DS 1: Thin Oxides and Oxide Layers (joint session DS/KFM)

Time: Monday 9:30–11:45 Location: A 053

DS 1.1 Mon 9:30 A 053

Non-collinear spin texture in thin rare-earth ion doped nickel ferrite films — •Anupam K. Singh[1], Katayoon Mohseni[1], Malleshwara R. Tangi[1], Verena Ney[2], Andreas Ney[2], Arthur Ernst[2], Yicheng Guan[1], Manuel Valvidares[3], P. Gargiani[3], Ilya Kostanvoskiy[1], Holger L. Meyerheim[1], and Stuart S. P. Parkin[1] — [1]Max Planck Institute of Microstructure Physics, Weinberg 2, 06120, Halle (Saale), Germany — [2]Johannes Kepler University Linz, Altenberger Straße 69, 4040 Linz, Austria — [3]ALBA Synchrotron, E-08290 Cerdanyola del Valle's, Barcelona, Spain

Ferrites are abundantly used as magnetic materials, but thus far, the detailed magnetic structure in ultra-thin films has escaped clear-cut characterization. The recent observation of rare-earth-induced DMI in low-dissipation insulating oxides calls for a deeper insight into their spin texture [1]. We have studied the atomic and magnetic structure of 5 to 40 nm thick Dy-doped (5%) Zn/Al-substituted nickel ferrite (Ni0.65Zn0.35Al0.8Fe1.2O4) films prepared by magnetron sputtering. Characterization by RBS, XRD, EXAFS and XMCD experiments at the Fe-K, L2,3 and the Dy-L2,3, M4,5 edges establish the formation of a tetragonally distorted spinel structure where Dy3+ ions occupy octahedral sites with a redistribution of the Fe2+ and Fe3+ cations. Temperature-dependent SQUID, XMCD and MOKE experiments indicate a spin-reorientation transition from in-plane easy axis below 200 K, thereby showing a non-monotonic behavior of the M(T) curve which is interpreted as due to the formation of a non-collinear spin structure. [1] L. Caretta, et al., Nat. Comm. 11, 1090 (2020).

DS 1.2 Mon 9:45 A 053

Defect and Strain Engineering in SrTiO3 and CaTiO3 Thin Films Epitaxially Grown by Metal Organic Vapor Phase Epitaxy (MOVPE) — •Mohamed Abdeldayem, Changming Liu, Izaz-Ali Shah, Andreas Fiedler, Martin Albrecht, and Jutta Schwarzkopf — Leibniz-Institut für Kristallzüchtung, Berlin, Germany

Neuromorphic devices attempt to imitate the human brain, and replace the conventional computer design to meet the demands of energy efficiency, and learning capacity. Memristive devices are a leading candidate to provide the physical properties needed for an artificial neural network. Here, we report a model in SrTiO3 and CaTiO3 thin films where resistive switching mechanism is based on polar nano-regions created by the formation of Ti anti-site defects in A-cation deficient growth regime. SrTiO3 and CaTiO3 thin films were grown epitaxially by metal-organic vapor phase epitaxy in which growth takes place near thermodynamic equilibrium and high oxygen partial pressure. This provides well-ordered epitaxial films with low defect density and negligible amount of oxygen vacancies. Moreover, chemical elements can be independently controlled by controlling the precursor fluxes in the gas phase, which enables the growth of stoichiometric and intentionally off-stoichiometric films. HRXRD, and AFM were used to verify epitaxial growth of high structural quality films with smooth surfaces. STEM-HAADF was utilized for detailed microscopic structural investigation, and showed the high homogeneity of stoichiometric films opposite to the intentionally defect ones with cloudy contrast and defect clustering.

