MM 64: Topical session: X-ray and neutron scattering in materials science V - X-ray Nanodiffraction Characterization of Inhomogeneous Structural and Mechanical Properties of Thin Films

Time: Friday 10:15–11:30 Location: BAR 205

Topical Talk MM 64.1 Fri 10:15 BAR 205

X-ray Nanodiffraction Characterization of Inhomogeneous Structural and Mechanical Properties of Thin Films — •Jozef Keckes — Department of Materials Physics, Montanuniversität Leoben, 8700 Leoben, Austria

Nanocrystalline and nanostructured thin films with grain size below 100nm exhibit typically inhomogeneous depth gradients of microstructure, strain and physical properties varying at the nano-scale. Currently, however, it is not trivial to reveal how these gradients relate to the macroscopic film behaviour. In this contribution, our recent results from position-resolved cross-sectional X-ray nanodiffraction studies of microstructure and strain in nanocrystalline films performed using monochromatic beams with diameters down to 50nm will be presented. On the examples of hard nitride coatings and metallic thin films, it will be demonstrated that the newly developed approaches can be used to analyse lateral- and thickness-dependent gradients of residual stress, crystallographic texture, phases and grain size with sub-micron resolution. Additionally, results from mechanical tests obtained from bending experiments on micro-cantilevers will be used to illustrate variability and anisotropy of mechanical properties in nanocrystalline coatings.

MM 64.2 Fri 10:45 BAR 205

Local strain and magnetization studies in single magnetoelectric microcomposites — •Stjepan Hrkac[1], Madjid Abes[1], Christian Koops[1], Christina Krywka[2,3], Martin Müller[1,2,3], Jeffrey McCord[4], Sören Kaps[4], Yogendra Mishra[4], Rainer Adelung[4], Manfred Burghammer[5], Olaf Magnussen[1,3], and Bridget Murphy[1,3] — [1]Institute for Experimental and Applied Physics, University of Kiel, Germany — [2]Institute of Materials Research, Helmholtz Zentrum Geesthacht, Germany — [3]Ruprecht Haensel Laboratory, University of Kiel, Germany — [4]Institute for Materials Science, University of Kiel, Germany — [5]European Synchrotron Radiation Facility, Grenoble, France

Magnetoelectric microcomposites are of interest for novel sensor application. We combine magneto-optic Kerr effect microscopy and nanofocus X-ray diffraction to map the local properties of ZnO microrods coated with an amorphous $(Fe_{90}Co_{10})_{78}Si_{12}B_{10}$ layer. We follow the magnetic domain behavior and lattice deformation upon applying an external magnetic field. In addition to the expected field induced strain, we observe a local magnetic induced strain in the 10^{-5} range in the ZnO localized near the $(Fe_{90}Co_{10})_{78}Si_{12}B_{10}$ /ZnO interface [1]. Financial support via the German Science Foundation (DFG) SFB 855 is acknowledged.

[1] S.B. Hrkac, M. Abes, C. T. Koops, C. Krywka, M. Müller, S. Kaps, R. Adelung, J. McCord, E. Lage, E. Quandt, O. M. Magnussen, and B. M. Murphy, Applied Physics Letters 103, 123111 (2013)

MM 64.3 Fri 11:00 BAR 205

Spider vibration sensor studied by X-ray scattering — •Maxim Erko[1], Friedrich G. Barth[2], Peter Fratzl[1], and Yael Politi[1] — [1]Max-Planck-Institut für Kolloid- und Grenzflächenforschung, Am Mühlenberg 1, D-14476 Potsdam — [2]Universität Wien. Althanstrasse 14, A-1090 Wien

Vibration sensors of spiders are known for their remarkable sensitivity and specificity. They allow the detection and recognition of complex environmental signals with relatively little down-stream processing by the central nervous system. As a consequence of the material composition and the structural architecture of these cuticular strain detectors, environmental signals are not merely collected, but are preferentially filtered for those of biological relevance. We studied the relationship between structure and function by applying X-ray microbeam scanning diffraction to non-nervous cuticular structures transforming the mechanical stimulus on its way to the sensory cells which innervate the vibration sensor. Our results include quantitative maps of structural and compositional variations within the spider cuticle obtained from X-ray scattering signals at wide and small angles (WAXS,SAXS), respectively. The structural and compositional details of the organ are then related to the mechanical properties measured by scanning acoustic microscopy (SAM) and nanoindentation. The data allow us to propose new details about the signal filtering mechanism of the spider vibration sensor. Overall, this work unveils the working principle of material-based vibration-filters in nature and can provide valuable input for future applications in bio-inspired sensory technology.

MM 64.4 Fri 11:15 BAR 205

Investigation of the piezoelectric behaviour in bones on a micrometer length scale — •D.C.F. Wieland[1], D. Kluess[2], E. Mick[2], C. Krywka[1], R. Willumeit[1], and R. Bader[2] — [1]Helmholtz-Zentrum Geesthacht, Institut für Werkstoffforschung, Max-Planck-Straße 1, 21502 Geesthacht, Germany — [2]Universitätsmedizin Rostock, Orthopädische Klinik und Poliklinik, 18057 Rostock, Germany

Electromagnetic stimulation is a clinical treatment for improving bone healing e.g. in the femoral head in case of avascular necrosis. It is supposed to be based on the principle of a reciprocal piezoelectric effect in combination with piezoelectric properties of bone tissue. Therefore, we have investigated the structure of bone at different applied voltages by means of micro diffraction at the nanofocus endstation of the P03., PETRA III, Germany. Slices of 150 *m thickness were cut from bovine trabecular bone and placed between two clamps designed to apply AC current on the sample. In order to extract the structure of the bone matrix at different positions with high resolution, the samples were scanned by a X-ray beam with the size of 1.5 *m. Each position was scanned over an array of 30 x 30 points within an area of 45 x 45 *m. To determine the effect of voltage applied at the bone samples, the measurements were repeated at 0V, 5V and 10V. Our data hints that the hydroxyapatite crystals in the bone matrix, which amount 65% of the bone mass are subject to mechanical stress if the applied voltage is increased from 0 to 10V. Furthermore, this effect depends strongly on the orientation of collagen fibrils in the bone matrix. Other properties of the hydroxyapatite like the orientation of the crystals are unaffected.