DS 54: Nanoengineered Thin Films

Time: Thursday 18:00–19:30 Location: GER 38

DS 54.1 Thu 18:00 GER 38

Photothermal Laser Processing of thin silicon nanoparticle films: Prospects in photovoltaic applications — •Dennis Behrenberg[1,3], Hartmut Wiggers[2,3], Steffen Franzka[1,3], and Nils Hartmann[1,3] — [1]Fakultät für Chemie — [2]IVG — [3]CeNIDE, NETZ, Universität Duisburg-Essen, Universitätsstr. 5, 45141 Essen, Germany

Semiconductor nanoparticles (NPs) show great promise as building blocks in a variety of energy applications including thermoelectrics and photovoltaics [1]. A key step towards functional devices is the development of suitable techniques for the fabrication of NPs-based coatings. Here, photothermal laser processing of thin Si-NPs films on Si substrates is investigated. Si-NPs (d = 45 nm) dispersions are spin-coated on Si substrates yielding films with thicknesses < 0.5 microns. Subsequently, laser processing is carried out with a focused beam of an cw-DPSS-laser at a wavelength of 532 nm and a 1/e spot diameter of about 1.4 microns [2]. Using a focused laser beam allows one to conveniently investigate the dependence of the initiated processes on the laser parameters on a single sample. Generally, laser irradiation results in a local temperature rise. Depending on the ambient environment sintering, melting and oxidation of the NPs takes place. Prospects of photothermal laser procedures in photovoltaic applications are discussed, e.g. targeting back surface doping of solar cells.

[1] R. Lechner, H. Wiggers, A. Ebbers, J. Steiger, M. Brandt, M. Stutzmann, Phys. Stat. Sol. (RRL) 1, No. 6 (2007) 262.

[2] T. Balgar, S. Franzka, N. Hartmann, Appl. Phys. A82 (2006) 689.

DS 54.2 Thu 18:15 GER 38

Glancing angle deposited Ge nanorod arrays on Si patterns — •Chinmay Khare[1], Jens Bauer[1], Bodo Fuhrmann[2], Hartmut S Leipner[2], and Bernd Rauschenbach[1] — [1]Leibniz Institute of Surface Modification, Permoserstraße 15, 04318 Leipzig, Germany — [2]Interdisciplinary Centre of Materials Science, Martin-Luther-University Halle-Wittenberg, Heinrich-Damerow-Straße 4, 06120 Halle, Germany

A strong dominance of the shadowing mechanism facilitates growth of highly porous films by a physical vapour deposition technique, glancing angle deposition (GLAD). Under shadowing condition, an oblique particle flux incidence at the substrate with an angle β (usually β>80°, as measured to the substrate normal) enables realization of columnar thin films, which can be sculpted into manifold of structures. Here, ion beam sputter glancing angle deposition of Ge nanorod arrays on customized Si patterns fabricated with a combinational approach of nanospehere lithography and reactive ion etching are presented. The effective morphological variations in shape and dimension of GLAD-grown nanorods on hexagonal-closed-packed (hcp) arrays and honeycomb-like arrays are strongly influenced by Si seed heights and inter-seed distances. The nanorod growth optimization could be realized through alterations in the Si seed widths (ws) and inter-seed distances Rs, enabling growth of individual nanorods on each Si pattern seed. Furthermore, with this promising method Si/Ge heterojunction GLAD-nanostructures could be realized with alternating material supply for potential application in a thermoelectric module.

DS 54.3 Thu 18:30 GER 38

Novel Plasma Process for the Deposition of Nanocomposites for Plasmonic Applications — •Ralph Schmittgens[1], Marcus Wolf[1], Peter Frach[2], and Gerald Gerlach[1] — [1]Technische Universität Dresden, Dresden, Deutschland — [2]Fraunhofer Institut für Elektronenstrahl- und Plasmatechnik, Dresden, Deutschland

There is a growing interest in the application of plasmonic effects in metal nanostructures, e.g. surface plasmon resonances in metallic nanocrystals embedded in a dielectric matrix. Applications like photovoltaics, optics or sensors require a process to produce these structures efficiently on large area substrates using low-temperature processes. At TU Dresden a hybrid vacuum deposition process was developed,where nanoparticles are generated in a gas phase condensation and subsequently embedded in a plasma deposited thin film. The process operates at room temperature and is up-scalable. In this contribution, results on the deposition of Ag nanoparticles in a dielectric matrix are presented. The films exhibit plasmonic absorption/scattering due to the Ag nanoparticle's surface plasmon resonances. The fill factor of the Ag nanoparticles can be easily adjusted so that nanocomposites below and above the percolation threshold can be deposited. This performance is demonstrated by optical absorption and capacitance/resistance measurements.

