Light emitting diode based on (In,Ga)As/GaAs coaxial multi-shell nanowires monolithically integrated on Silicon

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We demonstrate the use of III-arsenide nanowires as light emitting diodes (LEDs) monolithically integrated on Silicon. LEDs made of (In,Ga)As/GaAs coaxial multi-shell nanowires were grown catalyst-free directly on Si(111) by molecular beam epitaxy (MBE). The active region consists of a single (In,Ga)As/GaAs quantum well in the radial direction (Fig. 1-a). Correlating the emission properties of the quantum wells (Fig. 1-b) with the growth kinetics on the $(1\bar{1}0)$ side-walls, we were able to identify the optimal growth conditions for coherently strained quantum wells with high-quality interfaces and homogeneous structure (in terms of chemical composition and shell thicknesses) along the nanowire axes. Shell-doping methods were successfully employed for the realization of p- and n-type GaAs shells, while a planarization scheme with transparent ohmic contacts allowed massive biasing in parallel configuration of the free-standing nanowires on the Silicon substrate. Rectifying operation and room-temperature electroluminescence were obtained (Fig. 1-c), proving the great potential of this technology.

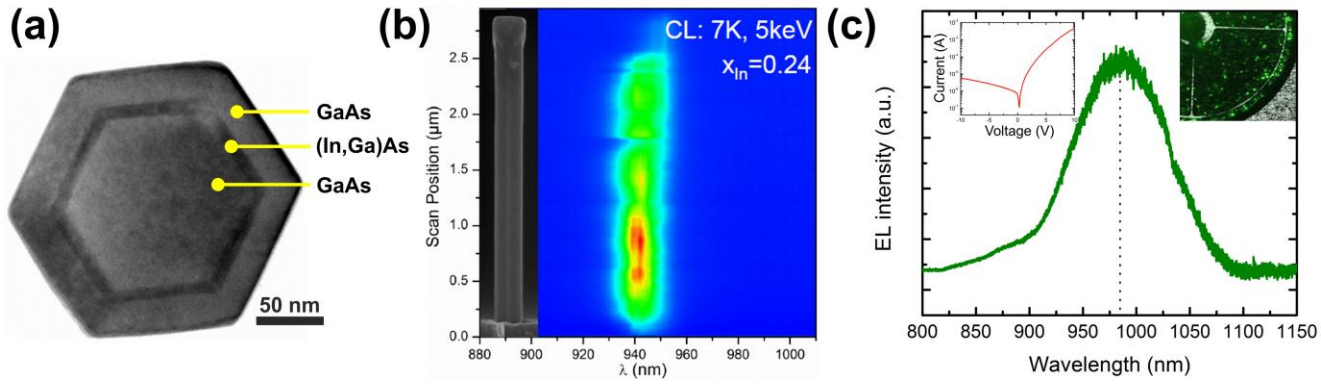

Figure 1: (a) Cross-sectional transmission electron micrograph of a nanowire with a single radial quantum well (SQWN) consisting of (In,Ga)As/GaAs shells around the GaAs core. (b) Low-temperature cathodoluminescence topography of a SQWN with In-content of 0.24. (c) LED electroluminescence at room-temperature centered at 985 nm; left inset: corresponding I-V characteristic; right inset: corresponding electroluminescence topography.