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Functional nanowire building blocks by post-synthesis modifications; Monolayer doping & self-processing synthesis

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Programmable introduction of heterogeneity at the nanoscale plays a key role in the design of functional building blocks for catalysis, electronic devices, and numerous other applications. Synthetic strategies for attaining well-defined heterogeneity in structure, shape, composition, and modulation of the electronic structure at selected regions of the nano system is therefore highly desired. 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. Ex-situ doping enables the transformation of un-doped silicon nanowires into heterogeneously doped building blocks featuring sharp p-i-n junctions across the nanowire. 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. (II) Self-processing synthesis of coinage metal-semiconductor hybrid structures. The hybrid nanostructures obtained for the coinage metals resemble the morphology of grass flowers, termed Nano-floret hybrid nanostructures consisting of a high aspect ratio SiGe nanowire (NW) with a metallic nanoshell cap. The new class of structures is useful in a variety of applications owing to the unique geometrical aspect ratio and electronic properties of the hybrid systems. The synthesis involves a sequence of selective etch and deposition steps which are self-initiated and self-terminated resulting in the hybrid nanostructures.

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