MM 31: Nano structured materials III

Time: Thursday 11:45–12:45 Location: H4

MM 31.1 Thu 11:45 H4

Influence of Grain Size and Porosity on Electrical Conductivity of Nanocrystalline Cerium Dioxide — •Adrian Ferdinand — AG Birringer, Universität des Saarlandes

The influence of grain size and porosity on the transport properties of nanocrystalline, porous cerium dioxide was investigated by impedance spectroscopy. Magnitude and type (ionic vs. electronic) of electrical conductivity of cerium dioxide depends on parameters such as acceptor concentration, oxygen partial pressure of the surrounding gas phase and the grain size in the case of polycrystalline materials. Materials characterised by grain sizes in the nanometer regime and high porosity over the whole sample are interesting for further studies due to their high ratio of surface to overall interface area. Therefore, as a first approach, the influence of grain size and porosity on electrical conductivity was explored. A series of samples was prepared by consolidation and sintering of cerium dioxide nanoparticles with a sufficient variation in the two essential fabrication parameters, i.e. pressure and sintering temperature. Grain size was determined by X-ray diffraction and microscopy methods (REM), porosity by a density measurement based on Archimedes' principle. Furthermore, information on the samples' free surface area could be obtained by nitrogen adsorption measurement. Impedance spectroscopy was used to measure the electrical conductivity. The experimental results are discussed in terms of the space charge model for polycrystalline ionic material.

MM 31.2 Thu 12:00 H4

Tuneable electrical resistance of nanocrystalline platinum — •Martin Sagmeister[1], Ulrich Brossmann[1], Stefan Landgraf[2], and Roland Würschum[1] — [1]Institut für Materialphysik, TU Graz, Petersgasse 16, 8010 Graz, Austria — [2]Institut für Physikalische und Theoretische Chemie, TU Graz, Technikerstrasse 4, 8010 Graz, Austria

Electric field-induced tuning of material properties is usually restricted to nonmetals such as semiconductors and piezoelectric ceramics. Based on nanocrystalline materials, metals with tunable mechanical [1], magnetic [2], and electronic properties [3] could recently be generated. We show that variations of the electrical resistance of a metal (platinum) in the range of several percent can be reversibly induced at low charging voltages making use of a nanocrystallite-electrolyte composite [3]. Surface charging of the porous nanocrystallite network occurs by the formation of an electro-chemical double layer. The charge-induced resistance variation is analyzed taking into account the modification of the charge carrier density and scattering rate by surface charging. The contribution rising from the charge-induced variation of the lattice constant is found to be small.

[1] J. Weissmüller, R.N. Viswanath, D. Kramer, P. Zimmer, R. Würschum, and H. Gleiter, Science **300** (2003) 312

[2] H. Drings, R.N. Viswanath, D. Kramer, Chr. Lemier, J. Weissmüller, and R. Würschum, Appl. Phys. Lett. **88** (2006) 253103

[3] M. Sagmeister, U. Brossmann, S. Landgraf, and R. Würschum: Phys. Rev. Lett. **96** (2006) 156601

MM 31.3 Thu 12:15 H4

Kinetic properties of internal interfaces in bulk nanostructured materials: radiotracer investigation — •Sergiy Divinski[1], Jens Ribbe[1], Guido Schmitz[1], Juri Estrin[2], Yaron Amouyal[3], Eugen Rabkin[3], and Christian Herzig[1] — [1]Institut für Materialphysik, University of Münster, Münster, Germany — [2]Technische Universität Clausthal, Lehrstuhl für Physikalische Werkstoffkunde, Clausthal-Zellerfeld, Germany — [3]Department of Materials Engineering, Technion - Israel Institute of Technology, Haifa, Israel

Nanostructured materials reveal often hierarchical microstructures. In nanocrystalline Fe-Ni alloy produced by powder metallurgy, the nanosized crystallites were found to be clustered in micrometer-large agglomerates, with grain boundaries between nanocrystallites and interfaces between agglomerates revealing fundamentally different kinetic properties. On the other hand, low-angle and high-angle boundaries typically co-exist in material after a severe plastic deformation procedure. Diffusion investigations in such materials demand a special care. A complete and consistent model of diffusion in such a material was elaborated that allows a systematic experimental investigation of self- and solute diffusion in all possible kinetic regimes.

The radiotracer technique is applied for measuring grain boundary diffusion of Ni and Fe in the nanocrystalline Fe-40Ni alloys produced by powder metallurgy and in nanostructured copper prepared by equal channel angular pressing. Typical boundaries between nanograins were found to reveal diffusivities, which are similar to those in their coarse-grained counterparts. The origin of fast diffusion paths is discussed.

MM 31.4 Thu 12:30 H4

Oxygen diffusion in fully dense nanocrystalline yttria-stabilized zirconia — •Harald Drings[1], Ulrich Brossmann[2], Hans-Eckhardt Schaefer[1], Agnes Szoekefalvi-Nagy[3], Heinz Dieter Carstanjen[3], and Jürgen Fleig[4] — [1]Institut für Theoretische und Angewandte Physik, Univ. Stuttgart — [2]Institut für Materialphysik, TU Graz, Österreich — [3]Max Planck Institut für Metallforschung, Stuttgart — [4]Institut für Chemische Technologien und Analytik, TU Wien, Österreich

It has been recently shown[1] that the oxygen diffusivity in the grain boundaries of n-$ZrO_2 \cdot Y_2O_3$ is strongly enhanced compared to the volume diffusivity. Therefore, nanocrystalline yttria-stabilized zirconia are a most promising material for the application as an oxygen ion conductor in gas sensors or solid oxide fuel cells. The oxygen diffusivity in n-$ZrO_2 \cdot 9.5\,\mathrm{mol\,\%}\, Y_2O_3$ was studied by ^{18}O Tracer diffusion and ERDA. In addition, the Zr diffusivity was studied by ^{95}Zr Tracer diffusion to gain information about the reliability of future n-$ZrO_2 \cdot Y_2O_3$-based devices. The specimens were prepared by gas-phase synthesis of a nanocrystalline metal powder and subsequent oxidation, compaction and sintering using a optimized procedure[2] to obtain fully dense specimens with minimum distance between cracks of more than $500\,\mu$m, allowing both tracer diffusion and impedance studies, which is of particular interest within the framework of the Nernst-Einstein relationship.

[1] Knöner et. al., PNAS **100**, 3870 (2003)

[2] Drings et. al., phys. stat. sol. (RRL) **1**,1, R7 (2007)