DS 10: Layer Properties II

Time: Wednesday 11:00–12:15 Location: SCH A 316

DS 10.1 Wed 11:00 SCH A 316

Electronic structure of epitaxial (Cr1-xMnx)2GaC thin films by X-ray absorption and optical spectroscopy — •Ivan Tarasov[1], Andrei Rogalev[2], Fabrice Wilhelm[2], Michael Farle[1], and Ulf Wiedwald[1] — [1]Faculty of Physics and Center for Nanointegration (CENIDE), University of Duisburg-Essen, 47057 Duisburg, Germany — [2]The European Synchrotron Radiation Facility (ESRF), 38000 Grenoble, France

Heteroepitaxial thin films of (Cr1-xMnx)2GaC MAX phase for x = of 0.13 - 1 were deposited on MgO(111), Al2O3(0001) and KAl3Si3O10(001) substrates by pulsed laser deposition at T = 500-600 °C. X-ray absorption near edge spectroscopy (XANES) spectra were collected at the Mn K-edge, Cr K-edge and Ga K-edge. Evidence of chemical disorder associated with (Mn, Cr) is observed. The similarity of the Cr K-edge spectra to Mn, and the presence of a strong X-ray linear dichroism signal for the Mn K-edge, indicates that Mn is substitutional for Cr in the MAX phase hexagonal lattice. With increasing of Mn content additional features attributed to a cubic antiperovskite structure are observed. Simulations of the XANES spectra confirm the origin of X-ray linear dichroism observed in the sample, which is due to the inherent nanolaminated structure of the MAX phase.

Funding by the Deutsche Forschungsgemeinschaft (DFG) within CRC/TRR 270, project B02 (Project-ID 405553726) is gratefully acknowledged. We thank Martina Schmid (University of Duisburg-Essen) for assistance and providing access to the ellipsometer.

DS 10.2 Wed 11:15 SCH A 316

Perovskite-organic multiple quantum wells towards lasing — •Tobias Antrack[1], Martin Kroll[1], Markas Sudzius[1], Changsoon Cho[1], Paulius Imbrasas[1], Miguel Albaladejo-Siguan[1], Johannes Benduhn[1], Lena Merten[2], Alexander Hinderhofer[2], Frank Schreiber[2], Sebastian Reineke[1], Yana Vaynzof[1], and Karl Leo[1] — [1]IAPP, TU Dresden, Dresden, Germany — [2]Institut für Angewandte Physik, Universität Tübingen, Tübingen, Germany

Metal halide perovskites are of high interest due to their excellent electro-optical properties. Their high damage threshold makes them of special interest for high-fluence applications like lasing devices, and the possibility of production by vacuum deposition is promising for future large-scale industrial production. This technique allows precise thickness control and, therefore, the production of multiple quantum wells (MQWs). Such structures result in high charge carrier concentration and enhanced electron-hole recombination, making them promising for high-performance and fine-tunable materials. This work presents a comprehensive study of the optical properties of vacuum-deposited $CsPbBr_3$ perovskite MQWs with organic (TPBi) barrier layers. Blue shifts in absorption and emission spectra with decreasing well width demonstrate quantum confinement and are confirmed by simulations. Additionally, the photoluminescence quantum yield increases by up to 32 times from bulk material to the thinnest well layers. Amplified spontaneous emission (ASE) measurements show very low thresholds down to 7.3 μJ cm^{-2} for a perovskite thickness of 8.7 nm, which is significantly lower than previously observed for $CsPbBr_3$ thin films.

DS 10.3 Wed 11:30 SCH A 316

Defect-engineered magnetic field dependent optoelectronics of vanadium doped tungsten diselenide monolayers — •Christin Mädler[1,2], Katharina Nisi[1,2], Jonas Kiemle[1,2], Lukas Powalla[3], Alessio Scavuzzo[3], Tuan Dung Nguyen[4,5], Dinh Loc Duong[4,5], Marko Burghard[3], Alexander W. Holleitner[1,2], and Christoph Kastl[1,2] — [1]Walter Schottky Institut, Technical University of Munich, Am Coulombwall 4a, 85748 Garching, Germany — [2]Munich Center of Quantum Science and Technology (MCQST), Schellingstrasse 4, 80799 Munich, Germany — [3]Max-Planck-Institut für Festkörperforschung, Heisenbergstrasse 1, D-70569 Stuttgart, Germany — [4]Center for Integrated Nanostructure Physics (CINAP), Institut for Basic Science (IBS), Suwon 16419, Republic of Korea — [5]Department of Energy Science, Sungkyunkwan University, Suwon 16419, Republic of Korea