DS 1.3 Mon 10:00 A 053

Electronic Reconstruction and Anomalous Hall Effect in the LaAlO3/SrRuO3 Heterostructure — •Merit Spring[1,2,3], Ji Soo Lim[1,2], Martin Kamp[1,4], Matthias Schmitt[1,2,3], Deepnarayan Biswas[3], Louis Veyrat[5], Pavel Potapov[5], Axel Lubk[5], Bernd Büchner[5], Tien-Lin Lee[3], Michael Sing[1,2], and Ralph Claessen[1,2] — [1]Physikalisches Institut, Würzburg, GER — [2]Würzburg-Dresden Cluster of Excellence ct.qmat — [3]Diamond Lightsource Ltd., Didcot, UK — [4]Wilhelm Conrad Röntgen-Center for Complex Material Systems, Universität Würzburg, GER — [5]Leibnitz Institute for Solid State and Materials Research, Dresden, GER

For the LaAlO3/SrRuO3 (LAO/SRO) system a similar electronic reconstruction to that of LaAlO3/SrTiO3 (LAO/STO) is expected, and charge is thought to be accumulated at the very interface giving rise to strong inversion-symmetry breaking and causing a topological transition of the electronic bands [1]. We show that the LAO capping drives the SRO, which turns insulating below 8 unit cells (uc) without capping, (deeper) into the metallic regime. Furthermore, we find not only signatures of an anomalous Hall effect (AHE) in 4 uc SRO films capped with LAO, but also an inversion of the sign of the AHE, when the 4uc SRO is replaced by metallic 10 uc of SRO indicating the topological phase transition. Moreover, we correlate these findings with hard and soft x-ray photoemission spectroscopy data, that show changes in the ruthenium electronic states, and discuss these changes in terms of correlated electrons. [1] Thiel, T. C. et al., Phys. Rev. Lett. 127, 127202 (2021)

DS 1.4 Mon 10:15 A 053

Exploration of zirconium doping in pulsed laser deposited α-Ga_2O_3 for devices — •Sofie Vogt[1], Thorsten Schultz[2,3], Clemens Petersen[1], Holger von Wenckstern[1], Norbert Koch[2,3], and Marius Grundmann[1] — [1]Universität Leipzig, Felix-Bloch-Institut, Leipzig — [2]Humboldt Universität zu Berlin, Institut für Physik, Berlin — [3]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Solar Energy, Berlin

Gallium oxide, known for its ultrawide bandgap, crystallizes in different polymorphs, of which the β-phase is the thermodynamically most stable and most investigated one. However, the metastable corundum structured α-phase exhibits a wider bandgap and therefore a potentially higher electrical breakdown field compared to β-Ga_2O_3[1]. Doping of α-Ga_2O_3 with tin, silicon and germanium has been demonstrated[2,3]. We present α-Ga_2O_3 thin films grown by pulsed laser deposition in a two-step process. Undoped α-Ga_2O_3 grown at high temperature is used as buffer layer. The zirconium doped α-Ga_2O_3 is deposited atop the buffer layer at a temperature $< 600°$C, to ensure the deposition of conductive thin films. The structural and electrical properties of Zr doped thin films are compared to Sn, Si and Ge doped thin films with regards to the crystal quality, conductivity, free carrier concentration and electron mobility. First Schottky barrier diodes based on the α-Ga_2O_3:Zr thin films are presented.

[1] Higashiwaki *et al.*, Appl. Phys. Lett., **100**, 013504 (2012)
[2] Akaiwa *et al.*, phys. status solidi (a), **217**, 3, 1900632 (2020)
[3] Vogt *et al.*, phys. status solidi (a), **220**, 3, 2200721 (2023)

15 min. break

DS 1.5 Mon 10:45 A 053

Epitaxy and transfer of freestanding $SrTiO_3$ membranes — •Jeremy Maltitz, Weaam Ayad, Jens Martin, and Jutta Schwarzkopf — Leibniz-Institut für Kristallzüchtung, Berlin, Germany

Layer transfer of thin films has established a new paradigm of material assembly and design in context of 2D-van-der-Waals crystals. Recently, freestanding oxide perovskite thin films have been achieved by introducing a perovskite-like, water-soluble sacrificial layer (Sr3Al2O6) between substrate and functional film. In combination with layer transfer, this provides a playground for fundamental investigations and technological applications of complex oxides beyond the limitations of classical heteroepitaxy. Requirements are the preparation of epitaxial oxide films with high structural quality of both sacrificial layer and functional oxide film and the controlled detachment from the growth substrate and transfer on another substrate. In this contribution, we will show the influence of the PLD parameters, film thicknesses and composition of the oxide films on the release process and crack formation in freestanding SrTiO3 thin films by using the solid-solution family of (Ba,Ca,Sr)3Al2O6 as sacrificial layer. While cracking of the SrTiO3 films during etching of the sacrificial layer can be largely avoided by the growth of an almost strain-free heterostructure, the transfer process remains challenging. One approach is the use of sub-mm small polymer stamps to transfer deliberately smaller pieces of the functional oxide film on the target substrate.

