Importance of Three-Dimensional Nanowire Networks in Optics, Magnetism, and Energy Harvesting

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Abstract

Three-dimensional nanowire networks are structures made of interconnected nanowires that form a three-dimensional mesh. They have the potential to revolutionize areas such as magnetism (generating materials with tailor magnetic behavior), electronics (generating new transistors and sensors), energy harvesting (since new phenomenology appear at nanoscale), energy storage (improving the performance of batteries and supercapacitors, making them more efficient and durable), or biomedical devices (such as new biosensors). These three-dimensional nanowire networks can be generated in areas from mm2 up to ∼m2. The junctions between adjacent nanowires render excellent mechanical stability. So, the nanowire network can be free-standing after elimination of the template or the substrate in which they have been grown. The wires mechanically support each other, and in case individual wires break, electrical or thermal transport can still occur via alternative nanowire interconnections.

By means of several examples, I will illustrate how 3D nanowire networks combine the advantages and ease of handling of macroscopic samples with the size-dependent properties of nanowires. For instance, they can be used to create high-performance transistors that are smaller than 10 nm. They can also be used to create biosensors that are highly sensitive to glucose. Furthermore, they can be used to create high-capacity lithium-ion batteries that are more efficient and durable than conventional batteries.

In this keynote, I will show some examples of Three-dimensional nanowires networks to generate materials with tailor magnetic behavior that could have important applications in fields such as data storage and spintronics. Or, to create flexible Bragg reflectors that could have applications in optics and photonics. Or, to eliminate phonon transport in thermoelectric metamaterials, which could have important applications in thermoelectric devices.