DS 35: Application of Thin Films

Time: Friday 9:30–12:00 Location: H8

DS 35.1 Fri 9:30 H8

Aperiodic multilayer mirrors for attosecond water window pulses — •Alexander Guggenmos[1,2], Roman Rauhut[1,2], Michael Hofstetter[1,2], Samira Hertrich[3], Bert Nickel[3], Eric M. Gullikson[4], Ferenc Krausz[1,2], and Ulf Kleineberg[1,2] — [1]Ludwig-Maximilians-Universität München, Fakultät für Physik, Garching, Germany — [2]Max-Planck-Institut für Quantenoptik, Garching, Germany — [3]Ludwig-Maximilians-Universität München, Fakultät für Physik, München, Germany — [4]Center for X-Ray Optics, Lawrence Berkeley National Lab, Berkeley, USA

Attosecond pulses pave the way towards the direct observation of electron dynamics in atoms, molecules or solid surfaces with an unprecedented temporal precision. Chirped broadband multilayer mirrors are key components to shape these pulses generated from high harmonic radiation facilitating an even deeper physical insight into these dynamics by compressing high harmonic pulses to their fourier limit utilizing short pulse pump-probe experiments. Aperiodic broadband multilayer XUV mirrors exhibit the required degree of freedom for tailored shaping of attosecond pulses. Extending the current technology to the water window spectral range around 300-500 eV requires multilayer optics of atomic precision since the spectral phase is extremely sensitive to even smallest thickness errors. We will present the investigations of chirped aperiodic multilayer XUV optics for the water window range with atomic precision to control spectral and temporal features. Furthermore simulations and optimizations of multilayer systems as well as experimental results of XRR and XUV measurements are presented.

DS 35.2 Fri 9:45 H8

Hard x-ray focusing below 10 nm by multilayer zone plates fabricated by the combination of pulsed laser deposition and focused ion beam — •Florian Döring[1], Christian Eberl[1], Tobias Liese[1], Felix Schlenkrich[1], Volker Radisch[1], Hans-Ulrich Krebs[1], Anna-Lena Robisch[2], Markus Osterhoff[2], Sarah Hoffmann[2], Matthias Bartels[2], and Tim Salditt[2] — [1]Institut für Materialphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institut für Röntgenphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

In hard x-ray microscopy, one approach for point transmission focusing is to use of multilayer zone plates instead of conventional Fresnel zone plates, which are difficult to prepare with high aspect ratio. Therefore, aperiodic W/Si multilayers were pulsed laser deposited (PLD at 248 nm) with high quality on a W wire with single layer thicknesses according to the zone plate law (width of smallest layer $\Delta r = 5.2$ nm). Then, from the coated wires, a lens was fabricated by cutting, transferring on a W-tip and polishing using focused ion beam (FIB). X-ray focusing experiments were performed at the coherence beamline P10 of Petra III, showing a far-field pattern which exhibits the expected high numerical aperture. Measured far-field pattern, the corresponding autocorrelation of the focal intensity distribution as well as a three plane iterative phase reconstruction of the zone plate exit wave are in agreement with a focal width in between 6 and 10nm (FWHM), which compares well with the expected 1.22 $\Delta r = 6.3$ nm.

DS 35.3 Fri 10:00 H8

Interface investigation of ion-beam deposited Chromium/ Scandium multilayer mirrors — •Roman Rauhut[1,2], Alexander Guggenmos[1,2], Samira Hertrich[3], Bert Nickel[3], Sriram Venkatesan[4], Christina Scheu[4], Eric M. Gullikson[5], Ferenc Krausz[1,2], and Ulf Kleineberg[1,2] — [1]Ludwig-Maximilians-Universität München, Fakultät für Physik, Garching, Germany — [2]Max-Planck-Institut für Quantenoptik, Garching, Germany — [3]Ludwig-Maximilians-Universität München, Fakultät für Physik, München, Germany — [4]Ludwig-Maximilians-Universität München, Fakultät für Chemie, München, Germany — [5]Center for X-Ray Optics, Lawrence Berkeley National Lab, Berkeley, USA

The direct observation of electron dynamics in atoms, molecules or on surfaces with a unprecedented temporal precision requires attosecond pulses from High Harmonic Generation (HHG) sources. Shaping, filtering and steering these pulses requires highly efficient XUV optics based in many cases on multilayer mirror technology. This leads to the necessity of developing as perfect interfaces as possible, due to the huge loss in reflectivity from boundary imperfections. We will present a systematic optimization of ion-beam deposited Cr/Sc multilayer mirrors by a variation of ion beam voltages during the deposition process as well as the application of ion-assisted deposition, which leads to the fabrication of highly reflecting multilayer optics in the water window. Experimental results from X-ray reflectometry, spectral ellipsometry and XUV reflectometry measurements as well as TEM cross section images are shown and discussed.

