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Controlled formation of epitaxial III-V nanowires for device applications

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For the realization of devices with dimensions on the 10 nm scale, there is today a great interest in the possible use of self-assembly as a tool. In this talk will be described the state-of-the-art in growth of epitaxially nucleated, vertically standing semiconductor nanowires made from III-V semiconductors, with high level of control of dimensions, position and structural properties. Such wires hold great promise for use in future electronics and photonics applications. Three key aspects will be specifically addressed, namely: **(1) The combination of top-down and bottom-up processes in lithographically aided formation of nanowires.** A concern from industry is that bottom up techniques should suffer from "fundamental placement problem[s], i.e. there is no practical and reliable way to precisely align and position them." (Chau R., et al. Opportunities and challenges of III-V nanoelectronics for future high-speed, low-power logic applications. (2005)). One way to resolve this issue is lithography where individual nanowire site control with high precision can be achieved. Electron beam lithography has the advantage of being a flexible high-resolution method, whereas nanoimprint lithography offers great opportunities for up-scaling and high-throughput processing. **(2) The successful growth of III-V nanowires on silicon, including designed heterostructures.** The special nanowire geometry with tens of nanometer radius and very small nanowire / substrate interface, enables monolithic integration of high-performance III-V materials on Silicon substrates. As an example, GaAsP heterostructure nanowires for photonic applications are discussed. Also the formation of InAs nanowires for high-speed and low-power-electronics directly on Si will be described. In the latter process, the use of foreign metal particles for wire growth is completely avoided, greatly reducing compatibility concerns between CMOS and nanowire technology. **(3) Nanowire devices**, such as field-effect transistors and light-emitting diodes will be discussed.