MM 65: Topical session: X-ray and neutron scattering in materials science VI - Which orientations can we expect for elongated particles in self-confined systems?

Time: Friday 11:45–13:00 Location: BAR 205

Topical Talk MM 65.1 Fri 11:45 BAR 205

Which orientations can we expect for elongated particles in self-confined systems? — •Ulla Vainio[1], Thea Schnoor[2], Jürgen Markmann[1,2], Ke Wang[2], Karl Schulte[2], Jörg Weissmüller[1,2], Erica Lilleodden[1], Andreas Schreyer[1], and Martin Müller[1] — [1]Helmholtz-Zentrum Geesthacht — [2]Technische Universität Hamburg-Harburg

Many new novel composite materials aim at orienting particles within a matrix in a preferred direction. It is commonly known that orientations of crystals in metals have a strong impact on the mechanical properties of the metals, and we expect the same for nanocomposite materials in which the orientation of particles is to a large extent limited by self-confinement. An example of a self-confined system is a carbon nanotube forest with its long cylindrical nanotubes growing away from a substrate and creating a seemingly homogeneous array of nanotubes with vertical alignment. Here we show that this vertical alignment cannot be described accurately by any of the commonly used distribution functions such as Gaussian or Lorentzian. Instead, the orientation distribution was measured using small-angle X-ray scattering (SAXS) and was fitted best by the generalized normal distribution, which is an extension to the Gaussian and allows one more degree of freedom. In another example we use small-angle neutron scattering (SANS) to study the orientation of ligaments in a nanoporous gold composite. In this case we observe the nanostructure after applying compressive deformation and can follow the changes in the orientation of the ligaments.

MM 65.2 Fri 12:15 BAR 205

In-situ Synchrotron Studies of Colloidal Crystallisation and the Influence of the Nanocrystal Shape — •Rainer T. Lechner[1], Max Burian[1], Christian Prehal[1], Maksym Yarema[2,3], Heinz Amenitsch[4], Wolfgang Heiss[2], and Oskar Paris[1] — [1]Institute of Physics, Montanuniversiaet Leoben, 8700 Leoben, Austria — [2]Institute of Semiconductor and Solid State Physics, JKU Linz, 4040 Linz, Austria — [3]Integrated Systems Laboratory, ETH Zürich J87, 8092 Zurich, Switzerland — [4]Institute of Inorganic Chemistry, TU Graz, 8010 Graz, Austria

Colloidal crystals using crystalline nanoparticles (NCs) as building blocks offer the opportunity for designing artificial solids [1] with tailored properties [2] used e.g. for nanoelectrodes [3]. The assembly of colloidal crystals is not only influenced the by the NC-size, but also by the shape of the individual NC.

We studied by *in-situ* SAXS/WAXS the template free self-assembled colloidal crystallization by diffusion of a non-solvent into the colloidal dispersion [1]. The SAXS patterns of the NC ensembles were recorded below the NC-solvent/non-solvent interface at the SAXS beamline at ELETTRA. Hence, we can follow the crystallization process in short time steps as a function of the non-solvent concentration. Furthermore, we retrieved the mean particle shape of the NCs and could show the influence of the elliptical and facetted shape on the super-crystal structure.

[1] M. Yarema, *et al.*, ACS Nano 6, (2012) [2] D.V. Talapin, MRS Bull. 37, (2012) [3] M.Yarema, *et al.*, JACS 132, (2010)

MM 65.3 Fri 12:30 BAR 205

Stabilization of ZnO nanoparticles - a SAXS/SANS study — •Torben Schindler, Martin Schmiele, Tilo Schmutzler, Christine Bauer, Caroline Weis, and Tobias Unruh — Work group nanomaterials characterization, Friedrich-Alexander University Erlangen Nuremberg, Staudtstr.3, 91058 Erlangen

Research on semiconductor nanoparticles (NPs) is of highest importance as the properties of the NPs can be adjusted due to the quantum size effect. For the integration in e.g. electronic devices or thin film solar cells, stable and well-defined NPs have to be designed, and knowledge about the nucleation and growth processes is crucial. The influence of surfactants is of highest importance as they have tremendous effects on the size and stability of the nanoparticles during preparation and storage, respectively.[1]

The influence of the stabilizer on the growth of zinc oxide nanoparticles was investigated using small angle neutron and X-ray scattering on the same sample. Only the use of both scattering techniques simultaneously allowed us to get detailed insight into the ripening process as SAXS is sensitive to the ZnO core and SANS to the stabilizing acetate shell. In this talk we will present the results from this combined approach to describe the ripening process not only by the changes of the size of the nanoparticles but also by the changes within the stabilizing layer which have a tremendous effect on the particle growth e.g. the stop of the ripening at a certain size.

[1]D. Segets et al., ACS Nano, 2011, 5 (6), 4658

MM 65.4 Fri 12:45 BAR 205

Ultrananocrystalline diamond films studied using GISAXS/GISANS — •Hadwig Sternschulte[1], Isabella Staudinger[1], Sebastian Simeth[1], Alessandro Sepe[1], Christine M. Papadakis[1], Jan Perlich[2], Stephan V. Roth[2], Jean-Francois Moulin[3], Slimane Ghodbane[4], and Doris Steinmüller-Nethl[4] — [1]TU München, Physik Department, Garching — [2]DESY, Hamburg — [3]Helmholtz-Zentrum Geesthacht, Garching — [4]DiaCoating GmbH, Innsbruck, Austria

Ultrananocrystalline diamond (UNCD) films are characterised by their small grain size of less than 10nm and a smooth surface with RMS values down to 10nm independent of the film thickness. The diamond grains in round shapes embedded in an amorphous C:H matrix are randomly oriented. Usually, UNCD films are studied by transmission electron microscopy (TEM) to obtain information about the grain size and the distance of the grains in the matrix. One disadvantage of TEM on diamond is that a highly sophisticated preparation is needed. For the first time we analysed UNCD films with grazing-incidence small-angle X-ray [1] and neutron scattering (GISAXS/GISANS). For this study UNCD films were grown on Si substrates by a modified hot filament technique using a CH_4/H_2 gas mixture. Prior to the deposition, the substrates have been pre-treated by an ultrasonic bath with diluted diamond powder. By data modelling and simulation we analyzed in detail the GISAXS/GISANS maps. The results will be discussed in comparison with TEM images with respect to growth processes. [1] H. Sternschulte et al, Diamond Relat. Mater. 37 (2013) 68