MM 8: Topical Session Nanoporous Functional Materials III

Time: Monday 14:45–16:30 Location: IFW A

Topical Talk MM 8.1 Mon 14:45 IFW A

Geordnetes nanoporöses Aluminiumoxid: Ein vielseitiges Templatsystem — •Ulrich Gösele — MPI für Mikrostrukturforschung, Halle

Elektrochemisch hergestelltes anodischen Aluminiumoxid mit zweidimensionalen geordneten Nanoporen hat sich zu einem der vielseitigsten Templatsysteme für die Nanotechnologie entwickelt. Mit relativ geringem Aufwand lassen sich diese geordneten Nanostrukturen aus Aluminiumoxid mit verschiedenen Porendurchmessern und Abständen erzeugen. Die Porenstrukturen können dann mit verschiedensten Methoden entweder mit bestimmten Materialien gefüllt werden, was zu Nanodrähten führt, oder aber beschichtet werden, was Nanoröhren ergibt. Es wird auf neuere Entwicklungen der Herstellung mittels der sogenannten harten Anodisation eingegangen, die es erlauben, geordnete Strukturen wesentlich schneller als mit der üblichen milden Anodisation und mit einer gezielten Variation des Porendurchmessers herzustellen. Ultradünne poröse Aluminiummembranen können als Masken für die Herstellung geordneter Nanostrukturen verwendet werden, wie z. B. für vertikale einkristalline Siliziumnanodrähte mit Durchmessern unter 10 nm oder für ferroelektrische Nanokondensatoren für die Datenspeicherung.

Der Beitrag beruht auf veröffentlichten Forschungsergebnissen aus dem MPI-Halle, die in Zusammenarbeit mit zahlreichen Doktoranden, Postdocs und Mitarbeiterinnen erzielt wurden, denen ich hiermit herzlich danke. Besonders hervorgehoben seien hier nur Frank Müller, Kornelius Nielsch, Martin Steinhart, Woo Lee und Liufeng Liu.

Topical Talk MM 8.2 Mon 15:15 IFW A

Porous silicon as functionalized magnetic material — •Heinz Krenn, Klemens Rumpf und Petra Granitzer — Institut für Physik, Bereich Experimentalphysik, Karl-Franzens-Universität Graz

Porous silicon prepared as a template for 1D wires or as 3D particles is increasingly used for gas testing, micro devices, batteries and for biological testing equipment. The focus of the present study will be on magnetic functionalization: The electrochemical synthesis of mesoporous silicon allows tailored pore sizes for a controllable inclusion of magnetic transistion metals (Ni, Co). The corresponding spin magnetism is well understood for magnetic fields below 1 Tesla. Interestingly for high fields ($>$ 3T) a novel kind of orbital magnetism [1] is observed mediated by spin injection from the metal into the silicon matrix (which is still crystalline) driven by impurity assisted tunneling. In the same way as electrochemical etching is self-limited by forming a depletion layer, the silicon matrix becomes intrinsic. Due to quantum and dielectric confinement the energy levels of ionized impurities are blue-shifted. If these levels are resonant with the Fermi-level of Ni or Co wire, unbalanced spins are injected and persistent currents around the wires cause orbital paramagnetism in the symmetry-breaking electric field of the interface barrier. Strange effects are observed: negative magnetization in the hysteresis loop, non-saturation up to 7 T, and suppression of orbital magnetism under cyclotron resonance conditions. [1] K. Rumpf, P. Granitzer, H. Krenn, J. Phys.: Condens. Matter 20 (2008) 454221. (Work supported by the Austrian Science Fund under grant P18593).

