DS 22: Thin Film Applications

Time: Thursday 9:30–12:15 Location: H39

DS 22.1 Thu 9:30 H39

Spin-to-charge conversion using NbSe2 thin films grown by MBE — •Avanindra Kumar Pandeya, Amilcar Bedoya Pinto, Kai Chang, Ilya Kostanovskiy, Edouard Lesne, and Stuart Parkin — Max Planck Institute of Microstructure Physics

Transition metal dichalcogenides (TMDCs) are commonly fabricated via exfoliation of high-quality bulk crystals. Although there has been tremendous progress in fabricating devices out of exfoliated heterostructures, there are other effects, such as spin transfer, that need atomically clean interfaces for an optimum harvesting. We grow high-quality NbSe2 layers on Al2O3 (0001) by molecular beam epitaxy (MBE), in order to gain a precise control of the layer thickness, electronic properties (doping) and improve the quality of the interfaces involved in spin transfer and spin-to-charge conversion experiments. In this work, we use spin-torque ferromagnetic resonance (ST-FMR) to explore the spin-orbit torques (SOTs) produced by the TMDC. In order to maximize the SOT transfer, we rely on the growth of a single-crystalline NbSe_2 layer and a Permalloy (Ni80Fe20) layer in ultra-high vacuum conditions. Preliminary ST-FMR results at room temperature show a strong symmetric component on the lineshape of the voltage detected across the ferromagnetic resonance, as well as a change of the resonance linewidth by applying an external DC bias through the bilayer, both signatures of sizable spin-orbit torques induced by the NbSe2 layer via spin-hall effect. This underlines the relevance of in-situ TMDC/ferromagnet heterostructures towards highly efficient spin-orbitronic devices.

DS 22.2 Thu 9:45 H39

Electrical and optical characterization of the correlated metals $AMoO_3$ (A = Ca, Sr, Ba) — •Mahdad Mohammadi, Aldin Radetinac, Iliya Radulov, Leopold Diop, Philipp Komissinskiy, and Lambert Alff — Institute of Materials Science, Technische Universität Darmstadt, Darmstadt

Transparent conducting materials (TCMs) are facing a steadily increasing demand for a variety of applications such as capacitive touchscreens, LCDs, solar cells and LEDs. In the majority of devices, ITO, a doped wide-gap semiconductor, is used due to the very good transparency in the visible light spectrum. Recently, correlated metals have gained attention as an alternative material class for application as TCMs. One prominent representative of this material class is the perovskite compound $SrMoO_3$ [1]. In this work, the influence of the A-site cation on the electrical and optical properties has been investigated by substituting Sr with Ca and Ba. The compounds were epitaxially grown using pulsed-laser deposition and characterized via XRD, XPS, UPS, Hall transport measurements and UV/VIS spectrophotometry. Due to the high conductivity of the molybdates, very thin films in the range of 10-30 nm are sufficient to achieve application relevant sheet resistances below 50 Ω/□ .This leads to similar transparencies in the visible light spectrum at comparable sheet resistances compared to ITO. Among the three investigated compounds, $BaMoO_3$ showed the highest transparency with resistivities around 30 $\mu\Omega$cm.

[1] A. Radetinac et al., J. Appl. Phys., 119, 055302 (2016)

DS 22.3 Thu 10:00 H39

Enhancing Performance of Sputter Deposited Photocatalytic Thin Films — Salih Veziroglu, Muhammad Zubair Ghori, Bodo Henkel, Alexander Vahl, Oleksandr Polonskyi, Thomas Strunskus, •Oral Cenk Aktas, and Franz Faupel — Institute for Materials Science, Multicomponent Materials, Faculty of Engineering, Christian-Albrechts-University of Kiel, Kaiserstraβe 2, Kiel 24143, Germany

Semiconductor oxides such as TiO2, ZnO, etc. have been used in various photocatalytic processes including environmental remediation, energy harvesting, anti-bacterial and self-cleaning applications. Several methods including decorating metallic nanoparticles on such oxides and/or adding a second oxide (mixed oxide) have been developed to enhance the photocatalytic performance of such oxides. Most of these preparation methods are mainly based on wet-chemical techniques (solution-based). In comparison, physical vapour deposition methods offer solvent-free synthesis, high purity and precise control of amount of the added second phase (metallic nanoparticle or oxide). In this current work we present various approaches to enhance the performance of sputter deposited photocatalytic thin films. First a novel approach, which leads enlacing the affective surface area of sputter deposited photocatalytic thin films by inducing controlled nanocrack networks, will be presented. Then the use of cluster source to decorate photocatalytic thin films with metallic nanoparticles will be discussed. The plasmon induced photocatalysis will be covered briefly. Additionally, some case studies on photocatalytic mixed oxide thin films will be shown.

