Condensed Matter Physics Institute Seminar

13:00 | Tuesday 16th February | P/T/111

Nano-scale building blocks with electronic and structural heterogeneity shaping by post-synthesis modifications; ex-situ doping and self-processing synthesis

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The intentional introduction of heterogeneity at the nanoscale plays a key role in the design of functional nanostructure building blocks. The heterogeneity is frequently manifested in structure, shape, composition, and electronic structure modulation of the nanostructure regions. I will present our research towards two methodologies for post-synthesis modification and symmetry breaking of semiconducting nanostructures using nanowires as the basic building blocks covering two aspects of post-synthesis modification of nanowires:

I. Ex-situ doping of silicon nanowires.
II. Self-processing synthesis of coinage metal-semiconductor hybrid structures.

Specifically, the transformation of un-doped silicon nanowires into heterogeneously doped building blocks featuring sharp p-i-n junctions across the nanowire is demonstrated using monolayer contact doping. Monolayer contact doping exploit surface chemistry for implementing monolayers as the source for dopant atoms. Relying on surface chemistry provides an accurate dose and initial positioning together with fine control over the diffusion processes. The monolayer doping methodologies are valuable for decoupling the doping step from the nanowire synthesis step, resulting in ex-situ doping. Since the formation of the dopant containing monolayer is applied on a separate substrate, the surface chemistry required for creating the dopants source monolayer is decoupled from the semiconductor material intended for doping. The surface chemistry, thermal fragmentation, and diffusion of both phosphorus and boron precursors were studied in this work for providing in-depth understanding of the monolayer doping processes.
In addition, the synthesis of coinage metal-semiconductor hybrid nanostructures will be presented. The synthesis involves a sequence of selective etch and deposition steps which are self-initiated and self-terminated. Each component of the process was studied for elucidating the underlying mechanisms. This understanding allows the fine tuning of each parameter of the resulting hybrid nanostructures.

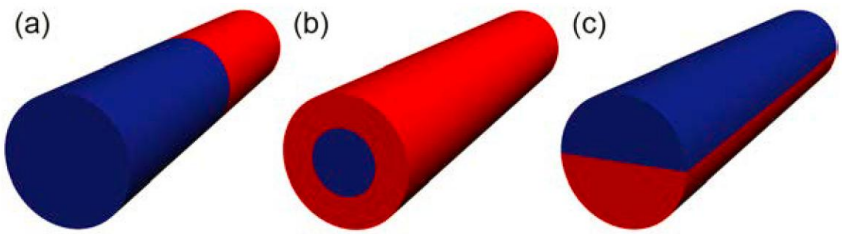

Figure. Nanowire-based p-n junctions (a) axial, (b) coaxial, and (c) parallel configurations (parallel configuration is obtained by one-step ex-situ monolayer contact doping)