DS 8: Application of Thin Films

Time: Monday 18:45–20:00 Location: H 0111

DS 8.1 Mon 18:45 H 0111

Physics behind the growth of Multilayer Zone Plates — •Christian Eberl[1], Florian Döring[1], Markus Osterhoff[2], Hans Hofsäss[3], Tim Salditt[2], and Hans-Ulrich Krebs[1] — [1]Institute for Materialphysics — [2]Institute for X-ray physics — [3]II. Institute of Physics, University of Göttingen, Germany

Due to the small wavelength and high penetration depth, X-ray microscopy is an auspicious technique for improved investigations of materials on nm-scale. For this, multilayer zone plates (MZP) with well-defined and smooth multilayers of low thickness grown on wires are promising focusing elements. We already have shown that high quality MZPs with sub-5nm focus size for hard x-rays can be fabricated using the combination of pulsed laser deposition (PLD) and focused ion beam (FIB) [1,2]. However, the growth of such multilayers onto wires with diameters of down to 500 nm is a challenging and ambitious project: During the multilayer growth occur stoichiometric changes, both element specific and angular dependent resputtering and backscattering as well as interfacial interactions. In order to control these effects, a deep understanding of the underlying processes is essential [2]. For this, detailed studies have been carried out using complementary methods such as X-ray diffraction (XRD), X-ray reflectivity (XRR), transmission electron microscopy (TEM) in cross-section as well as SDTrimSP simulations. Here, the most recent results obtained during growth of Ta_2O_5/ZrO_2-multilayers leading to high quality MZPs are discussed. [1] Döring et al., Opt. Expr. 21 (2013); [2] Eberl et al., Appl. Surf. Sci. 307 (2014)

DS 8.2 Mon 19:00 H 0111

Chromium/Scandium attosecond multilayer mirrors — •Alexander Guggenmos[1,2], Stefan Radünz[1,2], Michael Jobst[2], Marcus Ossiander[2], Johann Riemensberger[2], Bert Nickel[1], Christina Scheu[3], Eric Gullikson[4], Reinhard Kienberger[2,5], Ferenc Krausz[1,2], and Ulf Kleineberg[1,2] — [1]LMU München, Fakultät für Physik, Garching, Germany — [2]MPQ, Garching, Germany — [3]LMU, Fakultät für Chemie, München, Germany — [4]CXRO, Lawrence Berkeley National Lab, Berkeley, USA — [5]TUM, Fakultät für Physik, Garching, Germany

Recent advances in the development of attosecond soft X-ray sources ranging into the water window spectral range, between the 1s states of carbon and oxygen (284 eV-543 eV), are also driving the development of suited broadband multilayer optics for steering and shaping attosecond pulses, enabling for the first time the unique investigation of ultrafast electronic processes within the core states of bio-molecules as proteins or other organic materials. Current attosecond experiments in the sub-200 eV range also benefit from this optic improvement. We present our achievements in optimizing ion-beam deposited Cr/Sc multilayer mirrors by a tailored material dependent deposition and interface polishing process, which offers attosecond mirrors from 140 eV up to 400 eV, thus present and future attosecond optics. Experimental results from measurements using X-ray reflectometry, XUV reflectometry as well as attosecond streaking characterization are shown and discussed.

DS 8.3 Mon 19:15 H 0111

Fabrication of GDC membranes for electrical characterization — •Florian Kuhl[1,3], Matthias T. Elm[1,2], Daniel Reppin[1], Torsten Henning[1], Jürgen Janek[2], Stefan Kolling[3], and Peter J. Klar[1] — [1]I. Physikalisches Institut, Justus Liebig University, Heinrich-Buff-Ring 16, DE-35392 Giessen, Germany — [2]Physikalisch-Chemisches Institut, Justus Liebig University, Heinrich-Buff-Ring 58, DE-35392 Giessen, Germany — [3]Technische Hochschule Mittelhessen University of Applied Sciences Wiesenstrasse 14, DE-35390 Giessen, Germany

The oxygen-ion conductor GDC (gadolinium doped ceria) is an attractive material for the use as electrolyte in solid oxide fuel cells operating between 500 °C - 800 °C. Its rather high ionic conductivity is caused by oxygen vacancies which are formed when doping with gadolinium. For lowering the operation temperature of the SOFCs, miniaturization and reduction of the film thickness is needed. Another application of thin microfabricated GDC films may be their utilization as solid-state ion source.