DS 22.4 Thu 10:15 H39

Novel deposition approach of MoS_2 thin films for hydrogen evaluation reaction — •Talha Nisar, Torsten Balster, Francis Oliver Vinay Gomes, and Veit Wagner — Jacobs University Bremen gGmb, Campus Ring 1, 28759, Bremen

Electrolytic hydrogen evolution reaction is a promising way to store solar energy. It requires suitable materials as a catalyst to lower overpotential and minimize energy consumption. MoS_2 has been demonstrated to be a very promising candidate for hydrogen evolution reaction. In this work, MoS_2 films are deposited by spin coating using a Molybdenum (V) chloride precursor solution on Au and ITO substrates. The thickness of the deposited films is linearly dependent on the concentration of precursor. After spin-coating the thin layers are converted to MoS_2 by post annealing at temperature above 450°C with an additional sulfur source. The thickness of the films ranges from 2nm to 50nm. Raman measurements show E_2g and A_1g modes of MoS_2. The modes have reduced FWHM for higher annealing temperatures, confirming the formation of high quality crystals. This interpretation is supported by XPS, UV-Vis, AFM and XRD measurements. Finally hydrogen evolution activity is determined in dependence of the thickness.

DS 22.5 Thu 10:30 H39

Noise properties of oxygen engineered HfO_{2-x} based Resistive Random Access Memory devices — •Eszter Piros[1], Martin Lonsky[2], Stefan Petzold[1], Eric Jalaguier[3], Emmanuel Nolot[3], Christelle Charpin[3], Jens Müller[2], and Lambert Alff[1] — [1]Institute of Materials Science, Advanced Thin Film Technology, Technische Universität Darmstadt, Darmstadt, Germany — [2]Institute of Physics, Goethe-University Frankfurt, Frankfurt am Main, Germany — [3]CEA, LETI, Grenoble, France

Resistive Random Access Memory (RRAM) is one of the most promising candidates amongst emerging non-volatile memories because of their fast read/write speed, high endurance, and good retention properties. One of the biggest challenges, however, is to improve device reliability and variability, highlighting the necessity of a comprehensive physical picture on the resistive switching mechanism. Therefore, we comparatively investigated the noise properties of oxygen engineered stoichiometric and highly oxygen deficient hafnia [1], by electrical fluctuation spectroscopy to explore the physical nature of conduction in the high and low resistive state, finding a strong dependence on stoichiometry, voltage bias amplitude, and DC cycling. The investigations were carried out in both the time- and frequency domain. The observation of multilevel- and anomalous random telegraph noise and corresponding Lorentzian spectra are also discussed.

[1] S. U. Sharath, Adv. Funct. Mater. 27, 1700432 (2017)

15 min. break.

DS 22.6 Thu 11:00 H39

High resolution fast X-ray reflectivity data acquisition — •Milena Lippmann, Anita Ehnes, and Oliver Seeck — DESY, Hamburg

A new method for fast x-ray reflectivity data acquisition is presented. The method is based on a fast rotating, slightly tilted sample reflecting to a stationary mounted position sensitive detector and it allows for measurements of reflectivity curves in a quarter of a second. The resolution in q-space mainly depends on the beam properties and the pixel size of the detector. Maximum qz-value of 1 A-1 can be achieved. The time-temperature depending structure changes of poly(N-isopropylacrylamide) (PNIPAM) thin films were investigated in situ by applying the fast-reflectivity setup.

DS 22.7 Thu 11:15 H39

Integration of electro-optical devices in $LiNbO_3$ — •Felix vom Bruch, Patrick Bartkowiak, Sebastian Lengeling, Raimund Ricken, Victor Quiring, Harald Herrmann, and Christine Silberhorn — Universität Paderborn, Warburger Str. 100, 33098 Paderborn

The interest in quantum technology increases steadily within the last years. Many concepts are based on the utilisation of light and its quantum properties for encoding and transferring information. Comparable to integrated electronic devices, integrated electro-optical elements enable one to scale complex laboratory setups down to convenient and handy dimensions. Furthermore, this approach is suitable for an effective reduction of the expense for setups and experiments.
From many numerous telecom applications it is well known that ferroelectric $LiNbO_3$ provides an excellent platform for devices, such as frequency converters, phase and polarization modulators. For this purpose, the non-linear electro-optic properties of this material can be used to tailor conversion processes and modulators. Functionalities and characteristics of the latter parts are mainly governed by the design of electrodes used. However, scaling and integration of devices for quantum-optic applications remains challenging in terms of performance and robustness. For enhancing these features, studies on different concepts and architectures become inevitable. Here the influence of different thin layer systems, used as electrodes for modulators, is examined in terms of e.g. excess loss, switching speed and long-term stability.

