HL 2 Symposium ZnO - Rediscovered

Zeit: Freitag 10:45–13:15 Raum: TU P270

HL 2.1 Fr 10:45 TU P270

Excitonic Properties on ZnO — •Claus Klingshirn, Heiko Priller, Joachim Zeller und Heinz Kalt — Universität Karlsruhe, Institut für Angewandte Physik, Wolfgang-Gaede-Str. 1, 76131 Karlsruhe

After some introductory comments on the history of ZnO research, we present data on bulk ZnO epilayers, quantum wells, nano rods and dots covering the properties of free excitons in reflection, luminescence (dynamics) and absorption spectroscopy, high excitation processes and optical gain including biexcitons, scattering processes or the transition to an electron hole plasma. Finally we give a few comments on the presently revisited question of the valence band ordering.

HL 2.2 Fr 11:15 TU P270

Electrical properties of ZnO thin films and optical properties of ZnO-based nanostructures — •M. Grundmann — Universität Leipzig, Institut für Experimentelle Physik II

We compare the electrical properties of ZnO bulk crystals and ZnO thin films grown with pulsed laser deposition with regard to carrier concentration and mobility. Both by making highly pure layers and by compensation with acceptors very low carrier concentration can be achieved ($n < 10^{14} cm^{-3}$). We present Schottky diodes, e.g. Pd/ZnO, of high quality ($j = 4 \cdot 10^{-5} A/cm^2$ at a bias of -5V, n=1.4). The quality of the contacts is limited by the lateral homogeneity of the barrier height. Using the Schottky contacts the depletion layer can be investigated (CV, DLTS, admittance). We discuss the energetic position of various shallow and deep levels in bulk and thin films detected this way. ZnO allows the fabrication a various nanostructures such as belts, sheets and pillars. The latter mostly exhibit a hexagonal cross section. Using whispering gallery modes (WGM) in the visible and UV spectral region with mode numbers down to N=1, the size and cross-sectional shape of the pillars and needles (tapered pillars) can be detected spatially resolved. The polarization-dependent WGM spectra compare rather well to numerical simulations. This work was supported by Deutsche Forschungsgemeinschaft in the framework of SPP 1136 and FOR 522 and is in collaboration with H. v. Wenckstern, R. Pickenhain, A. Rahm, Th. Nobis and M. Lorenz.

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Bound exciton recombinations in ZnO — •Bruno K. Meyer, Joachim Sann, Detlev M. Hofmann, Christian Neumann, and Arndt Zeuner — I. Physikalisches Institut, Justus-Liebig-Universität-Giessen, Heinrich-Buff-Ring 16, D-35392 Giessen, Germany

In order to realize controlled p-type doping in ZnO the role of extrinsic and intrinsic donors have to be clarified. The extrinsic n-type dopants Al, Ga and In are commonly found in bulk ZnO crystals. Also hydrogen acts as a shallow donor, and appears in relevant concentrations in nominally undoped ZnO. The optical properties of excitonic recombinations in bulk, n-type ZnO are investigated by photoluminescence (PL). At liquid helium temperature the neutral donor bound excitons dominate in the PL spectrum. Two electron satellite transitions (TES) of the donor bound excitons allow to determine the donor binding energies ranging from 46 to 73 meV. The H, Al, Ga and In donor bound exciton recombinations are identified based on doping and diffusion experiments, magnetic resonance and using secondary ion mass spectroscopy. The influence of acceptor doping on the band edge recombinations will be discussed.

HL 2.4 Fr 12:15 TU P270

Microscopic Luminescence Properties of ZnO and ZnO based Heterostructures — •Jürgen Christen and Frank Bertram — Institute of Experimental Physics, Otto-von-Guericke-University Magdeburg, PSF 4120, Magdeburg, D-39016, Germany

ZnO has re-emerged into the center of international attention. Although know for many years, there is still a lack of information on its microstructure and in particular its microscopic electronic and optical properties. We present spatially resolved luminescence investigations directly correlating the optical characteristics to the nano-scale morphology. The strong impact of local internal fields (Franz-Keldysh-Effect) is evidenced. Expected for hetero-interfaces (spontaneous / piezo-polarization), this is also found at homo-interfaces and even in ZnO single crystals at domain boundaries. In epitaxially grown Zno films, a direct correlation between defects and morphology and specific spectral features is found. The bound exciton luminescence I8 directly images the dislocation network and its spectral position maps the lateral strain profile. A selective incorporation of those impurities associated with I0 and I1 at the micro-domain boundaries is evidenced. The situation further complicates when adding ternary alloys such as MgZnO or CdZnO, needed for heterostructures and Quantum Wells. A one-by-one correlation of local stoicheometry and micro-morphology as well as its impact on the relaxation and recombination kinetics is presented.

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Transition metal ions in ZnO a challenge for spintronic applications — •Axel Hoffmann[1], Enno Malguth[1], Martin Strassburg[2], Mathew H. Kane[2], and Ian T. Ferguson[2] — [1]Institut für Festkörperphysik, Technische Universität Berlin, D - 10623 Berlin, Germany. — [2]Georgia Institute of Technology, School of Electrical and Computer Engineering, Atlanta, GA 30332, U.S.A.

Increased efforts on transition metal (TM) doped wide bandgap materials, such as ZnO and GaN, were triggered by theoretical predictions suggesting ferromagnetism of diluted magnetic semiconductors with Curie temperatures above room temperature. Experimental results have demonstrated room temperature ferromagnetism in these systems, though many growth techniques used to date for this system are not ideal for device applications. Non-equilibrium growth methods, such as molecular beam epitaxy (MBE) and metal-organic vapor phase epitaxy (MOCVD), have been applied to achieve high carrier and dopant concentrations. This paper reports on optical and magneto-optical properties of TM doped ZnO and on the state of the art of ferromagnetism in ZnO.