For the fabrication of free-standing membranes, GDC thin films were deposited onto a Si-Wafer by CVD. Afterwards the silicon was partially removed by etching. The shape of the membranes is defined by the masking patterns in SiO_2. In order to measure the electric properties using electrochemical impedance spectroscopy, Pt electrodes were deposited onto the free-standing membranes. Results of investigations of the correlation between the lateral dimensions of the membrane, its thickness and its total conductivity will be discussed.

DS 8.4 Mon 19:30 H 0111

Spike-timing dependent plasticity in $BiFeO_3$ based artificial synapses — •N. Du[1], T. You[1], M. Kiani[1], C. Mayr[2], R. Schueffny[3], D. Buerger[1], I. Skorupa[1,4], O. G. Schmidt[1,5], and H. Schmidt[1] — [1]TU Chemnitz — [2]University of Zurich and ETH Zurich — [3]TU Dresden — [4]HZDR — [5]IFW Dresden

With the rapid progress in complementary metal-oxide-semiconductor (CMOS) integrated circuit technology, also a fast development of neuromorphic cognitive systems is expected. In this work spike-timing dependent plasticity (STDP) [1] with one pairing of a single presynaptic spike and of a single postsynaptic spike has been investigated in $BiFeO_3$-based artificial synapses. The forming-free, nonvolatile, analog resistive switching of $BiFeO_3$ [2] allows to adjust the synaptic weight of $BiFeO_3$-based artificial synapses in dependence on the time delay between the single pre- and postspike in classical STDP with 60-80 single pairings [3] and in STDP with one single pairing. Due to the easy pulse sequence in one single pairing STDP, the time delay could be reduced to few microseconds, memory consolidation in delay learning could be investigated, and energy consumption per setting pulse could be reduced to only 4.5 pJ. Using $BiFeO_3$-based artificial synapses with different flexible electrodes [4], we have realized STDP, Anti-STDP and both STDP/Anti-STDP within a single cell! [1] G. S. Snider, In Proc. IEEE Int. Symp. Nanoscale Architechtures, 85-92 (2008) [2] Y. Shuai, N. Du et al., IEEE Elec. Dev. Lett. 34, 54-56 (2013) [3] C. Mayr, N. Du et al., Adv. Neural Inf. Process. Syst. 25, 1700-1708 (2012) [4] T. You, N. Du et al., Adv. Funct. Mater. 24, 3357-3365 (2014)

DS 8.5 Mon 19:45 H 0111

Tip radius dependence of Young's modulus of 2D materials extracted via nanoindentation — •Gerard Verbiest, Jan-Felix Moneke, and Christoph Stampfer — JARA-FIT and 2nd Institute of Physics, RWTH Aachen University, 52074 Aachen, Germany

Tow-dimensional (2D) materials are known for their remarkable electronic, optical, and mechanical properties. For example, graphene is only one atomic layer thick, but it is far stronger than steel and has an extremely high Young's Modulus of 1.02 TPa.

The standard way of determining the Young's Modulus of 2D materials is via nanoindentation experiments. In these experiments, a cantilever is used to indent a suspended part of the 2D material. From these measurements, one obtains the force on the 2D material as a function of the indentation depth into the 2D material. These curves strongly depend on the Young's modulus of the material. However, to extract the Young's modulus, one has to resort to an analytical model. Usually, one assumes a point load indenter in the center of the suspended 2D material.

Here we show that this model of a point load indenter in the center is not valid. Using the full nonlinear elasticity theory, we calculated the force vs. indentation depth for various tip radii of the cantilever and various indentation positions. Analyzing these curves with the point load model shows an overestimation of the Young's modulus by more than a factor 4 for a tip radius of 10 nm.