DS 22.8 Thu 11:30 H39

Microfabricated switchable THz flat lenses made out of VO_2 thin films — •Florian Kuhl[1], Angelika Polity[1], Yan Zhang[2], and Peter J. Klar[1] — [1]Institute of Experimental Physics I and Center for Materials Research (ZfM/LaMa), Justus Liebig University Giessen, Heinrich-Buff-Ring 16, DE-35392 Giessen, Germany — [2]Beijing Key Lab for Metamaterials and Devices, Capital Normal University, Beijing, China

Terahertz radiation and its various applications have gained a lot of interest in the last few years and, thus, the importance of switchable THz devices has increased. Thermochromic VO_2 shows a semiconductor to metal transition and hence is a suitable material for designing thermally switchable structures.
We present microfabricated resonator structures in rf-magnetron sputtered VO_2 thin films. It is necessary to choose the type of substrate and to optimize the properties of the buffer layer and the thin film. The resonator structures were transfered into the thin films via photolithography and ion-beam etching. Measurements on unstructured thin films of VO_2 show the typical switching behaviour in the infrared region and typical switching temperatures for thin films of about 55 °C. The switching behaviour of structured thin films was investigated with terahertz time-domain spectroscopy (THz-TDS) at low and high temperatures to demonstrate the two desired operating modes of the designed structures. While no effect on incoming radiation could be observed at low temperatures, a focussing behaviour was detected at higher temperatures when the VO_2 micro resonators become metallic.

DS 22.9 Thu 11:45 H39

Investigations of the physical properties of lithium-based solid electrolyte thin films in the system Li-P-S-O-N — •Fabian Michel[1,3], Martin Becker[1,3], Jürgen Janek[2,3], and Angelika Polity[1,3] — [1]I. Institute of Experimental Physics, JLU Gießen, 35392 Gießen — [2]Institute of Physical Chemistry, JLU Gießen, 35392 Gießen — [3]Center for Material Research (ZfM/LaMa, JLU Gießen, 35392 Gießen

Using the technique of x-ray photoelectron spectroscopy (XPS) the composition of the radio-frequency sputtered lithium-based solid electrolyte thin films was determined. Additional electrochemical impedance spectroscopy (EIS) was performed to gain knowledge about the electrochemical properties especially the ionic conductivity of such films. An optimization of the physical properties, which are important for a battery (ionic conductivity) or electrochromic applications (transmission), was attained by changing the deposition parameters. During this optimization process a maximum in ionic conductivity of about 15.8 μS/cm was found referring to the different composition (sulfur content) and process parameters (ratio between argon and nitrogen flux). Compared with earlier findings of related investigations one can monitor the improvements made.

DS 22.10 Thu 12:00 H39

Highly rectifying contacts on Ga_2O_3, In_2O_3 and $(In,Ga)_2O_3$ thin films — •Daniel Splith — Universität Leipzig, Felix-Bloch-Institut für Festkörperphysik, Leipzig, Germany

Oxide semiconductors like gallium oxide or indium oxide are promising materials for a new generation of transparent electronic devices. Additionally, alloying both materials allows band-gap engineering, enabling e. g. the fabrication of wave-length selective photodetectors. In order to realize devices like diodes, field-effect transistors and photodetectors, the fabrication of rectifying contacts is essential. Further, such contacts also enable the investigation of the materials by means of space charge region based methods like thermal admittance spectroscopy.

In this contribution the properties of Schottky contacts and pn-heterojunctions on heteroepitaxial Ga_2O_3 and In_2O_3 thin films grown by pulsed laser deposition are discussed. Additionally, the properties of such rectifying contacts on $(In,Ga)_2O_3$ thin films having a lateral composition gradient are presented. In order to improve the rectification of the contacts, different vertical layouts were investigated. Further, a comprehensive model, taking into account thermionic emission, thermionic field emission and charging currents as well as non-idealities like barrier height inhomogeneities, current spreading and variations of the net-doping density in growth direction, was employed in order to understand the measured characteristics.