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Epitaxial growth and design of semiconductor nanowires

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Semiconductor nanowires represent an important technology for future applications in electronics and optoelectronics. In order to realize this potential, precise control of their synthesis must be achieved in terms of morphology, size, position, chemical composition and crystal structure. In this presentation, recent progress on controlled fabrication of III-V semiconductor nanowire structures will be discussed. The most common and versatile technique using for nanowire fabrication today uses metal alloy particles as templates for one-dimensional crystal growth. These particles may be fabricated in vapor or colloidal suspension or by agglomeration of thin films. Position controlled arrays may be achieved using lithographically-patterned thin metal films as growth seeds. The advantages and limitations of these techniques will be compared. As well, the effect of alloy particle metal choice on nanowire morphology will be discussed. Crystal structure control is also essential to applications of semiconductor nanowires. This is particularly important for III-V materials, which often exhibit an intermixing of cubic and hexagonal structures. The ability to selectively tune the structure, and to combine these structures in a precise manner, will be discussed in terms of accessible growth parameters. Finally, more complex structures can be fabricated once controlled fabrication of simple nanowires is achieved. Different semiconductor materials can be combined either axially or radially to produce heterostructures. Lattice matching is of lesser importance in nanowire systems due to lateral strain relaxation. However, growth from seed particles introduces new challenges, which will be discussed here. More complex structures may also be fabricated by incorporating sequential generations of nanowires into complex networks.