HL 36.1 Wed 14:00 POT 51

Ultrafast exciton dynamics of highly excited ZnO — •JAN-PIETER RIJCKERTS, TINA SHIPE, JURGEN GUTOWSKI, and TOBIAS VOGL •Institute of Solid State Physics of the Leibniz University Hannover, 30167 Hannover, Germany — School of Engineering and Applied Sciences and Department of Physics, Harvard University, Cambridge, MA, USA

Large band-gap semiconductors like ZnO are currently of great interest as light emitting material and lasing media in the blue-UV spectral range. In order to make use of these materials it is mandatory to understand the charge carrier dynamics and excitonic effects at high excitation densities.

We present results of pump-probe reflectance spectroscopy of c-plane and m-plane ZnO bulk material with a temporal resolution of Δt < 200 fs. The sample is excited using a frequency tripled (266 nm) Ti:Sapphire laser. The white light probe pulse (300 nm < λprobe < 600 nm) is generated by converting the Ti:Sapphire pulse with a CaF2 crystal. We analyze the results of the reflectivity measurements using an exciton polariton model, from which we can obtain damping, shift, and broadening of the exciton resonances. For excitation densities T > 107 cm−2, we observe an exciton-exciton interaction-induced blue shift of the spectral luminescence maximum over time. This can be explained by a slow process at higher emission energies.

In this contribution, we present the spectral and temperature dependent optical properties of c-plane ZnO and m-plane ZnO films at high excitation densities. For low temperatures, we observe a blue shift of the spectral luminescence maximum over time. This can be explained by a slow process at higher emission energies. The transients could be fitted using a sum of two model decay functions. The time-integrated intensities of the model decays show different spectral maxima. We attribute these to the emission of donor-bound and free excitons.

15 min. break

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Properties of hydrogen doped ZnO thin films prepared by RF magnetron sputtering — •ACHIM KRONENBERGER, MARC K. DIETRICH, STEVE PETZICK, ANDREAS LAUFER, ANGELIKA POLITY, and BRUNO K. MEYER •Fakultät für Physik und Geowissenschaften, Universität Leipzig, Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik II, Linnestr. 5, 04103 Leipzig, Germany

In this 1950s E. Mollwo observed the effect that hydrogen diffused into ZnO single crystals strongly decreases their resistivity. About 50 years later the forming of shallow donor levels due to hydrogen incorporation in ZnO was described theoretically by C. G. Van de Walle and experimentally proved by several groups [3,4]. In our work hydrogen doped thin films have been prepared by radio frequency magnetron sputtering at different substrate temperatures using hydrogen and oxygen as reactive gases. The incorporation of hydrogen was quantified by secondary ion mass spectrometry and its influences on the structural, electrical and optical film properties have been investigated. By varying the deposition parameters we were able to adjust the electrical properties between semiconductor like and degenerated (highly conductive) behaviour for films deposited at room temperature.


HL 36.4 Wed 14:45 POT 51

Excitonic Recombination in MgZnO thin films — •ALEXANDER MÜLLER, MARKO STÖLZEL, GABRIELE BENNDORF, HOLGER HOCHMUTH, MICHAEL LORENZ, and MARIUS GRUNDMANN •Universität Leipzig, Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik II, Linnestr. 5, 04103 Leipzig, Germany

We present time-resolved photoluminescence (TRPL) measurements on MgZnO thin films. The samples have been grown by pulsed laser deposition on a-plane sapphire. We used time-correlated single photon counting to investigate the luminescence decay. The measured transients have been fitted using the convolution of a model decay function with the device function.

In this contribution, we present the spectral and temperature dependent optical properties of MgZnO thin films. For low temperatures, we observe a blue shift of the spectral luminescence maximum over time. This can be explained by a slow process at higher emission energies. The transients could be fitted using a sum of two model decay functions. The time-integrated intensities of the model decays show different spectral maxima. We attribute these to the emission of donor-bound and free excitons.
We investigated deep levels in a nitrogen implanted, PLD grown ZnO thin film. Subsequent to the ion implantation the sample has been thermally annealed. In preparation of capacitance spectroscopy measurements a Schottky contact made from evaporated palladium was deposited on the sample. From capacitance – voltage measurements the spacial dependence of the net doping concentration was obtained. Deep level transient spectroscopy was employed for the characterisation of deep levels with binding energies $E_{c} - E_{d} < 700$ meV below the conduction band edge. The prominent deep level E3 and a deeper one with $E_{c} - E_{d} \approx 590$ meV were detected. The presence of further defects was proven by photo – capacitance and photo – current measurements. A strong increase of the capacitance as well as on the current was observed for excitation with energies approx. 200 meV below the bandgap. This behaviour hints to the existence of a trap close to the valence band edge.

Nitrogen doping of ZnO — Michael Hofmann1, Melanie Pinnisch1, Andreas Laufer1, Sebastian Zöller1, Sebastian Eisermann1, Stefan Lautenschläger1, Bruno K. Meyer1, Gordon Callison2, Markus R. Wagner2, and Axel Hoffmann2 — 1Ist physics institute, Justus Liebig University Gießen — 2institute for semiconductor physics, Hardenbergstraße, Berlin

The controlled incorporation of acceptors into the ZnO matrix is still a not well understood obstacle for the fabrication of bipolar ZnO devices. We investigated the incorporation of nitrogen using low groth temperatures, different nitrogen percursors and polar or non polar ZnO surfaces. To characterize our thin films we used Raman spectroscopy, low temperature photoluminescence and secondary ion mass spectrometry measurements. It turned out that certain conditions, especially substrate polarity and temperature, favour the nitrogen incorporation.

On Cu diffusion in ZnO — F. Herklotz, E.V. Lavrov, and J. Weber — Technische Universität Dresden, 01062 Dresden, Germany

Copper in ZnO is of special interest since recent theoretical and experimental studies found ferromagnetic behavior of ZnO:Cu at room temperature. In addition, Cu is a deep acceptor in ZnO and one of the causes of the green emission band.

Experimental studies of Cu diffusion in bulk ZnO single crystals were carried out in the temperature range $1030 \text{ to } 1180 \, ^\circ \text{C}$. Concentration profiles of substitutional Cu were determined via IR absorption at 5817 cm$^{-1}$. Our findings reveal that the diffusion coefficient of Cu is $7.6 \times 10^7 \exp(-4.56 \, \text{eV}/k_B T)$ cm$^2$s$^{-1}$. This is about a factor of 25 higher than reported in the earlier studies, which probed the total Cu concentration. The discrepancy is explained by the formation of Cu complexes, which occurs at high concentrations. Diffusion mechanisms are discussed.