Phonon coupling in a GaAs/AlAs core/multi-shell nanowire

P. Plochocka[1], J. Jadczak[1], A. A. Mitioglu[1], D. K. Maude[1], G. L. J. A. Rikken[1], Ronit Popovitz-Biro[2] and Hadas Shtrikman[3]

1) Laboratoire National des Champs Magnetiques Intenses, CNRS-UJF-UPS-INSA, France
2) Microscopy Unit, Weizmann Institute, Rehovot 76100, Israel
3) Braun Center for Submicron Research, Weizmann Institute, Rehovot 76100, Israel
Email of presenting author: paulina.plochocka@lncmi.cnrs.fr

The talk will focus on the optical properties of excitons in a core/multi-shell zinc-blende GaAs/AlAs nanowire (NW). Our results show that residual carbon which is preferentially incorporated into the narrow 1 nm quantum well in the shell of the NW during growth leads to the formation of a high density 2D hole gas at the facets of the NW core. The emission spectrum of such NWs is extremely rich. In addition to the previously reported KP series of emission lines in the energy range 1.504–1.511eV [1], we observe features at lower energy linked to emission from excitons bound at the carbon acceptor sites. At higher energies (~1.525eV) we observe bound exciton emission which is blue shifted due to the quantum confinement. The activation energy of this emission is roughly twice that of the bound exciton emission from the core of the NW as expected in 2D.

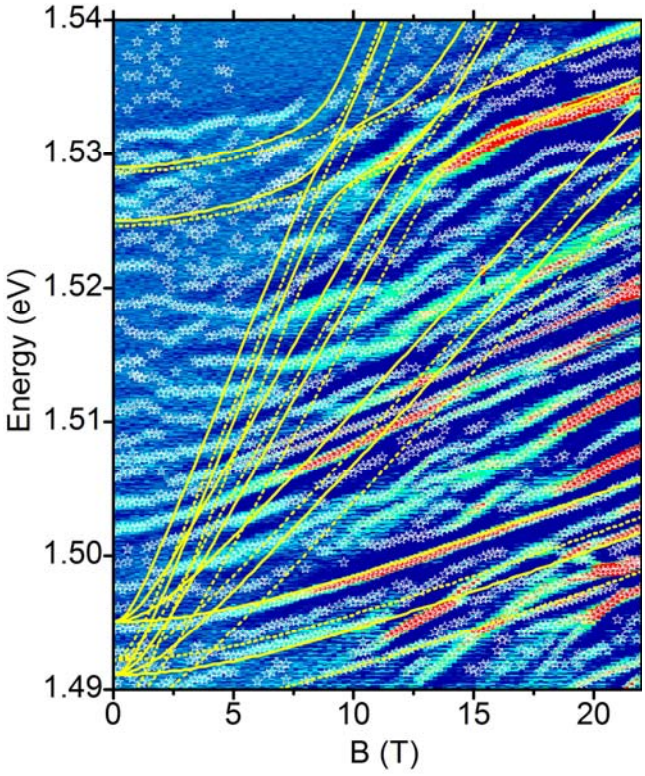

Figure 1. *Differential μPL spectra showing the evolution of the emission as a function of magnetic field applied perpendicular to the NW at T = 1.7K. The anti-crossing of the N=2 phonon replica with the N=0 Landau level of the confined exciton emission is clearly visible. The yellow curves are the calculated energies of the N=0,1,2,3 TO (dashed lines) and LO (solid lines) phonon replicas. The anti-crossing is included in the calculations using a perturbation approach.*

In a magnetic field the shift of the Landau level N=0 emission line is consistent with the light hole mass m*=0.087 (see Figure 1). In addition several features corresponding to LO and TO phonon replicas of the N=0 confined exciton emission are observed (yellow lines). Moreover, there is an anti-crossing between the N=0 emission and the N=2 phonon replica. For this to take place the Fermi energy has to be at least comparable to the phonon energy (36meV) suggesting that the 2D hole gas has a very high density (>5 x 10^{12} cm^{-2}).

[1] Plochocka et al. Nano Letters, **13**, 2442, (2013)