

MM 46: Nanomaterials I

Time: Thursday 10:15–11:45

Location: H 1029

MM 46.1 Thu 10:15 H 1029

SiC formation in carbon nanotubes grown from permalloy catalyst particles — ●ANJA KIESSLING¹, DARIUS POHL¹, CHRISTINE TÄSCHNER¹, ROLF ERNI², MARK HERMANN RÜMMELI¹, LUDWIG SCHULTZ¹, and BERND RELLINGHAUS¹ — ¹IFW Dresden, Helmholtzstr. 20, D-01069 Dresden, Germany — ²Electron Microscopy Center, Empa, Swiss Federal Laboratories for Materials Science and Technology, 8600 Dübendorf, Switzerland

Carbon nanotubes (CNT) were grown from Ni₈₀Fe₂₀ ("permalloy") catalyst particles on Si substrates using plasma-enhanced chemical vapour deposition (PE-CVD). The as-produced CNT were characterized by means of aberration-corrected high resolution transmission electron microscopy (using a FEI TITAN³ 80-300 microscope operated at 80kV). The as-grown CNT exhibit a clear contrast difference between the particle, the concentric graphene layers of the CNT and their cores. Electron Energy Loss (EEL) spectra reveal the core to be SiC from the occurrence of a Si-L absorption edge at around $\Delta E=100\text{eV}$ followed by a broad double-peak. Furthermore the CNT are found to be covered by a SiO₂ layer. The SiC core is expected to form during CNT growth as well as a Si film around the CNT due to the presence of Si in gas phase. This then oxidizes during exposure to ambient air. In summary, the CNT exhibit a complex core-shell structure consisting of a SiC core, a shell of concentric graphene layers and an amorphous SiO₂ overcoat.

MM 46.2 Thu 10:30 H 1029

Evolution of nanoporosity via dealloying in binary and ternary Pt alloys — ●HENNING GALINSKI¹, THOMAS RYLL¹, YANG LIN¹, LUDWIG J. GAUCKLER¹, and MAX DÖBELI² — ¹Nonmetallic Inorganic Materials, ETH Zurich, Zurich, Switzerland — ²Ion Beam Physics, ETH Zurich, Zurich, Switzerland

The controlled tailoring of nano-porosity in metallic thin films of several 100 nm thickness using dealloying has gained renewed attention in recent years, as such nanoporous thin films are candidates for applications in sensors, micro-fuel cells and super-capacitors. In this contribution the physical mechanism of nanoporosity formation during the dealloying process of binary PtAl- and ternary PtYAl-alloy thin films is examined using focused ion beam (FIB) nanotomography and Rutherford backscattering spectrometry (RBS). The dynamics of nanoporosity formation is found to obey a superposition of a reaction-diffusion equation describing a linearly propagating diffusion front¹ and a secondary slower dissolution process away from the moving interface. An increased Al content as well as a partial substitution of Pt by Y results in a slower dealloying kinetics with a slower linearly propagating diffusion front. The resulting nanoporous Pt thin films perform exceptionally well as oxygen reduction electrodes in a micro-solid oxide fuel cell setup² in the temperature range from 473 to 1073 K.

¹ PRL 107, 225503 (2011), ² PRB 84, 184111 (2011)

MM 46.3 Thu 10:45 H 1029

Metallic nanowire growth from solution using dielectrophoresis — ●ALEXANDER NEROWSKI¹, MARKUS PÖTSCHKE¹, MANFRED BOBETH¹, LARYSA BARABAN¹, JÖRG OPITZ^{1,2}, and GIANAURELIO CUNIBERTI¹ — ¹Institute for Materials Science and Max Bergmann Center of Biomaterials, TU Dresden, 01062 Dresden, Germany — ²Fraunhofer-Institute for Non-Destructive Testing, 01109 Dresden, Germany

Growth of metal nanowires from solution is a promising "bottom-up" method which can represent an efficient alternative to classical lithography. Here we present a dielectrophoretic growth of nanowires on an amorphous glass substrate in a solution containing Pt-complexes. Aiming at a controlled growth of straight and as thin as possible wires, the growth process is investigated both in theory and experiment. The metallic nanowire tip is modeled as a sphere electrode. The model includes the dielectrophoretic force on uncharged metal complexes as well as their diffusion in the solution. Experimental data suggest that the deposition process traverses from reaction-limited to diffusion-limited when going from low to high temperatures. Possible reasons for the rate limitation are discussed. Potassium ions in the solution are found to have a great influence on the deposition rate. Finally, we compare

the experimentally measured growth velocities with those theoretically calculated.