Topical Talk MM 8.3 Mon 15:45 IFW A

Nanoporous gold: surface chemistry and catalysis — •Marcus Bäumer — Institut für Angewandte und Physikalische Chemie, Universität Bremen, Germany

Nanoporous gold (npAu) is a material with remarkable surface chemical properties. Recently, we found out that it catalyzes low temperature CO oxidation without meeting the requirements usually considered to be important for gold catalysts (small particle sizes, oxide supports). Moreover, we could show that is a promising catalyst for the selective oxidation of alcohols. For the latter reaction the results are in full agreement to UHV studies on gold single crystal surfaces [1] proving that such model systems allow elucidating details of the surface chemistry of npAu at the atomic level. Another interesting feature of the material is the high surface-to-volume ratio resulting in macroscopic length changes as a response of reactions taking place on the surface of the porous structure. Apart from these applications, also the role of residual silver in the material and the question whether a bimetallic surface composition is important for the observed phenomena will be addressed. (The following collaborations are acknowledged: J. Biener/A. Hamza, Lawrence Livermore Nat. Lab.; C. Friend/R.J. Madix, Harvard University; J. Weissmüller, INT FZ Karlsruhe; M. Gottfried, H.-P. Steinrück, Univ. Erlangen) [1] R.J. Madix et al., J. Catal. 258 (2008) 410.

MM 8.4 Mon 16:15 IFW A

Electrochemically-gated field-effect transistor with Indium Tin Oxide nanoparticles as active layer — •Subho Dasgupta, Robert Kruk, and Horst Hahn — Institute for Nanotechnology, Forschungszentrum Karlsruhe GmbH, P.O. Box 3640, D-76021 Karlsruhe, Germany

We report a Field Effect Transistor (FET) device with a Transparent Conducting Oxide (TCO) nanoparticle channel, using solid electrolyte as a gate [1]. FETs in the nanometer scale require channel conductivities as high as possible, therefore, a conductor like Indium Tin Oxide (ITO) was chosen as an active element. ITO nanoparticles were used in order to maximize the active surface area. In the present work, the device principle is based on the variation of the drain current induced by the capacitive double layer charging at the electrolyte/nanoparticle interfaces. The device with metallic conducting channel made of ITO nanoparticles exhibits an on/off ratio of 2×10^3 even when the gate potential is limited within the electrochemical capacitive region to avoid redox reactions at the interface. The field-effect mobility is calculated to be 24.3 cm^2/Vs which exceeds the values reported earlier for the PbSe and In_2O_3 nanocrystalline channel FETs. A subthreshold swing between 230-425 mV/decade is observed.

[1] S. Dasgupta, S. Gottschalk, R. Kruk, H. Hahn, Nanotechnology 19, 435203 (2008)

MM 9: Intermetallic Phases I

Time: Monday 14:45–15:45 Location: IFW B

MM 9.1 Mon 14:45 IFW B

Ab-initio based study of antisite-precipitates in B2-CoAl — •Nils Schindzielorz and Stefan Müller — Universität Erlangen-Nürnberg, Lehrstuhl für Theoretische Physik 2, Staudstr. 7 D-91058 Erlangen

It is well-known that for high temperatures around 1500K the B2-phase of CoAl up to about 70% Co is stabilized by the existence of so called antisite atoms [1]. By quenching the crystal to low temperatures, this phase separates into an ideal B2-CoAl crystal and precipitates consisting of Co antisites only. By the combination of a density functional theory based cluster expansion Hamiltonian with Monte-Carlo simulations it will be demonstrated that these Co clusters show a characteristic size-shape-temperature dependence. Furthermore, we find a flattening of the precipitates at low temperatures due to the anisotropy of the interfacial energy which is wiped out at higher temperature by entropy. A detailed knowledge of the structure of these nanoclusters is of special importance as they lead to local magnetism in a non-magnetic intermetallic compound.
Supported by Deutsche Forschungsgemeinschaft.
[1] V. Blum et al., Phys. Rev. Lett. 89, 266102 (2002)

MM 9.2 Mon 15:00 IFW B

Effective potentials for rhenium in Ni–Al superalloys — •Peter Brommer[1,2], Stefano Angioletti-Uberti[2], and Mike Finnis[2] — [1]Institut für Theoretische und Angewandte Physik, Universität Stuttgart, Germany — [2]Thomas Young Centre, Imperial College, London, UK

It is widely believed that rhenium, which is commonly used in alloys for