

MM 21: Topical Session Nanoporous Functional Materials - Poster

Time: Tuesday 14:45–16:30

Location: P4

MM 21.1 Tue 14:45 P4

Synthesis and Characterization of Nanocomposites for Application as Nanoporous Cathodes in Solid Oxide Fuel Cell — ●AZAD J. DARBANDI^{1,2} and HORST HAHN^{2,3} — ¹Center for Functional Nanostructures, Universität Karlsruhe (TH) — ²Gemeinschafts Labor Nanomaterialien, Technische Universität Darmstadt und Forschungszentrum Karlsruhe — ³Institut für Nanotechnologie, Forschungszentrum Karlsruhe

A recent trend of research on Solid Oxide Fuel Cells is the lowering of the operating temperature for example for Low Temperature Micro-SOFCs. The present work describes the synthesis and a single step coating process of thin film nanocrystalline functional cathode layers. Single phase nanocrystalline (LSCF) cathode powder with ultrafine microstructure and high specific surface area was synthesized via a unique spray pyrolysis process. The powders have been characterized by various methods such as high temperature in-situ X-ray diffraction, DSC-TGA, ICP, HRSEM, TEM, Nitrogen adsorption, Particle size distribution and Zeta-Potential. Yttria stabilized Zirconia substrates were coated with nanodispersion containing LSCF and Gadolinium doped Ceria particles. The electrochemical impedance spectroscopy was carried out on symmetrical samples in dependence of temperature and oxygen partial pressure. The Area Specific Resistance of 50 and 140 mΩ.cm² at 700°C and 650°C, respectively, are considerably lower than values reported in literature. High electrochemical activity at low thickness, cost effective coating process and low sintering temperatures are beneficial for low temperature Micro-SOFCs application.

MM 21.2 Tue 14:45 P4

Metals with tunable properties based on porous nanostructures — ●THOMAS TRAUSSNIG¹, KLEMENS RUMPF², PETRA GRANITZER², STEPHAN LANDGRAF³, HEINZ KRENN², and ROLAND WÜRSCHUM¹ — ¹Institut für Materialphysik, Technische Universität Graz, Petersgasse 16, A-8010 Graz, Austria — ²Institut für Physik, Karl Franzens Universität Graz, Graz, Austria — ³Institut für Physik. u. Theoret. Chemie, Technische Universität 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 of metals have been initiated recently making use of nanocomposites of porous nanocrystalline metals and liquid electrolytes [1-3]. Owing to the high surface-to-volume ratio of nanoscale metals, voltage-induced formation of electrochemical double layers gives rise to a high fraction of interfacial space-charge regions which results in a reversible change of the overall physical properties of the metal. Studies of the variation of the magnetic behaviour of nanophase metals and alloys upon in-situ charging in a SQUID magnetometer will be presented.

[1] J. Weissmüller et al., Science 300 (2003) 312.

[2] H. Drings et al., Appl. Phys. Lett. 88 (2006) 253103.

[3] M. Sagmeister et al., Phys. Rev. Lett. 96 (2006) 156601

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

MM 21.3 Tue 14:45 P4

Study on structural and electrical properties of Al-doped ZnO thin films prepared by sol-gel method — ●BABAK NASR, SUBHO DASGUPTA, ROBERT KRUK, and HORST HAHN — Forschungszentrum Karlsruhe, Institute for Nanotechnology, D-76344 Eggenstein-Leopoldshafen, Germany

The screening length of the external field is one of the critical parameters to tune the transport properties of a material. Therefore, the systems of interest are those with carrier concentrations in the same order as the induced maximum surface charge density achievable. In view of this criterion we choose Al-doped ZnO (AZO) oxides with a near metallic conductivity, and a carrier density easily controllable via Al doping. This study is an attempt to optimize conductivity of the nanocrystalline films through the Al concentration and morphology modifications.

The AZO thin films were prepared by the sol-gel process [1]. The thin film deposition was carried out by spin-coating technique on high quality float glass substrates. The film structure and morphology were characterized by profilometer, X-ray diffraction, Scanning Electron Microscopy and Transmission Electron Microscopy. The transport prop-

erties were measured with the four point resistance and Hall-effect measurements using standard van der Pauw geometry. The effects of precursor concentrations, annealing temperature on the structural and electrical properties are discussed.

[1] S. Y Chang, Y. Hsiao, Y. Huang, Surface and Coatings Technology, 202 (2008) 5416

MM 21.4 Tue 14:45 P4

Nanoindentation and micro-compression testing of nanoporous gold — ●EIKE EPLER¹, T. JOHN BALK², and CYNTHIA A. VOLKERT¹ — ¹Institut für Materialphysik, Georg-August-Universität Göttingen — ²Department of Chemical and Materials Engineering, University of Kentucky

Recent studies on materials such as nanoporous Au have shown that the strength of open-cell foams can be increased at a fixed porosity by decreasing the foam length scale (ligament diameter and length). This effect is attributed to the difficulty of activating dislocations in sub-micron crystal volumes. If high strength nanoporous materials are to be used to advantage in technical applications, the details of the parameters determining their strength need to be understood.