MM 46.4 Thu 11:00 H 1029

Si/SiO₂ nanostructures grown by dewetting of ultrathin amorphous Si-layers for photovoltaic applications — ●JAN AMARU TÖFFLINGER¹, MAURIZIO ROCZEN¹, MARTIN SCHADE², ORMAN GREF¹, ANDREAS SCHÖPKE¹, ENNO MALGUTH¹, LARS KORTE¹, HARTMUT LEIPNER², and BERND RECH¹ — ¹HZB, Inst. Si-Photovoltaik, Berlin, Deutschland — ²MLU, IZM, Halle, Deutschland

Si nanodots embedded in a SiO₂ matrix hold the potential for an enhancement of the efficiency of silicon based solar cells. The application of such Si/SiO₂ nanostructures as hetero-emitter on top of an oxidized wafer is investigated. For Si-wafer passivation tunneling oxides with thicknesses down to 1 nm are developed by means of UHV-oxidation using neutral, thermalized oxygen atoms. The density of states at the Si/SiO₂ interface as well as its chemical composition is examined via in-situ photoelectron spectroscopy. The UHV-synthesis of Si nanodots is performed by deposition of a thin (1-10 nm) undoped amorphous Si film on top of the oxidized wafer and a subsequent 600°C annealing step. This leads to the self-organized formation of highly crystalline Si nanodots. Nanodot diameters <10 nm are achieved which in principle allows to exploit quantum size effects. The influence of Sb-doping of the initial a-Si film on nanodot formation is investigated. Stacked Si/SiO₂ nanodot systems via layer by layer repetition of oxidation and nanodot formation are manufactured and investigated via HRTEM and electrical measurements. Cross sectional images indicate high density of nanodots separated by tunneling oxides allowing an electrical current through the nanodot system by tunneling processes.

MM 46.5 Thu 11:15 H 1029

Tailoring magnetization reversal in magnetic nano-dots with 3D shape modifications — ●TOMASZ BLACHOWICZ¹ and ANDREA EHRMANN² — ¹Institute of Physics, Silesian University of Technology, Gliwice, Poland — ²Hochschule Niederrhein, Faculty of Textile and Clothing Technology, Mönchengladbach, Germany

Understanding reversal mechanisms and dynamics of magnetic nanosystems is one of the leading topics in contemporary physics. In our study, the magnetization reversal dynamics and hysteresis loops of three-dimensional ferromagnetic permalloy half-balls have been examined using micromagnetic simulations and finite element methods [1].

Comparison of samples with different 3D shape modifications enables observations of the nature of switching, oscillation types and frequencies as well as times of reversal, triggered by an external magnetic field. It has been found that a moderate imperfection can enhance the switching process and strongly suppress magnetization oscillations.

Since magnetization characteristics can be modified by changes in the geometry of the magnetic nano-particles, an exact design of the nano-dots allows for tailoring the desired properties for new applications in magneto-electronics, like magnetic field sensors or data storage devices.

[1] T. Blachowicz, A. Ehrmann, P. Steblinski, and L. Pawela: Magnetization reversal in magnetic half-balls influenced by shape perturbations, J. Appl. Phys. 108, 123906 (2010)

MM 46.6 Thu 11:30 H 1029

Electrochemical charging-induced variation of the magnetic moment of γ -Fe₂O₃ nanoparticles investigated by SQUID magnetometry with in-situ cyclic voltammetry — ●STEFAN TOPOLOVEC¹, PETER JERABEK², DOROTHÉE VINGA SZABÓ³, HEINZ KRENN², and ROLAND WÜRSCHUM¹ — ¹Inst. für Materialphysik, TU Graz, Graz, Austria — ²Inst. für Physik, Univ. Graz, Graz, Austria — ³Inst. für Angewandte Materialien - Werkstoffprozessertechnik, KIT, Karlsruhe, Germany

Recently, the reversible variation of the magnetic moment of γ -Fe₂O₃ nanoparticles by electrochemical charging could be demonstrated [1]. In order to study the underlying electrochemical processes in more detail, in-situ cyclic voltammetry in a SQUID magnetometer was performed in the present work. To obtain a conductive electrode, the insulating γ -Fe₂O₃ nanoparticles, which were prepared by microwave plasma synthesis, were intermixed with Pt nanoparticles and com-

pacted to a porous pellet. The magnetic moment of the pellet was measured during recording cyclic voltammograms in a specially designed electrochemical cell. It turns out that the charge dependence of the magnetic moment is significantly affected by reduction and oxidation processes. The magnetic moment could be reversibly tuned up

to several percent.

Financial support by the FWF Austrian Science Fund is appreciated (project S10405-N16).

[1] T. Traußnig et al., Phys. Status Solidi - Rapid Res. Lett. 5 (2011) 150.