DS 31: Poster: Layer Deposition and Layer Properties

Time: Wednesday 15:00–18:00 Location: P1A

DS 31.1 Wed 15:00 P1A

Influence of Stoichiometry on the properties of Mn_2Au thin films — •Daragh Mullarkey, Daniel Casey, and Igor V. Shvets — School of Physics, Trinity College Dublin, The University of Dublin, Dublin 2, Ireland

Mn_2Au is a bimetallic antiferromagnet with a Néel temperature of approximately 1500 K. Here, we deposit (110) Mn_2Au thin films onto Pt (111)/Al_2O_3 via molecular beam epitaxy. By varying the ratio of the Mn and Au atomic fluxes from separate Knudsen cells, precise control over the stoichiometry of the films can be obtained. We investigate how modifying the stoichiometry away from the ideal 2:1 Mn:Au ratio effects the crystallographic, electrical, and magnetic properties of the Mn_2Au thin films.

DS 31.2 Wed 15:00 P1A

Improvement of TiO_2 VO_2 multi-layers for application in thermochromic window-glazing — •Lukas Frommel, Martin Becker, Philip Klement, Florian Kuhl, Sebastian Benz, Jonas Hauptmann, Jörg Schörmann, and Sangam Chatterjee — Institute of Experimental Physics I and Center for Materials Research, Heinrich-Buff-Ring 16, Justus Liebig University Giessen, D-35392 Giessen, Germany

Thermochromic window glazing is a possible innovation to optimize the heat exchange in buildings. Vanadiumdioxid is a promising material for this application, because of a reversible insulator-to-metal transition at 68°C. To modify the characteristic temperature of this transition, a TiO_2 buffer layer can be used. While conventional preparation methods fail in terms of lateral upscaling, a new synthesis route for larger scales needs to be established.

Here, we prepare TiO_2 thin films by atomic layer deposition. Under variation of the process parameters, reactor temperature and precursor pulse times among others, different types and phases of TiO_2 are deposited and examined via X-Ray Reflectometry, Atomic Force Microscopy and Raman Spectroscopy. A VO_2 layer on top is prepared by rf-sputtering and the resulting multi-layer structure examined via UV-NIR Spectroscopy. The thickness and different structures of the TiO_2 buffer layer were found to significantly affect the switching properties of the VO_2.

DS 31.3 Wed 15:00 P1A

Compositionally Modulated $La_{1-x(t)}Sr_{x(t)}MnO_3$ Superlattices — •Yannik Sievers, Robert Gruhl, Vitaly Bruchmann-Bamberg, and Vasily Moshnyaga — Erstes Physikalisches Institut, Georg-August-Universität Göttingen

Bulk perovskite manganites $La_{1-x}Sr_xMnO_3$ (LSMO) possess a rich phase diagram, depending on the Sr-doping level, x. Usually, one examines only few special doping levels depending on the desired properties. Instead of a fixed doping level we studied LSMO films in a form of artificial lattices, consisting of layers with a different and alternating doping levels, yielding compositionally modulated $La_{1-x(t)}Sr_{x(t)}MnO_3$ superlattices with controllable doping level x(t) (x = t/d with t = [0,d]: time and d: transition-layer width). To grow such gradient lattices we further developed our metal-organic aerosol deposition (MAD), making possible the simultaneous usage of LMO and SMO precursor channels, which can be supplied by controllable feeding rates. The resulting artificial LSMO superlattices have been grown on $SrTiO_3$(100) and characterized by AFM, XRD, XRR, SQUID, Raman-Spectroscopy as well as by in-situ ellipsometry. Financial support by DFG via SFB 1073 is acknowledged.

