DS 14: Thin Oxides and Oxide Layers

Time: Thursday 9:30–11:15 Location: SCH A 315

DS 14.1 Thu 9:30 SCH A 315

Strain effects of the electronic and magnetic properties of thulium iron garnet films — •Sibylle Gemming[1], Georgeta Salvan[1], Apoorva Sharma[1], Oana T. Ciubotariu[2], and Manfred Albrecht[2] — [1]Institute of Physics, TU Chemnitz — [2]Institute of Physics, U Augsburg.

Rare earth iron garnets are magnetic insulators, in which two structurally distinct iron centers form sublattices, which couple antiferromagnetically. The overall magnetization of the compounds results from the alignment of the local magnetic moments of the 4f electrons at the rare earth sites and is sensitive to external effects such as temperature and strain. We performed gradient-corrected density-functional calculations including spin-orbit and correlation corrections to study the property-thickness relation of thin thulium iron garnet films that had been grown epitaxially under tensile strain on a doped gallium gadolinium garnet substrate. We could rationalize the observed growth modes for different film thicknesses with strain arguments and correlate it with the observed electronic properties (Funding: DFG, GE 1202/12-1)

DS 14.2 Thu 9:45 SCH A 315

Optoelectronic Properties of Al-doped ZnO Films Prepared by ALD and Flash Lamp Annealing — •Guoxiu Zhang[1,2], Oliver Steuer[1], Yu Cheng[1], Yi Li[1], Kaiman Lin[1], Shengqing Zhou[1], Yufei Liu[2,3], and Slawomir Prucnal[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstrasse 400, Dresden, 01328, Germany — [2]Key Laboratory of Optoelectronic Technology & Systems (Chongqing University), Ministry of Education, Chongqing 400044, China — [3]Faculty of Science and Engineering, Swansea University, Swansea SA2 8PP, UK

Zinc oxide (ZnO) is a wide-band-gap semiconductor considered for transparent and flexible optoelectronics. Effective and controlled doping of ZnO can be realized by substitution Zn or O atoms with metal or non-metal elements like H, Al, Ga for n-type doping and e.g. group V elements for p-type doping. In this work, we have investigated the optoelectronic properties of *-doped ZnO with Al. 100 nm thick Al-doped ZnO (AZO) films were deposited on Si wafers by atomic layer deposition (ALD) varying the distance between Al-layers. After ALD process samples were annealed using ms-range flash lamp annealing (FLA) in either nitrogen or oxygen atmosphere. The highest carrier concentration estimated from Hall-effect measurements is 2.7 *1021 cm-3 and the resistivity is 8.8*10-4 Ωcm, for AZO films where the Al-*-layer is separated by 20-layers of Zn. In general annealing in N2 atmosphere promotes n-type doping while annealing in O2 leads to the formation of highly resistive films.

DS 14.3 Thu 10:00 SCH A 315

Strain Engineering of Buffer Layers: A Way to Overcome Film/Substrate Lattice Misfit — •Pia Henning[1], Ulrich Ross[2], Karen Stroh[1], Vitaly Bruchmann-Bamberg[1], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen, Germany — [2]Institut für Materialphysik, Georg-August-Universität Göttingen, Germany

A fundamental problem in thin film physics is the film/substrate lattice misfit and the related epitaxial strain. An especially important role plays stress for perovskite manganites, e.g. colossal magnetoresistive $(La_{0.6}Pr_{0.4})_{0.7}Ca_{0.3}MnO_3$ (LPCMO), yielding a suppression of the metal-insulator and ferromagnetic phase transition for LPCMO thin films grown on standard perovskite substrates, like SrTiO3 (STO, tensile stress) and LaAlO3 (LAO, compressive stress). We propose a route to engineer the strain via LAO buffers epitaxially grown on STO substrates by means of metalorganic aerosol deposition to obtain epitaxial stress-free LPCMO films. By changing the LAO thickness in the range d_{LAO}~2-35 nm and precisely tuning the stress in it, an ideal lattice adjustment between LPCMO and LAO has been achieved. This allows us to grow stress-free epitaxial LPCMO/LAO/STO(100) thin and ultrathin (d_{LPCMO}~10 nm) films with bulk properties. The structure and microstructure of these films as well as the stress distribution within layers was studied by X-ray diffraction and high resolution transmission electron microscopy. A generalization of this method on other film/buffer/substrate combinations has been proposed.

DS 14.4 Thu 10:15 SCH A 315

Transfer and Thermal Processing of Freestanding Oxide Membranes — •Yu-Jung Wu, Varun Harbola, Sander Smink, Sarah C. Parks, and Jochen Mannhart — Max Planck Institute for Solid State Research, Heisenbergstraße 1, 70569 Stuttgart, Germany

Epitaxial films of complex oxides have gained interest due to their wide-ranging physical properties, including high-temperature superconductivity, magnetism, ferroelectricity, and multiferroicity. The conventionally grown single-crystalline oxide thin films are usually bound to their substrates, which imposes constraints on their properties and usage. Therefore, growth techniques have recently been developed that enable lifting-off freestanding complex oxide membranes by wet etching of oxide buffer layers. To achieve transfer of large-area oxide films, we have systematically studied growth and transfer of a variety of thin films, grown on aluminate and manganite wet-etchable buffer layers. Various oxide membranes were successfully transferred with good quality and up to 3x 2 mm2 area with minimal cracking. Furthermore, after thermal processing the stack of the transferred membrane on sapphire, the transferred membrane starts dewetting, yielding nanostructures. This work is not only expected to enable a wide range of oxide films to be transferred in high quality for fundamental studies and applications in oxide electronic devices but also serves as a starting point for crystalline nano-structuring of oxide materials.