DS 35.4 Fri 10:15 H8

Temperature and bias voltage induced electron tunneling through ultrathin TaOx barriers. — •Ievgen Nedrygailov[1], Katrin Asteman[2], Eckart Hasselbrink[1], and Detlef Diesing[1] — [1]Fakultät für Chemie, Universität Duisburg-Essen, D-45117 Essen, Germany — [2]Heraeus Precious Metals GmbH & Co. KG, Conductive Polymer Division (Clevios), Chempark Leverkusen, 51368 Leverkusen, Germany

The ability to control tunneling of electrons through ultrathin (1-5 nm) dielectric films is a prerequisite for high-performance metal-insulator-metal (MIM) structures. Due to the nonlinear current-voltage characteristics and ultrafast transport of charge carriers through the built-in potential barrier these structures are widely used in nanoelectronic applications such as single electron transistors, thermometers, coolers, radiation and chemically excited hot charge carriers (chemicurrents) detectors.

In this contribution we discuss the use of Pt-TaOx-Ta structures for detection of chemicurrents under elevated temperature conditions, which are typical for higher pressure catalysis. We focus on the separation of the current of hot charge carriers and secondary effects, such as the current induced by the temperature difference across the tunnel junction or by an applied bias voltage. Possible advantages of ultrathin MIM structures over metal-semiconductor detectors, which are commonly used in chemicurrent studies, are also discussed.

DS 35.5 Fri 10:30 H8

Effect of composition and strain on conductivity of $LaNiO_3$ thin films — Mingwei Zhu[1,2], •Philipp Komissinskiy[1], Aldin Radetinac[1], Mehran Vafaee[1], and Lambert Alff[1] — [1]Department of Materials Science, Technische Universität Darmstadt, 64287 Darmstadt, Germany — [2]Shenyang National laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences, Wenhua Road 72, 110016 Shenyang, People's Republic of China

Highly conductive oxide $LaNiO_3$ (LNO) is an excellent electrode material for all-oxide electronic devices. We have grown 35-50 nm thick $La_{1+x}Ni_{1-x}O_3$ thin films by pulsed laser deposition. Fine tuning of the Ni/La ratio in the films is achieved by using targets with various cation stoichiometry x = 0.04, 0.01, -0.09 as measured by energy dispersive spectrometry. We observe that the conductivity of the LNO films can be controlled by tailoring the Ni/La ratio. The LNO films deposited using a target with slight excess of Ni show record low resistivity values of about 80 $\mu\Omega \cdot cm$ at room temperature. The excess Ni oxidizes to NiO as evident from X-ray diffraction measurements. The effect of compressive and tensile strain on conductivity was studied using LNO films grown on $SrTiO_3$, $LaAlO_3$, $LaSrAlO_4$, and $(La,Sr)(Al,Ta)O_3$ substrates. This work was supported by the National Natural Science Foundation of China (No.51202256) and China Scholarship Council (CSC)

DS 35.6 Fri 10:45 H8

Growth of highly conductive $SrMoO_3$ as lattice matched oxide electrode material for $(Ba,Sr)TiO_3$ based thin film heterostructures — •Aldin Radetinac, Jürgen Ziegler, Mehran Vafaee, Philipp Komissinskiy und Lambert Alff — Materialwissenschaften, Technische Universität Darmstadt, Petersenstraße 23, 64287 Darmstadt, Germany

We have grown epitaxial heterostructures of $Ba_{0.6}Sr_{0.4}TiO_3$ and $SrMoO_3$ [1] by pulsed laser deposition on $SrTiO_3$ (001) substrates. A 5 nm thick interlayer of $Ba_{0.6}Sr_{0.4}TiO_{3-\delta}$ grown at low oxygen pressures and flow prevents oxidation of the conducting $SrMoO_3$ bottom electrode. Beneath this capping layer, a Mo^{4+} valence state fraction of 80% is maintained even after oxygen annealing as observed by X-ray photoelectron spectrometry (XPS). The described oxygen interface

engineering allows fully epitaxial growth of the heterostructure enabling the future use of the novel highly conductive electrode material $SrMoO_3$ e.g. in tunable varactors.
This work was supported by the DFG projects GRK 1037 (TICMO) and KO 4093/1-1.

[1] A. Radetinac, K. S. Takahashi, L. Alff, M. Kawasaki, and Y. Tokura, Appl. Phys. Express **3**, 073003(2010).