DS 31.4 Wed 15:00 P1A

Broadband antireflection coatings on polymethylmethacrylate prepared by Atomic Layer Deposition — •Lukas Gümbel, Philip Klement, Jörg Schörmann, and Sangam Chatterjee — Institute of Experimental Physics I and Center for Materials Research (ZfM), Justus Liebig University Giessen, Giessen, Germany

Transparent plastic optics are lighter than glass and easy to manufacture. They require surface functionalities such as antireflection and scratch-resistant coatings to enable their applications which is typically done by plasma-assisted processes that can damage the polymer substrate. Atomic Layer Deposition (ALD) offers precise thickness and composition control without thermally or plasma-stressing the underlying substrate.

Here we present broadband antireflection coatings on polymethylmethacrylate prepared by Atomic Layer Deposition. A thin Al_2O_3 film acting as adhesion layer is deposited from the trimethylaluminum-H_2O-process, and the processing parameters are optimized yielding a high GPC and ultra-smooth surfaces. Combining this with ALD-grown ZnO and SiO_2 facilitates antireflection coatings in the visible range that perfectly match precalculated antireflection designs. Our results enable precise conformal antireflection coatings of plastic optics.

DS 31.5 Wed 15:00 P1A

Exploring fragmentation processes in FXBID nanofabrication — •Andreas Späth[1], Kim Thomann[1], Benedikt Wolz[1], Kevin C. Prince[2], Robert Richter[2], Wolfgang Hieringer[3], and Rainer H. Fink[1] — [1]Physikalische Chemie II, FAU Erlangen-Nürnberg, Germany — [2]Elettra Sincrotrone Trieste, Basovizza, Italy — [3]Theoretische Chemie, FAU Erlangen-Nürnberg, Germany

Focused X-ray beam induced deposition (FXBID) is a novel technique for the additive fabrication of metallic nanostructures by illuminating metal organic precursor molecules with focused soft X-rays in a Fresnel zone plate based scanning transmission X-ray microscope (STXM) [1]. Fragmentation in FXBID is mainly caused by low-energy secondary electrons and, therefore, the fundamental processes of nanofabrication are very similar to such in electron beam induced deposition. However, FXBID provides tuning of deposition rate and potentially also fragment formation by variation of incident photon energy. For a detailed analysis of this aspect we have performed photon energy dependent mass spectrometry and secondary electron spectroscopy studies for several metal organic precursor molecules. The results are correlated with TD-DFT calculations of the molecular orbitals involved in soft X-ray absorption for a correlation of electron density localization and fragmentation. The project is funded by DFG grant SP 1775/1-1.

[1] A. Späth, Micromachines, 2019, 10, 834.

DS 31.6 Wed 15:00 P1A

Cesium-intercalated bulk $HfSe_2$ investigated by electron spectroscopy — •Jochen Simon, Martin Knupfer, and Bernd Büchner — Leibniz Institute for Solid State and Materials Research, Dresden, Germany

We studied cesium-intercalated bulk $HfSe_2$ by combining electron energy loss spectroscopy and angle-resolved photoemission spectroscopy. The strong anisotropy, the band gap and the predicted electron mobilities make $HfSe_2$ a promising candidate for optical and electrical devices. Intercalation leads to a degree of disorder in the crystalline structure while superstructures emerge for higher doping levels. The change of the lattice parameters is less than 1% (in-plane) and 70% (out-of-plane), respectively. Loss spectra reveal features we consider to be charge carrier plasmons, in agreement with the semiconductor-to-metal transition indicated by angle-resolved photoemission spectroscopy. As expected for an ideal electron gas, the plasmon shows a quadratic momentum dispersion.

