DS 15: Functional Oxides

Time: Tuesday 14:30–16:30 Location: H 2032

Invited Talk DS 15.1 Tue 14:30 H 2032

The truth about ferromagnetic ZnO — •Kay Potzger[1], Shengqiang Zhou[1], Georg Talut[1], Karsten Kuepper[1], Helfried Reuther[1], Arndt Mücklich[1], Jörg Grenzer[1], Manfred Helm[1], Jürgen Fassbender[1], Heidemarie Schmidt[1], Quingyu Xu[1], and Michael Lorenz[2] — [1]Forschungszentrum Dresden-Rossendorf, Bautzner Landstrasse 128, 01328 Dresden — [2]Universität Leipzig, Institut für Experimentelle Physik II, Linnéstraße 5, 04103 Leipzig

The combination of magnetic and semiconducting properties in oxides is currently one of most popular fields in materials research. Besides the expected gain of knowledge about basic physics, such materials have a large application potential in spin electronics. We present a summary of our results on transition metal doping of ZnO single crystals and thin films by means of ion implantation. We found that none of the samples investigated represents a diluted magnetic semiconductor as predicted by theory [1]. Nevertheless, transition metal ions can be dispersed within the ZnO matrix residing on different sites within the lattice depending on initial preparation conditions. The observed ferromagnetism mainly originates from secondary phase formation (metals or inverted spinels). We discuss the potential of those granular structures in spin-electronics. Moreover, we highlight the suppression of secondary phase formation by means of deliberately lowering the crystalline quality prior to the doping. In that case, purely defect induced ferromagnetic properties are observed. The effect of spin doping of such a defect induced ferromagnet is discussed.

[1] K. Sato and H. Katayama-Yoshida, Physica E 10, 251 (2001).

Invited Talk DS 15.2 Tue 15:00 H 2032

ZnO-based Hetero- and Quantum Well Structures for Light-Emitting Applications — •Fritz Henneberger and Sergey Sadofev — Humboldt-Universität zu Berlin, Institut für Physik, Newtonstr. 15, 12489 Berlin

Molecular-beam epitaxial growth far from thermal equilibrium allows us to overcome the standard solubility limit and to alloy ZnO with MgO or CdO in strict wurtzite phase up to mole fractions of several 10 %. In this way, a band-gap range from 2.1 to 4.4 eV can be covered. For epitaxy on ZnO substrates, we observe rocking curve widths of the ternaries as small as 19 arcsec and pseudomorphic growth over several 100 nm. A clear layer-by-layer growth mode controlled by RHEED oscillations enables us the fabrication atomically smooth heterointerfaces and well-defined quantum well structures exhibiting prominent band-gap related light emission in the whole composition range. Strong built-in polarization fields are screened off by moderate optical pumping. On appropriately designed structures, laser action from the UV down to green wavelengths and up to room temperature is achieved. All these findings make ZnO-based heterostructures promising candidates for opto-electronic applications in the short-wavelength range.

Invited Talk DS 15.3 Tue 15:30 H 2032

Large Area Deposition of Transparent Conductive Oxide Films — •Bernd Szyszka, Volker Sittinger, Andreas Pflug, Stephan Ulrich, and Felix Horstmann — Fraunhofer IST, Bienroder Weg 54e, 38108 Braunschweig

Transparent and conductive oxide films such as tin doped indium oxide (ITO), fluorine or atimony doped tin oxide and aluminum doped zinc oxide are key components for optoelectronic devcies such as thin film solar cells and flat panel displays.

This paper gives and outline on the material science of TCO films with special emphasize on ZnO:Al films. These films can be deposited at low temperature by reactive AC magnetron sputtering from metallic Zn:Al targets. They are a cost effective alternative for front electrodes of a-Si:H solar cells and also for ITO for flat panel displays. Films with resistivity of * < 270 **cm and low absorption (k@550 nm < 2 x 10-3) have been grown on 100 x 60 cm2 glass substrates. The optical properties of these films are characterized by ellipsometry and spectral photometry. Advanced models based on the Gerlach Grosse theory are implemented for the evaluation of free electron properties. Structural investigations are performed using XRD, SEM and HRTEM.

DS 15.4 Tue 16:00 H 2032

Effect of isothermal annealing on electrical and optical properties of Al-doped ZnO films — •Mykola Vinnichenko, Anatoly Rogozin, Natalia Shevchenko, Andreas Kolitsch, and Wolfhardt Möller — Institut für Ionenstrahlphysik und Materialforschung, Forchungszentrum Dresden-Rossendorf, P.F. 510119, 01314 Dresden, Germany

The aim of present work is to investigate mechanisms of Al incorporation and its effects on electrical and optical properties of ZnO films. Highly c-axis textured polycrystalline thin films of insulating ZnO were implanted by 110 keV Al^+ ions and then annealed at 520 °C. The films were characterized by Hall effect, four-point probe, spectroscopic ellipsometry and x-ray diffraction techniques. The films are nanocrystalline in as-implanted state. Their dielectric function shows broadened features near the band gap energy and increased, compared to unimplanted films, absorption in the near IR and visible spectral range. If the implantation dose is below $2x10^{16}$ cm^{-2}, the free electron density, Ne, increases after annealing and the film resistivity decreases monotonously during annealing. If the dose is above $2x10^{16}$ cm^{-2}, Ne decreases after annealing while film resistivity reaches minimum and then increases during the treatment. The annealing decreases optical absorption in the near IR and visible and improves film crystallinity. The behavior of the film electrical properties may be explained by the interplay between oxygen vacancies formation and Al donor activation.

DS 15.5 Tue 16:15 H 2032

Laser-assisted deposition and element analysis of nanocomposite oxide thin films — •Johannes Pedarnig[1,2], Johannes Heitz[1,2], Thomas Stehrer[1,2], Bernhard Praher[1,2], Richard Viskup[1,2], Khurram Siraj[2], Andreas Moser[2], Angela Vlad[2], Marius Bodea[2], Dieter Bäuerle[2], N. Hari Babu[3], and David Cardwell[3] — [1]Christian Doppler Laboratory for Laser-Assisted Diagnostics, — [2]Institute of Applied Physics, Johannes Kepler University Linz, A-4040 Linz, Austria — [3]Department of Engineering and IRC in Superconductivity, University of Cambridge,

Functional oxide thin films are epitaxially grown by pulsed-laser deposition (PLD) method. High-Tc superconducting (HTS) films of enhanced critical current density Jc are deposited by laser ablation of $YBa_2Cu_3O_7$ (Y-123) ceramics containing $Y_2Ba_4CuMO_x$ (M-2411, M = Ag, Nb, Ru, Zr) nano-particles. The Jc enhancement of nanocomposite films depends on the secondary phase content of the ceramic targets. Piezoelectric oxides such as novel $GaPO_4$ and ZnO doped with Lithium and Aluminum are grown as thin films and double-layers.

The monitoring of deposition processes and the element analysis of layers and ceramics are performed by laser-induced break down spectroscopy (LIBS). The LIBS signals recorded in situ are stable for more than 10000 laser pulses employed for target ablation. The relative element concentration in thin films and ceramics is the same demonstrating stoichiometric ablation and transfer of the multi-component oxide materials.