DS 54.4 Thu 18:45 GER 38

Vertically contacting ultrathin semiconductor nanomembranes by rolled-up metallic contacts incorporating selective etching techniques. — •Dominic J. Thurmer[1], Carlos Cesar Bof Bufon[1], Christoph Deneke[1], and Oliver G. Schmidt[1,2] — [1]IFW Dresden, Dresden, Germany — [2]TU Chemnitz, Chemnitz, Germany

Merging modern self-assembly techniques with well established top-down processing methods is paving the way for more sophisticated device generations in the future. Nanomembranes, composed of many different material classes, have already been shown to provide the necessary framework for a diverse range of structures and devices incorporating wrinkling, buckling, folding and rolling of thin films. In the past decade, an elegant symbiosis of bottom-up and top-down methods has emerged to fabricate hybrid layer systems incorporating the controlled release and rearrangement of inherently strained layers. Using selective III-V etchants in combination with inherently strained layers we are able to fabricate structures which allow us to contact through single and multi-material semiconductor nanomembrane creating many devices in parallel and on the original semiconductor substrate. We demonstrate this technique by creating hybrid superconducting junctions created by sandwiching the semiconductor nanomembrane between two superconducting contacts. Using solely optical lithography techniques we are able to form junctions with lateral dimensions of a few micrometers and a semiconductor barrier thickness of down to 5 nm. D. J. Thurmer et al. Nano Lett. 10, 3704 (2010).

DS 54.5 Thu 19:00 GER 38

Sodium engineering in multifunctional Na_xCoO_2 thin films grown by pulsed laser deposition — •Sandra Hildebrandt[1], Ingo Fritsch[2], Dirk Becker[1], Philipp Komissinskiy[1], Hanns-Ulrich Habermeier[2], Wolfram Jaegermann[1], and Lambert Alff[1] — [1]Institut für Materialwissenschaft, TU Darmstadt, Petersenstr. 23, 64287 Darmstadt, Germany — [2]Max Planck Institut für Festkörperforschung, Heisenbergstr. 1, 70569 Stuttgart, Germany

We report on the growth of Na_xCoO_2 thin films by pulsed laser deposition. The sodium content in as grown films is always about $x = 0.6$. By annealing, x can be varied between 0.58 and 0.77. Further Na deintercalation down to $x = 0.35$ is achieved by chemical treatment of the film with a bromine solution. In the presence of water, a phase mixture of $Na_{0.35}CoO_2$ and $Na_{0.35}CoO_2{\cdot}0.9H_2O$ is obtained. This can be transformed into the superconducting compound $Na_{0.35}CoO_2{\cdot}1.3H_2O$ by subsequent water intercalation [1]. The Na_xCoO_2 films with higher sodium content ($0.6 < x < 1$) have typical resistivities of about 7 mΩcm at room temperature. This material already known for its large thermoelectric power, now comes in the focus as substitutional material for Li_xCoO_2 in solid state batteries. A high sodium ion conductance still has to be confirmed. We would like to acknowledge the financial support from DFG-Project AL560/6-1.

[1] Y. Krockenberger, I. Fritsch, G. Christiani, H.-U. Habermeier, Li Yu, C. Bernhard, B. Keimer, and L. Alff. Appl. Phys. Lett. 88, 162501 (2006).

DS 54.6 Thu 19:15 GER 38

Phase transitions in nano-grained close-packed Pd thin films — Erwin Hüger[1], •Tomas Kana[2,3], and Mojmír Šob[4,2] — [1]Institute of Metallurgy, Clausthal University of Technology, D-38678 Clausthal-Zellerfeld, Germany — [2]Institute of Physics of Materials, Academy of Sciences of the Czech Republic, CZ-616 62 Brno, Czech Republic — [3]Faculty of Mechanical Engineering, Brno University of Technology, CZ-616 69 Brno, Czech Republic — [4]Department of Chemistry, Faculty of Science, Masaryk University, CZ-611 37 Brno, Czech Republic

Using ab initio density functional calculations, we analyze experimental data and corresponding energy barriers of phase transitions in the $(11\bar{2}0)$ oriented hcp Pd thin films grown on W(001) and Nb(001) sub-

strates. We elucidate the feasibility of the experimentally observed phase transformation between the hcp and double hcp (dhcp) structures and absence of the hcp–fcc transformation in those films. The proposed model of the experimentally observed hcp–dhcp transformation preserves the existing domain topology of the Pd films and exhibits a sufficiently low energy barrier. On the other hand, the orthogonal pattern of rectangular domains induced by the four-fold symmetry of the substrate surface hinders the hcp Pd phase to convert back to the ground-state fcc phase, although there exists a transformation path exhibiting a very low energy barrier between the hcp and fcc structures. This path, however, would break the domain arrangement and, therefore, it cannot be accomplished. In this way, the hcp crystalline phase is locked inside of nanograins.