DS 31.7 Wed 15:00 P1A

Structure and Ferroelectricity in Strain-Stabilized Hexagonal TbMnO3 Thin Films — •Moritz Hirsbrunner[1], Rajesh Mandal[2], Daniel Steil[1], Karen Stroh[1], and Vasily Moshnyaga[1] — [1]Erstes Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, D-37077, Göttingen, Germany — [2]SRF, Department of Physics, Indian Institute of Science Education and Research, Pune, India-411008

Rare-earth-manganite-based multiferroic materials are of great interest because of their strong coupling of magnetic and electronic systems, resulting in cross-controlled magnetoelectric properties. Hexagonal TbMnO3 (h-TMO) films with room temperature ferroelectricity (FE) is of particular importance. Bulk TMO displays orthorhombic structure and exhibits FE with low polarization 0.06 μC/cm2 and ferromagnetism (FM) well below 100K. However, stabilization of hexagonal structure in TMO thin films by epitaxy strain was shown to result in a much larger room temperature polarization (8 μC/cm2). We optimized the growth of h-TMO thin films on YSZ(111) substrates by Metalorganic Aerosol Deposition (MAD) by varying the precursor ratio, substrate temperature, growth and cooling rate. X-ray diffraction

(XRD) confirms the hexagonal structure of the films, showing a smooth surface with RMS ~0.3nm (AFM). Furthermore, optical spectroscopy and second harmonic generation (SHG) were measured to characterize the ferroelectricity of h-TbMnO3. The financial support of DFG via SFB1073 (A02, A06) is acknowledged.

DS 31.8 Wed 15:00 P1A

Strain Engineering of Antiferroelectric Thin Films — •Thorsten Schneider, Mahdad Mohammadi, Juliette Cardoletti, Maohua Zhang, Philipp Komissinskiy, and Lambert Alff — TU Darmstadt, Darmstadt, Germany

The demand for smaller and more efficient energy storage devices is ever-present in modern society. Within these, capacitors play an important role for short-time energy storage and conversion with high power density. However, to reduce the space consumption of these capacitors, the necessity for larger energy densities is of significant importance.

Antiferroelectric (AFE) Materials have the opportunity to overcome the problem of low energy density while maintaining a large power density due to a high polarization with no remnant polarization. Of the few known, lead-free AFE materials, $NaNbO_3$ offers a good opportunity to investigate the interplay between the polar and antipolar phase, since the energy barrier between these two phases is very small.
Here we present investigations of $NaNbO_3$ thin films. By utilizing epitaxial strain, a property closely linked with ferroelectricity, we manipulate the energy difference between the AFE and FE state in an attempt to stabilize the AFE double-hysteresis behaviour. As shown by X-Ray Diffraction measurements, the $NaNbO_3$ thin films grown on various perovskite single-crystals like $SrTiO_3$, LSAT and $DyScO_3$, are epitaxially strained. The AFE properties of the films are monitored using measurements of the polarization versus the electric field.

DS 31.9 Wed 15:00 P1A

Low-temperature characterization of ultra-strongly driven nanomembrane resonators — •Mengqi Fu, Fan Yang, and Elke Scheer — University of Konstanz, Konstanz, Germany

Ultra-strong nonlinear vibrations of nanoresonators with very high amplitude at room temperature recently have attracted broad interest[1,2]. However, the mechanism behind some of the observations (e.g. squeezing) cannot be derived from the existing theoretical models for strong nonlinearities and including thermal fluctuations.

To reduce the effects of thermal fluctuations of the environment and to elucidate other possible origins of these ultra-strong nonlinear effects, we developed a low-temperature (down to 4K) measurement system to detect flexural vibrations by using on-chip nanoelectrodes and the electromagnetic induction effect in a magnetic field. We characterize this novel detection scheme by studying the flexural vibrations of nanomembrane resonators from the linear to the ultra-strong nonlinear regime at variable temperature. The accuracy of the amplitude detection is 1 nm or better with high stability at all temperatures (4 K to 300 K). In addition, because the deflection signal is converted into high-frequency voltage signals rather than to the commonly used optical interference signal, the inductive scheme presented here is not subject to fundamental limitations imposed by the optical wavelength and is thus well-suited for measurements of the ultra-strong nonlinear regime with high deflection amplitudes.

References [1] F. Yang et al., Phys. Rev. Lett. 122, 154301 (2019). [2] J.S. Huber et al., [arXiv:1903.07601v2].