DS 35.7 Fri 11:00 H8

Chemical purity in high performance solution processed zinc oxide TFTs — •Marlis Ortel, Torsten Balster, and Veit Wagner — Research Center for Functional Materials and Nanomolecular Science, Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany

Conversion of precursor materials in solution processed semiconductor plays an important role in device application. The organic by-products from zinc acetate conversion into ZnO have a significant influence on the electronic structure of the resulting semiconductor layer. They can significantly influence charge transport in the material. Hence the impact of deposition and post-deposition annealing on the chemical composition of the ZnO semiconductor was investigated by means of x-ray photoelectron spectroscopy (XPS), optical and electrical measurements in a wide process temperature range from 200°C to 500°C. It was found, that the increase in deposition temperature from 360°C to 500°C leads to a reduction in carbon content by 30% and an increase of the oxygen to zinc ratio from 0.82 to 0.96. These XPS results correspond well with optical measurements, which exhibit a blue-shift of the optical band gap by 20 meV to a value of 3.19 eV reflecting an improved layer quality. The layers were electrically analyzed in a field-effect transistor geometry. The optimization in the purity of the ZnO semiconductor by thermal treatment lead to an improvement of the field-effect mobility up to $13 cm^2 V^{-1} s^{-1}$. The increase in mobility is found to be correlated to an on-set voltage shift from 14V to an ideal value of 0V, which reflects a reduction in the level of deep traps.

DS 35.8 Fri 11:15 H8

Retention of Ferroelectric VDF-TrFE Copolymer Thin Films Characterized by Nondestructive Polarization Readout — •Danny von Nordheim[1], Sebastian Koch[1], Soichiro Okamura[2], and Bernd Ploss[1] — [1]Department of SciTec, University of Applied Sciences Jena, Carl-Zeiss-Promenade 2, 07745 Jena, Germany — [2]Department of Applied Physics, Tokyo University of Science, Shinjuku, Tokyo 162-8601, Japan

Usual retention tests are based on the application of read pulses to a ferroelectric sample while the charge response is recorded. These tests, however, do not allow the continuous recording of retention as after the application of the read pulse the ferroelectric is in a new state defined by the sign of the read pulse. We propose a novel approach which is based on the nondestructive readout of the remanent polarization by measurement of small signal dielectric nonlinearities. The temporal development of the remanent polarization is directly accessible from the measured first and second harmonics in the current response to a small sinusoidal voltage signal. The novel technique has been used to investigate the retention of thin VDF-TrFE copolymer films of molar ratio 70/30 with thickness below 200 nm. This technique may also be useful for the nondestructive readout of ferroelectric memory cells. Compared to the destructive readout by polarization switching the rewrite of the initial polarization is not required and the lifetime of the memory cell increased.

DS 35.9 Fri 11:30 H8

The Co2p spin and oxidation state in Co-PI catalysts — •Matthias Richter and Dieter Schmeisser — Brandenburg University of Technology Cottbus, Applied Physics and Sensors, K.-Wachsmann-Allee 17, 03046 Cottbus, Germany

The electronic structure of cobalt based catalysts used for photocatalytic water splitting in solar cells is analyzed using synchrotron radiation photoelectron spectroscopy. The catalyst films are prepared by electrochemical deposition. We employ a X-ray photoelectron spectroscopy study to analyze the Co2p and O1s core levels, absorption edges and valence bands. We discuss our resonant data in terms of the partial density of states of the valence and conduction band. We find a difference in the Co oxidation state as a function of film thickness (deposited charge). From the relative amount of Co, O, K and P we favor the molecular cobaltate cluster-like structure as the structural motif of the Co-PI catalyst. Further, at resonant PES at the Co2p edge we find the Co2p partial DOS to exhibit no sharp features next to the VBM, instead there is a broad emission at around 6eV below E_{Fermi}. The former are found in $LiCoO_2$ and other Co-oxide systems with a Co^{3+} ground state. We attribute such sharp features to the low spin (LS) configuration of Co^{3+} and deduce that in the Co catalysts there is no evidence for the corresponding LS contributions. Our data prove the Co^{2+} ground state and demonstrate that it is exclusively in the $Co3d^7$ high spin state in the pristine catalyst films.

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Epitaxial Ag: Opening Doors to New Opportunities in Plasmonics — •Charlotte E. Sanders[1], Bo-Hong Li[2], Chih-Kang Shih[1], and Xianggang Qiu[2] — [1]The University of Texas at Austin, Department of Physics, Austin, TX U.S.A. — [2]Chinese Academy of Sciences, Beijing National Laboratory for Condensed Matter Physics and Institute of Physics, Beijing, China

It has been shown that noble metals can grow epitaxially on semiconducting and insulating substrates: although such films constitute non-wetting systems, low temperature deposition followed by room temperature annealing leads to atomically flat film. We recently made a major breakthrough with the demonstration of the superiority of epitaxial Ag as a low-loss plasmonics platform in the visible regime, and with the harnessing of the special plasmonic properties of Ag for plasmonic nanolasing (Science 337, 450 (2012)). Now we have extended our investigation to the infrared regime, where we have measured extraordinary optical transmission through arrays of subwavelength-diameter perforations in order to compare the strength of plasmonic resonances in epitaxial Ag film with those in polycrystalline Ag film grown by thermal evaporation. Our results suggest (in agreement with simulation and with our previous findings in the visible regime) that the high losses and short propagation distances that until now have been typical in surface plasmon studies are due largely to scattering from the surface roughness characteristic of thermally evaporated polycrystalline films. These results, newly published in Nano Letters (doi:10.1021/nl303029s), will be elaborated upon in this presentation.