DS 14.5 Thu 10:30 SCH A 315

Tungsten-oxide thin films characterized by Positron Annihilation Spectroscopy — •Vassily Vadimovitch Burwitz[1], Annemarie Kärcher[2,3], Lucian Mathes[1], Thomas Schwarz-Selinger[3], Maik Butterling[4], Eric Hirschmann[4], Maciej Oskar Liedke[4], Andreas Wagner[4], and Christoph Hugenschmidt[1] — [1]Heinz Maier-Leibnitz Zentrum, TU München — [2]TU München — [3]Max-Planck-Institut für Plasmaphysik, Garching bei München — [4]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiation Physics

For future nuclear fusion reactors it is foreseen that tungsten is used as inner wall cladding. Understanding the formation and behaviour of radiation induced defects in tungsten is therefore important for their safe operation. Tungsten mono-crystal model systems are studied by positron annihilation Doppler-broadening spectroscopy (DBS) and positron annihilation lifetime spectroscopy (PALS) to foster the understanding of the type and evolution of these defects. Both methods are sensitive tools when examining the defect type and concentration. However, data obtained by either of these methods is influenced by any thin oxide film on the surface of a sample. Such a film is present on any tungsten sample exposed to air, therefore its effect on DBS and PALS results needs to be known for their correct interpretation. In this work we measured tungsten-oxide thin films grown by thermal and electrochemical methods as well as by exposure to air by DBS and PALS. The DBS measurements were performed using a moderated β^+ emitter, the PALS measurements at an accelerator-based positron source.

DS 14.6 Thu 10:45 SCH A 315

Monitoring switching process in Fe_3O_4/STO heterostructures via in-situ instrument — •Yifan Xu[1], Mai Hussein Hamed[1,2], Connie Bednarski-Meinke[1], Asmaa Qdemat[1], Steffen Tober[1], Emmanuel Kentzinger[1], Oleg Petracic[1], and Thomas Brückel[1] — [1]Jülich Centre for Neutron Science (JCNS-2) and Peter Grünberg Institut (PGI-4), JARA-FIT, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — [2]Faculty of Science, Helwan University, 11795 Cairo, Egyp

The ability to tune magnetic oxide phases via redox reactions across their heterointerfaces could lead to useful spintronic and memristive device applications. By applying a small electric field, oxidation/reduction occurs at the heterointerface and leads to a reversible phase transition. In this talk, we present the preparation and characterization of epitaxial Fe_3O_4 thin films grown on TiO_2-terminated Nb:STO via pulsed laser deposition (PLD). Using magnetometry, we detect the Verwey transition; a strong indicator of the oxygen content in the Fe_3O_4 films. We observe the disappearance in the Verwey transition temperature with an applied positive electric field. This could be explained by oxygen diffusion through the interface which then leads to a reversible phase transition from Fe_3O_4(magnetite) to γ-Fe_2O_3(maghemite). Using ex-situ x-ray diffraction (XRD), we observe the structural transitions from (001) to (111) in the out-of-plane direction influenced by the applied voltage. Interestingly, by grazing-incidence small-angle X-ray scattering, we observe a change in the magnetite domain size for the sample after applying the electric field.

DS 14.7 Thu 11:00 SCH A 315

Engineering magnetic anisotropy by Rashba spin-orbit coupling in 3d-5d oxide heterostructures — •Megha Vagadia, Jaya Prakash Sahoo, Ankit Kumar, Suman Sardar, Tejas Tank, and D.S. Rana — 1Department of Physics, Indian Institute of Science Education and Research Bhopal, M.P. 462066, India

In recent times, Rashba spin-orbit coupling (SOC) has been successfully employed for the emergence of exotic phenomena at the quantum oxide interfaces. In these systems, the combined effect of charge transfer, broken symmetries, and SOC yields intriguing interfacial magnetism and transport properties. However, role of Rashba SOC, particularly without applied bias, in modulating magnetic anisotropy of oxide heterostructures is unexplored. Here, we provide insight into tuning transport phenomena by the charge transfer driven Rashba SOC in CaMnO3/CaIrO3 heterostructures. Rashba SOC remarkably enhances the anomalous Hall conductivity and reconstructs the Berry curvature. From the anisotropy magnetoresistance measurements, we demonstrate that Rashba SOC is instrumental in tailoring magnetic anisotropy where magnetization easy-axis rotates from the out-of-plane direction to the in-plane direction. The ability to tune Rashba SOC and resulting competing magnetic anisotropies provides a route to manipulate electronic band structure for the origin of non-trivial spin texture useful for spin-orbitronics applications.