Correlation of structural and optical properties of single core shell GaAs/AlAs nanowire in polarization-resolved and power-dependent photoluminescence

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Polarization-resolved micro-photoluminescence (μPL) of single core shell GaAs/AlAs nanowires (NWs) is used to probe their low temperature (T=5.5K) structural and optical properties. The NW was excited using a Ti: Sapphire laser tuned to 760 nm with powers in the range 0.5 to 15 μW. Under the low excitation power the dominant part of the spectrum is found below 1.519 eV, where shoulders at 1.496 eV and 1.507eV are distinguished as well as prominent emission lines centered at 1.510 eV and 1.516 eV (dashed white lines). Further increase of the power excitation causes the emergence of a new peak of stronger intensity at higher energy 1.529 eV. The low energy lines were identified with recombination of excitons bound to defect pairs. The emission at 1.516 eV and 1.529 eV was attributed to the recombination of exciton in purely ZB or WZ segments (the thickness of the insertions in the NW controls the energy of transitions between electrons confined in ZB sections and holes in WZ sections). In order to determine the crystal structures of the NW we determined it's orientation on the substrate and analyzed the emission polarization with setups shown in Fig.1(c-d). Results are shown in standard form of color maps of emission intensity as a function of polarization angle (Fig.1(a-b)). Using the Jones formalism, we found that the PL intensity is proportional to $I \sim \sin^2(2c-\alpha)$, where c is the position of $\lambda/2$ and α the NW orientation. It clearly shows the different selection rules for WZ and ZB sections; transition above 1.519 eV exhibits polarized emission perpendicular to NW axis, while lines observed below are more prominent for polarization parallel to NW axis.

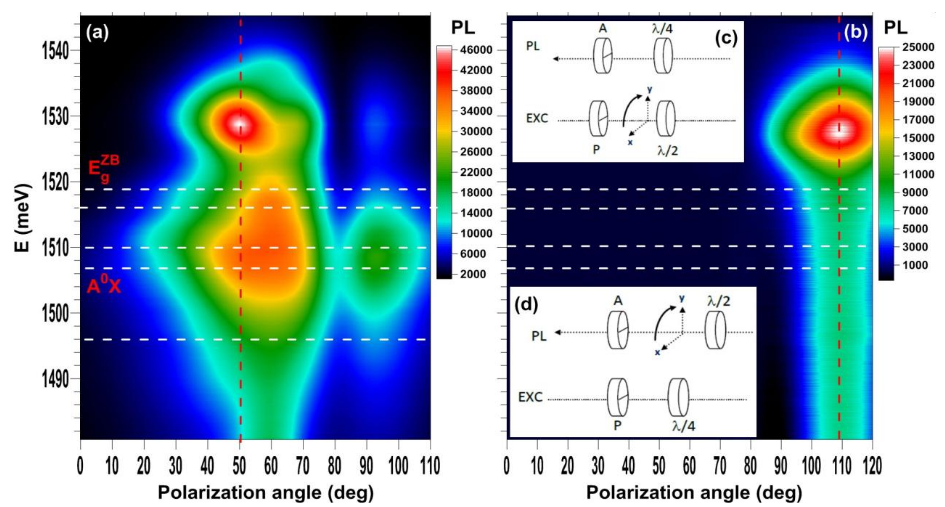

Figure 1: PL emission from a single core shell NW as a function of the polarization. (a) Rotating the linear polarization of the excitation (see c) to determine the orientation of the NW. (b) Rotating the linearly polarized detection (see d) to determine selection rules.