In this work, we investigate semiconducting WSe_2 monolayers, substitutionally doped with vanadium atoms, using low temperature luminescence and optoelectronic spectroscopy. V-dopants lead to a p-type doping character and an impurity-related emission $\sim$ 160 meV below neutral exciton, both of which scale with the nominal percentage of vanadium dopants. Measurements using field-effect devices of 0.3% V-doped WSe_2 demonstrate bipolar carrier tunability. The doped monolayers display a clear magnetic hysteresis in photocurrent measurments for the studied range of carrier densities, whereas the valley polarization of the excitons reveals a non-linear g-factor without a magnetic hysteresis within the experimental uncertainty.

DS 10.4 Wed 11:45 SCH A 316

On the influence of the cation composition in reactively co-sputtered $Ag_xCu_{1-x}I$ thin films: Characterization of electrical, optical and structural properties — •Sofie Vogt, Christiane Dethloff, Jorrit Bredow, Tillmann Stralka, Holger von Wenckstern, and Marius Grundmann — Universität Leipzig, Felix-Bloch-Institut, Germany

CuI and its alloys are promising transparent p-type materials for complementary transparent devices. Polycrystalline thin films exhibit hole mobilities of about $19\,\mathrm{cm^2V^{-1}s^{-1}}$, which is comparable to the electron mobility of commercially used indium-gallium-zinc-oxide thin films[1,2]. It has been shown that alloying CuI with Ag leads to a transition from p-type material to n-type material for $x \approx 0.5$[3]. This paves the way for $Ag_xCu_{1-x}I/Ag_yCu_{1-y}I$ based homojunction diodes. We present reactively co-sputtered $Ag_xCu_{1-x}I$ thin films in a range of $0.01 \leq x \leq 0.86$. The thin films were deposited on glass substrates and crystallized in the γ-phase up to $x \leq 0.67$ and exhibit an additional AgI phase for higher Ag contents. An increase of the thin film resistivity from $2 \times 10^{-4}\,\Omega$m to $30\,\Omega$m was achieved by increasing the silver content from $x = 0.01$ to $x = 0.67$. All thin films are transparent in the visible light range and the expected decrease of the exciton binding energy up to $x \approx 0.5$ is observed, above which it remains constant.

[1] C. Yang *et al.*, ACS Appl. Electr. Mater., 2, 3627-3632, 2020.
[2] S. Yang *et al.*, IEEE Electron Device Lett., 32 (12), 1692-1694, 2011.
[3] A. Annadi *et al.*, Appl. Mater. Today, 20, 100703, 2020.

DS 10.5 Wed 12:00 SCH A 316

Novel Energy-Filtered Field Stop Technology For Highly Blocking IGBTs — •Robert Koch[1], Marcel Gerold[1], Shavkat Akhmadaliev[2], Michael Rüb[1], and Elke Wendler[3] — [1]Ernst-Abbe-Hochschule, Fachbereich SciTec, Jena, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [3]Friedrich-Schiller-Universität, Physikalisch-Astronomische Fakultät, Jena, Germany

Insulated Gate Bipolar Transistors (IGBTs) require on the one hand adjustable switching behavior and on the other hand high blocking capability. The technology presented in this work aims at implementing continuous deep carrier profiles as field stop structures. We insert a micro-patterned silicon membrane (energy filter) into the primary ion beam. This broadens its energy spectrum in a well controlled way, allowing production of extended continuous profiles. The micro patterns are restricted to rectangular shapes, due to the KOH etching manufacturing process. This means, instead of using multiple implantation steps for field-stop formation, our approach results in tailored smooth profiles by using energy-filtered Hydrogen implantations in the range of 1500 to 2500 keV. The defect profiles generated by H-implantation, are transformed into hydrogen-related donors by annealing at 300 to 400 °C. The annealing efficiency is related to the implanted dose (10^{13} to $5 \times 10^{15}\,\mathrm{cm^{-2}}$), annealing temperature, hold time and the process gas composition (H_2 content 2 %). The defect profiles caused by proton bombardment using an energy filter and subsequent annealing are analyzed by Spreading Resistance Profiling (SRP).