DS 1.6 Mon 11:00 A 053

Investigation of electrical properties of metal oxide semiconductors thinfilms — •Pinar Oruc[1], Ali Orkun Cagirtekin[1], Sukru Cavdar[1], Nihat Tugluoglu[2], and Haluk Koralay[1] — [1]Gazi University, Faculty of Science Department of Physics, Ankara Turkiye. — [2]Giresun University, Faculty of Engineering, Department of Energy Engineering, Giresun, Turkiye.

Metal oxide semiconductor materials such as TiO2, ZnO, V2O5, and

MoO3 have very large technological area because of their useful properties [1]. Generally, these materials are interesting by scientific community because they have wide forbidden energy band gap, good electrical, and optical properties [2]. With the development of technology, the development of higher performance and cost-effective devices has become more important. For these reasons, the importance of these semiconductor metal oxide structures has gradually increased. In this study, electrical characterization of multilayer semiconductors device was investigated. Different metal oxide thin film layers were grown on the fluorine doped tin oxide (FTO) substrate by using different methods. It has been observed that both thin films obtained with different techniques have a homogeneous surface. Electrical measurements of the device were taken at different temperatures, widely frequency regions. As a result of electrical measurements, the device showed good diode behavior also electrical behavior of the fabricated device showed better electrical properties as the increasing temperature. According to the results, the fabricated device can be used many electronic areas.

DS 1.7 Mon 11:15 A 053

Engineering electrochemical conversion in La_2NiMnO_6 using magnetic ground states — •Pia Henning and Jasnamol Palakkal — Institute of Materials Physics, Georg-August-University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

For a more sustainable future, the identification of new electrocatalyst materials for the oxygen evolution reaction (OER) plays an important role. In the course of this, the oxide double perovskite La_2NiMnO_6 exhibits a promising role [1]. Especially interesting for this material is the interplay between magnetic ground state and OER activity. The catalytic activity of La_2NiMnO_6 powder samples is enhanced when a vibronic superexchange interaction is present, dominating over static exchange interactions [1]. However, the magnetic structure is closely linked to the oxygen content in the sample and a low Curie temperature can also be originating from oxygen vacancies in the lattice [2]. To resolve this, we prepared La_2NiMnO_6 thin films with our hybrid PLD set-up, combining standard PLD with MBE techniques. The samples were carefully modified by controlling the oxygen content. These modifications of the B-site electronic configuration were then related to the OER activities of the samples, using the magnetic properties as descriptor.

[1] Y. Tong, J. Wu, P. Chen, H. Liu, W. Chu, C. Wu, Y. Xie, Journal of the American Chemical Society 2018, 140(36), 11165.

[2] J. P. Palakkal, T. Schneider, L. Alff, AIP Advances 2022, 12(3), 035116.

DS 1.8 Mon 11:30 A 053

Ferroelectric polarization rotation through He irradiation induced uniaxial strain — •Andreas Herklotz[1], Robert Roth[1], Kathrin Dörr[1], Alessandro Mazza[2], and Thomas Zac Ward[3] — [1]1) Institute for Physics, Martin-Luther-University Halle-Wittenberg, Halle, Germany — [2]2) Los Alamos National Laboratory, Los Alamos, USA — [3]3) Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, USA

The physical properties of ferroic thin films are typically dominated by their domain configurations and their responses to external fields. A central prerequisite to domain engineering and harnessing functionalities of ferroelectric thin films is thus the control of the polarization orientation. Historically, the symmetry of ferroelectric films has been mainly tailored by heteroepitaxial in-plane strain or a variation of growth conditions inducing defects.

Here, we deploy low-energy He implantation as an alternative approach. Ion implantation induces uniaxial out-of-plane strain, while the in-plane strain remains fixed due to epitaxial constraint. We show that this kind of uniaxial strain engineering effectively leads to polarization rotation from in-plane towards out-of-plane as the uniaxial strain is increasing. We find that this polarization rotation can be achieved via two different mechanisms: (i) via a sequence of phase transitions related to changes of crystal symmetries and (ii) via a continuous shift of the ferroelectric domain ratio towards out-of-plane oriented domains.