GaAs-GaNAs core-shell nanowires growth by MOVPE

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Core-(multi)shell nanowires (NWs) based on III-N-V semiconductors have potential applications to high-efficiency solar cells [1] and NIR-emitting laser devices [2]. However, III-N-V compounds are highly mismatched alloys and their fabrication requires growth conditions far from equilibrium. To date, the growth of GaAs-GaNAs core-(multi)shell NWs has been reported by plasma-assisted molecular beam epitaxy only [3]: GaNAs shells are grown at around 430°C so to achieve sufficient N incorporation; N concentrations in as-grown GaNAs alloys up to 2% have been demonstrated. However, the low growth temperatures required by MBE may promote the formation of N-related recombination centres, degrading the material internal quantum efficiency.

We report for the first time on the low-pressure MOVPE of GaAs-GaNAs core-shell NWs using tertiary-butyl-hydrazine as N-precursor, along with trimetyl-gallium, trimetyl-aluminum and tertiarybutyl-arsine. Dense arrays of GaAs NW cores were grown at 400°C on (111)B-GaAs by the Au catalyzed method [3], and overgrown at 540□560°C by a GaNAs shell followed by a thin AlGaAs shell for passivation purposes and a GaAs thin shell (Figure 1a). Different V:III and N:As ratios in the vapor and growth rates during GaNAs shell growth were used to study the degree of N-incorporation.

GaAs-GaNAs NWs were studied by FE-SEM and PL spectroscopy. A NIR broad band emission was detected in the 7K PL spectra of dense NW arrays (Figure 1b), and ascribed to the radiative emission related to the intermediate bandgap ($E_{\square}$) of GaNAs alloy, corresponding to an estimated N-content of the GaNAs shells up to ~0.3%. The N-content and NW diameters decrease with the NW array density, which is explained by a change of GaNAs shell growth rate with the NW density on the substrate [4].

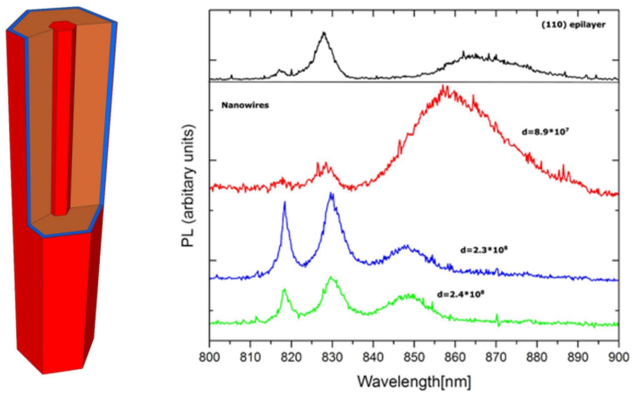

Figure 1. (a) Schematic of the GaAs-GaNAs core-shell nanowire structure. (b) PL spectra of as-grown nanowires (coloured lines) as function of their density, and of a (110)-oriented GaAs-GaNAs planar sample (black line).

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