In this study, the mechanical response of nanoporous Au fabricated by electrochemical dissolution from a Au-Ag alloy, is investigated by indentation using a cube corner tip as well as by micro-compression testing of columns fabricated by focused ion beam machining. The tests reveal a significant time-dependence or creep behavior in the 30% relative density foam that is not observed in fully dense gold. The origins of this effect will be probed by varying the length scale of the foam. In addition, a large scatter in mechanical behavior, particularly in the elastic response, is observed from position to position and sample to sample, which is attributed to small variations in the open cell structure.

MM 21.5 Tue 14:45 P4

Thermodynamic Investigations of Nitrogen confined in Mesopores — ●SEBASTIAN MÖRZ and PATRICK HUBER — Technische Physik, Universität des Saarlandes, Saarbrücken

The thermodynamic behaviour of nitrogen confined in a mesoporous silica matrix (SBA-15) has been studied by differential scanning calorimetry (DSC) in the temperature range from the bulk melting point down to 42 K and as a function of the filling fraction of the matrix. The heat capacity shows a single melting anomaly in the vicinity of 55 K and a complex freezing anomaly between 47 K and 52 K

Additionally, the structure of the confining matrix has been studied by sorption isotherms which reveal a pore size distribution consisting of uniform mesopores as well as a pronounced corona of micro- and smaller mesopores.

MM 21.6 Tue 14:45 P4

Phase Transitions and Molecular Dynamics of *n*-Alcohols Confined in Mesoporous Silicon — ●RENE BERWANGER and ROLF PELSTER — Universität des Saarlandes, Saarbrücken, Germany

We have studied phase transitions and molecular dynamics of several *n*-alcohols in their bulk state and confined into nanotubes with a diameter of 8 nm (mesoporous silica). For this purpose we have combined x-ray, infrared and dielectric measurements. Under confinement the transition temperatures are lowered by up to approximately 30 K. In addition, there is a fundamental structural difference in the crystalline phase. While the bulk alcohols exhibits a polycrystalline mixture of orthorhombic β - and monoclinic γ -forms, geometrical confinement favors the more simple β -form: only crystallites are formed, where the chain axis are parallel to the layer normal. However, the γ -form, in which the chain axis are tilted with respect to the layer normal, is suppressed. A reason for this might be the irregular shape of the nanotubes, into which the crystallites have to fit, favoring the formation of the geometrically more simple and less bulky form. The β -crystallites form bi-layers, that are not randomly orientated in the pores. The molecules are arranged with their long axis perpendicular to the pore axis and parallel to the plane normal of the respective silicon facets (the [011] and [0-11] direction of the silicon matrix).

MM 21.7 Tue 14:45 P4

Dynamics and Structure of *n*-Nonanol Confined in Silicon

Nanochannels — ●CHRISTOPH SCHUHMACHER, RENE BERWANGER, and ROLF PELSTER — Universität des Saarlandes, Saarbrücken, Germany

The behavior of the short n-alcohol $C_9H_{19}OH$ as bulk material and confined in tubular meso-pores of porous silicon has been studied by infrared spectroscopy. The porous silicon samples were prepared by electrochemical etching and the mean pore-radius was varied from $r = 3$ nm to $r = 15$ nm. Therefore, we are able to study the influence of geometrical confinement on the liquid-crystalline phase transition. We use several vibrations to determine the transition temperatures, for example the OH-stretching vibration, the CH_2 scissor vibration or the vibration of the C-C-backbone. We also discuss differences in the crystalline structure of bulk and confined $C_9H_{19}OH$.

MM 21.8 Tue 14:45 P4

Optical birefringence study of molecular ordering in tubular silica nanochannels — ●MATTHIAS WOLFF¹, ANDRIY KITKY², KLAUS KNORR¹, and PATRICK HUBER¹ — ¹Technische Physik, Universität des Saarlandes, Germany — ²Institute for Computer Science, Czestochowa University of Technology, Poland

The condensation of different liquids in nanoporous silicon oxide is studied by combined volumetric adsorption isotherm and optical bire-

fringence measurements. Obtained results suggest that molecules adsorbed in the nanoporous matrix exhibit a weak orientational order in the first adsorbed layers. We could also observe continuous paranematic-to-nematic ordering transitions of liquid crystals in the tubular silica nanochannels¹.

(1) A.V. Kityk, M. Wolff, K. Knorr, D. Morineau, R. Lefort, P. Huber: PRL 101, 187801 (2008).

MM 21.9 Tue 14:45 P4

Transfer of length scales and periodicity of nanowires grown in templates — ●HONG-DAN YAN^{1,2}, PETER LEMMENS^{1,2}, HANNO DIERKE¹, ANDREAS KRUSE¹, DIRK MENZEL¹, FRANK LUDWIG³, and MEINHARD SCHILLING^{2,3} — ¹IPKM, TU Braunschweig, Germany — ²IGSM, TU Braunschweig, Germany — ³EMG, TU Braunschweig, Germany

A series of magnetic and optical metamaterials based on Fe, Ni, Fe_xNi_{1-x} and Au wires in porous alumina templates have been synthesized using electrochemistry. Electron microscopy shows a single wire microstructure with uniform size, a diameter of about 30nm - 90nm, and a length controllable by the deposition time. Magnetic measurements (SQUID) show a hysteresis of the magnetization and an anisotropy switching with wire diameter. Work supported by IGSM.