DS 7: Nanophotonics - Theory of Nanophotonic Devices III

Time: Monday 15:30–17:00 Location: GER 38

Topical Talk DS 7.1 Mon 15:30 GER 38

Theory of carrier dynamics in quantum dot light emitters — •Ermin Malic[1], Marten Richter[1], Jeong-Eun Kim[1], Janik Wolters[1], Matthias-Rene Dachner[1], Ulrike Woggon[2], and Andreas Knorr[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin — [2]Institut für Optik und Atomare Physik, Technische Universität Berlin

We present a microscopic theory describing the charge carrier dynamics in quantum dot light emitters, such as lasers and amplifiers. The theoretical approach is based on quantum dot Bloch equations including microscopically calculated Coulomb and electron-phonon scattering rates between bound quantum dot, continuous wetting layer, and bulk states. After electrical injection of charge carriers, their subsequent transfer from bulk into the wetting layer and quantum dot is considered via phonon induced relaxation processes. The latter generate hot non-equilibrium carriers. As a result the electronic temperature is increased. At high charge carrier densities, Coulomb scattering modifies the picture. Here, we focus on two typical aspects: i) Gain dynamics of QD amplifiers at high electrical injection, ii) Switch-on dynamics of QD-VCELS and edge emitters.

We discuss the importance of the interplay between scattering contributions and induced emission and absorption processes on the device properties. These investigations are performed at different temperatures, for different density regimes, and for various pulse areas.

Topical Talk DS 7.2 Mon 16:00 GER 38

Photo- and spin current generation and dynamics in semiconductor nanostructures — Huynh Thanh Duc, Jens Förstner, and •Torsten Meier — Deparment Physik, Fakultät für Naturwissenschaften, Universität Paderborn, Warburger Str. 100, D-33098 Paderborn

The band structure and wave functions of GaAs quantum wells are computed via k.p band structure theory including anisotropy and spin splitting. Using these results, the process of generating photocurrents by optical excitation is analyzed. Depending on the symmetry of the material, the direction of the laser beam, and the polarization direction of the light field/s, one can coherently generate charge and/or spin photocurrents on ultrashort time scales. The direction, the strength, and the dynamics of these photocurrents are computed and discussed.

DS 7.3 Mon 16:30 GER 38

Microscopic modelling of Auger losses in wide bandgap nitrides — •Jörg Hader[1,2], Jerome V. Moloney[1,2], Bernhard Pasenow[3], and Stephan W. Koch[3] — [1]Nonlinear Control Strategies Inc., 3542 N. Geronimo Ave., Tucson, AZ 85705, USA — [2]College of Optical Sciences, University of Arizona, Tucson, AZ 85721, USA — [3]Fachbereich Physik und Wissenschaftliches Zentrum für Materialwissenschaften, Philipps-Univrsität Marburg, Renthof 5, 35032 Marburg, Germany

The internal quantum efficiency in GaN-based light emitting diodes is generally found to have a maximum at very low pump densities and to fall off for higher densities. Using phenomenological models, this efficiency 'droop' can be fitted asuming a non-radiative loss mechanism that has the cubic density dependence usually associated with Auger recombination losses. Here, we use a set of fully microscopic models to investigate the actual importance of Auger losses in these systems. We give a brief description of the involved models for absorption/gain, spontaneous emission and carrier losses due to radiative and direct and phonon-assisted Auger losses. The predicitve nature of these fit-parameter free models is demonstrated and shortcomings of simplified phenomenological models are discussed - in particular, the general failure of the cubic density dependence for Auger losses. It is shown that direct Auger losses cannot explain the efficiency droop[1] and the possible impact of phonon-assisted processes is analyzed.

[1] J. Hader, et al., Appl. Phys. Lett. 92, 261103 (2008)

DS 7.4 Mon 16:45 GER 38

Numerical simulation of tilted wave lasers — •Jan Pomplun[1], Frank Schmidt[1], Kristijan Posilovic[2], Vitaly A. Shchukin[2], Nikolai N. Ledentsov[2], and Dieter Bimberg[2] — [1]Zuse Institut Berlin, Takustr. 7, 14195 Berlin, Deutschland — [2]Institut für Festkörperphysik, TU Berlin, Hardenbergstr. 36, 10623 Berlin, Deutschland

The tilted wave concept offers the possibility to realize ultrahigh-brightness wavelength-stabilized lasers, which are important for many applications like data transmission and solid state laser pumping.

In a tilted wave laser (TWL) the narrow active waveguide is coupled to a broad second waveguide. The lasing mode leaks from the active region creating a mode in the second waveguide. The coupling of both modes results in wavelength stabilization but is also very sensitive to the design of the system. Numerical simulations are therefore very important to obtain desired properties and increase the performance of TWLs.

In our contribution we analyze tilted wave lasers numerically. The influence of design parameters on the propagating lasing eigenmodes and the emitted far field is analyzed. Our results are compared to experimental measurements of different TWLs.