Optical properties of core-shell GaAs-AlGaAs nanowires on silicon

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During the last years, core-shell nanowires based on III-As compounds are extensively studied due to their enhanced optoelectronic properties. GaAs nanowires (NWs) are prominent candidates for novel devices due to their one-dimensional geometry, the ability to form radial or axial hete-rostructures, whilst they are characterized by unique waveguiding effects and increased absorp-tion compared to their bulk counterparts. Nevertheless their efficiency is directly affected by the poor quality native oxide present at the NW surface and the increased number of traps. In order to avoid the aforementioned factors which deteriorate the NW optoelectronic properties, an AlGaAs shell is grown around them, acting as an efficient passivation layer, increasing drastically the PL yield and carrier lifetimes. In addition, the AlGaAs shell induces significant piezoelectric fields, improving the electron hole separation, and thus reducing recombination losses, which is a key factor for high efficiency solar cell devices. In this work we investigate the optical properties of core-shell GaAs-AlGaAs nanowires grown on n+ Si(111) substrates. The samples are grown by molecular beam epitaxy via the Ga-assisted Vapor-Liquid-Solid (VLS) mechanism. In order to achieve the core-shell architecture, we follow a two-stage growth, where initially the GaAs core is grown, subsequently the Ga droplet is removed and finally an $Al_{0.3}Ga_{0.7}As$ shell is deposited around the NW following the nominal conditions for a 2D growth. The diameter of the GaAs core is approximately 75nm, while the overall NW diameter ranges from 150nm-280nm, depending on the 2D growth time. Here, we report on a combination of experimental methods applied to these NWs such as photoluminescence (PL) (Fig. 2), time-resolved PL, μPL, cathodoluminescence (CL) (Fig. 1), which allowed us to demonstrate the high optical quality of these nanostructures.

Figure 1: CL measurements in a single NW depicting the emission from different regions.

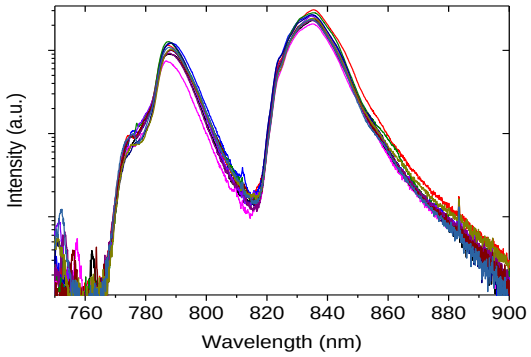

Figure 2: PL spectra at T=15K

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