse transformation shift to lower temperatures.

MM 40.3 Thu 16:45 IFW B

Melting of faceted Pb nanoparticles — •Anna Moros, Harald Rösner, and Gerhard Wilde — Westfälische Wilhelms-Universität Münster, Institut für Materialphysik, Wilhelm-Klemm-Straße 10, 48149 Münster

Melting of confined and nanometer-sized Pb inclusions embedded in a polycrystalline aluminum matrix has been intensively investigated in order to utilize the experimental results obtained on this model system for clarifying the relevance of different models that describe the size dependence of reversible phase transformations. Yet, this phenomenon is still not completely understood. For this reason a study of the melting behaviour of nanometer-sized and faceted Pb particles embedded in an Al matrix based on calorimetry and transmission electron microscopy has been performed. The size distribution of the Pb inclusions was obtained and utilized for the deconvolution of the contributions of different size classes to the total melting signal. Detailed calorimetric analyses revealed that faceted Pb particles melt at elevated temperatures but have reduced melting enthalpy compared to the bulk material. The related thermodynamic consequences are critically discussed.

MM 40.4 Thu 17:00 IFW B

3D imaging of electrostatic potentials in nanostructures with electron holographic tomography — •Wolf Daniel[1], Lubk Axel[2], and Lichte Hannes[1] — [1]Triebenberg Laboratory, Institute of Structure Physics, Technische Universität Dresden, 01062 Dresden, Germany — [2]CEMES-CNRS, 29 rue J. Marvig, 31055 Toulouse, France

Electron-holographic tomography (EHT), that is, the combination of off-axis electron holography (EH) with electron tomography (ET), allows the quantitative 3D mapping of electrostatic potentials and magnetostatic vector fields with a resolution of a few (5-10) nanometers. The 3D potential offers the outer (morphology) and inner structure, as well as the mean inner potential (MIP) of the nano object. This is shown on epitaxially grown nanowires (NWs) of GaAs and AlGaAs. The 3D morphology is studied using the corresponding iso-surfaces of the 3D potential: The facets on the nanowires surface allow conclusions about the crystalline structure. Moreover, the reconstructed 3D potential of a AlGaAs/GaAs NW clearly shows its core/shell structure due to the MIP difference between GaAs and AlGaAs of $0.61\,V$. For doped semiconductor structures with pn-junctions (e.g. transistors) the potential distribution, reconstructed by EHT, also provides access to the built-in voltage across the pn-junction. The built-in voltage ΔV_{pn} can be analyzed in 3D and measured without projection and surface effects (e.g. dead layers) within the sample. The measurements of ΔV_{pn} in three needle-shaped specimens, prepared by FIB, yield for two silicon needles $1.0\,V$ and $0.5\,V$, and for a germanium needle $0.4\,V$.

MM 40.5 Thu 17:15 IFW B

Elastic properties and deformation of mesoporous glass during sorption of argon — •Klaus Schappert and Rolf Pelster — Universität des Saarlandes, FR 7.2 Experimentalphysik, Campus E2.6, 66123 Saarbrücken, Germany

Sorption of atoms or molecules in porous matrices can induce stress and thus a noteworthy deformation of the material. Here, we present measurements of the length change of mesoporous Vycor glass during isothermal adsorption and desorption of argon both above and below its freezing point. We compare the behaviour of this macroscopic length change with the elastic properties of the adsorbed argon, that we evaluate via ultrasonic measurements. Thereby, we are able to relate the deformation of the porous sample to the microstructure of the adsorbate.