# GaAs:Si nanowires: critical reduction of the effect of ZB/WZ polytypism on the electronic structure

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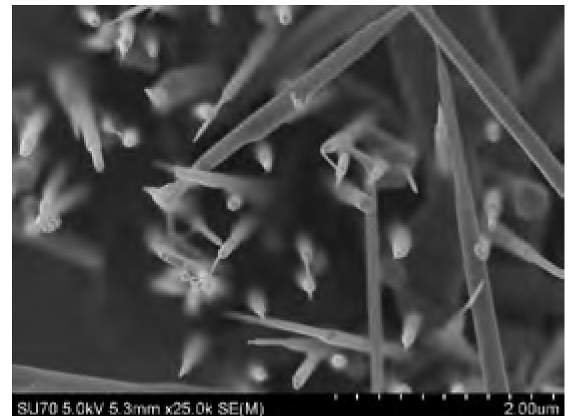
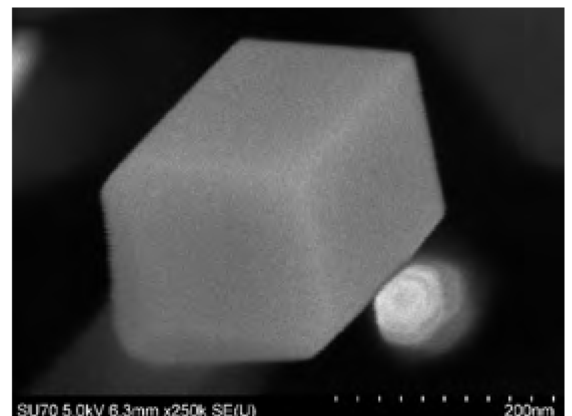
The unique properties of semiconductor nanowires (NWs), such as: large surface-to-volume ratio, possible quantum confinement effects, NW's diameter dependence of excitation and emission of electronic states, give these nano-building blocks outstanding potential for electronic, photonic, mechanical, biological, and energy-conversion applications. The NWs' growth parameters influence the material composition, doping, and crystal quality, enabling to tailor their structural, electrical and optical properties, which are relevant for potential applications. Therefore, two major issues should be understood: i) the presence of polytypism (wurtzite (WZ) and zinc-blende (ZB)) that strongly influences the electronic structure of the NWs and ii) the ability to control the dopants in order to tune the semiconductor's optical and electrical properties. In this work, we study the effect of silicon (Si) doping on the electronic structure of GaAs NWs grown on GaAs (111) B substrates by molecular beam epitaxy. Si atoms can occupy both cation and anion sites in III–V semiconductors, i.e., they exhibit an amphoteric behaviour. For high doping levels, the presence of a huge density of charged defects creates fluctuations of the electric potential along the nanostructure. We demonstrate that the presence of such fluctuating potentials in the samples with the highest doping levels drastically decreases the influence of polytypism on the electronic structure, thus preventing the localization of charge carriers at the WZ/ZB interfaces (Fig.1).

Our findings are of high interest for optoelectronic applications based on III–V NWs and were achieved thanks to the fruitful collaborations of our group in UA with other European and Brazilian groups.



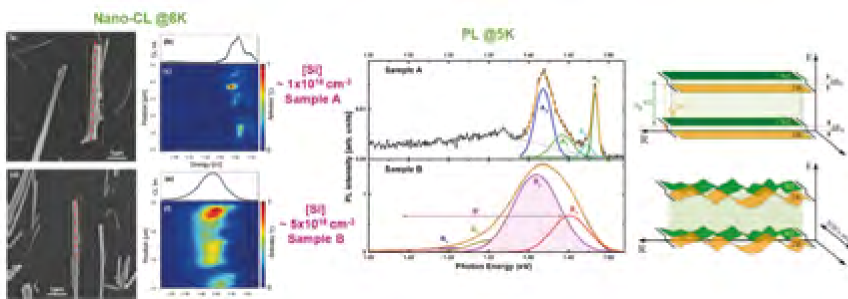




**FIGURE 1**
Left: Low-temperature hyperspectral cathodoluminescence (CL) images of individual Si-doped GaAs NWs. Middle: Low-temperature photoluminescence (PL) spectra measurement (black) and best-fit model (orange) using Gaussian components of Si-doped GaAs NW ensemble. Right: Electronic structure of Si-doped GaAs NW materials: $\Delta E_c$ and $\Delta E_v$ are the conduction and valence band offsets at the WZ/ZB interface. Upper figures correspond to the lightly doped NWs and lower figures correspond to highly doped and compensated NWs.