HL 57: ZnO: Optical Properties

Time: Wednesday 14:30–15:30 Location: POT 151

HL 57.1 Wed 14:30 POT 151

Localization of light in ZnO nano-needle arrays — •David Leipold, Christoph Minz, and Erich Runge — Technische Universität Ilmenau, 98693 Ilmenau, Germany

Localization of electromagnetic waves due to multiple scattering is an astonishing phenomenon. The strong electromagnetic fields concentrated to small spatial dimensions allow for novel ultrafast, non-linear, nano-optical experiments and applications. Recent experiments provide strong evidence for the existence of highly localized photon modes in a system of homogeneous, randomly distributed, vertically aligned ZnO nano-needles: Hot spots with hugely enhanced intensity were observed in the spatial distribution of the second harmonic generation (SHG) signal. We present results of full 3D solutions of Maxwell's equations for a model system. Several aspects of these results are quantitatively compared to experimental data.

We thank Manfred Maschek, Slawa Schmidt, Martin Silies, and Christoph Lienau from the Carl von Ossietzky Universität Oldenburg as well as Takashi Yatsui, Kokoro Kitamura and Motoichi Ohtsu from the University of Tokyo, who did the experiments which inspired this theoretical work.

HL 57.2 Wed 14:45 POT 151

Time-resolved photoluminescence spectroscopy of ZnO / (ZnMg)O heterostructures — •Verena Bornwasser[1], Alexej Chernikov[1], Martin Koch[1], Sangam Chatterjee[1], Stephan W. Koch[1], Bernhard Laumer[2], and Martin Eickhoff[3] — [1]Department of Physics and Material Sciences Center, Philipps-Universität Marburg, Renthof 5, D 35032 Marburg — [2]Walter Schottky Institut, Technische Universität München, Am Coulombwall 4, D 85748 Garching — [3]Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, D 35392 Giessen

ZnO-based materials are promising for the realization of optoelectronic devices operating in the UV. ZnO has a band gap energy of about 3.4eV, a large exciton binding energy of 60meV and a high material quality due to recently improved growth methods. Hence, a detailed understanding of the optical properties and carrier dynamics in this system is crucial to further optimize growth procedures and device performance. Here we present time-resolved photoluminescence measurements of the hetero- and homoepitaxially grown ZnO quantum wells and (ZnMg)O barrier layers. Our results show a strong correlation between the substrate and the material quality for the quantum well system. In the case of the (ZnMg)O barriers, post-growth annealing significantly improves the material quality. In addition a structural phase separation is observed as the annealing temperature exceeds 950°C.

HL 57.3 Wed 15:00 POT 151

Low-temperature dielectric tensor of MgZnO thin films and ZnO single crystals — •David Schumacher, Rüdiger Schmidt-Grund, Helena Hilmer, Chirs Sturm, Holger Hochmuth, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnestr. 5, Leipzig, Germany

We determined the temperature evolution of the spin-orbit interaction and crystal field splitting energies in a-plane $Mg_xZn_{1-x}O$ ($x < 0.1$) thin films and m-plane ZnO single crystals. In so doing we obtained hints on the ZnO valence band (VB) ordering, which is still under debate.

The temperature dependent dielectric tensor has been obtained by means of spectroscopic ellipsometry in the near band-gap spectral range (1 - 4.5) eV and temperatures (10 - 470) K. We derived the near bandgap band-to-band transition energies, amplitudes and broadening parameters. In order to get insight in the VB ordering of wurtzite ZnO our model dielectric function were constrained to satisfy the quasi cubic model, which gives expressions for the energy differences of the split-off bands due to spin-orbit interaction and crystal field splitting. We discuss the evolution of these quasi-cubic parameters, Δ_{so} and Δ_{cf}, as a function of temperature and Mg-content under the assumption of positive as well as negative spin-orbit-coupling.

We would like to stress that during the analysis our model had to be expanded by an additional ZnO surface-near-region layer in order to describe the data adequately. We ascribe this finding to the influence of electronic surface states and to mechanical damages of the surface.

HL 57.4 Wed 15:15 POT 151

Emission Properties of ZnMgO/ZnO Quantum Wells — •Pascal Becker[1], Bernhard Laumer[1,2], Fabian Schuster[2], Martin Eickhoff[1], and Detlev M. Hofmann[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, D-35392 Giessen — [2]Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, D-85748 Garching

ZnO quantum wells embedded in $Zn_{(1-x)}Mg_xO$ barriers are possible candidates for the realization of light emitters in the blue and near UV spectral range and exhibit interesting optical properties due to the presence of spontaneous and piezoelectric polarisation fields, which give rise to the quantum confined Stark effect. Here, we investigated MBE-grown ZnO quantum wells with different thickness and barrier composition x by luminescence and magneto-optical spectroscopy. The properties of wide quantum wells (> 5nm) are in good agreement to published data. However, for narrow quantum wells we observe an opposite sign of the magnetic circular polarisation of the emission (MCPE) and an inverted slope of the magnetic field dependence. We will discuss this effect in terms of changes in the valence band ordering.