Cardamom Planters' Association College
(Re-accredited with 'B' Grade by NAAC)
Pankajam Nagar, Bodinayakanur - 625 582.

Nanowires and its synthesis

Dr. B. Kavitha
Assistant Professor
PG and Research Department of Chemistry
C.P.A. College, Bodinayakanur

Nanowires

A nanowires is a wire of diameter of the order of a nanometer (10^{-9} meters). Alternatively, nanowires can be defined as structures that have a lateral size constrained to tens of nanometers or less and an unconstrained longitudinal size. At these scales, quantum mechanical effects are important hence such wires are also known as "quantum wires". Many different types of nanowires exist, including metallic (e.g., Ni, Pt, Au), semiconducting (e.g., Si, InP, GaN, etc), and insulating (e.g., SiO_2, TiO_2).

Molecular nanowires are composed of repeating molecular units either organic (e.g. DNA) or inorganic (e.g. $Mo_6S_{9-x}I_x$).

The nanowires could be used, in the near future, to link tiny electronic components into extremely small electronic circuits. Using nanotechnology, such components could be created out of chemical compounds.

Typical nanowires exhibit aspect ratios (length-to-width ratio) of 1000 or more. Nanowires have many interesting properties that are not seen in bulk or 3-D materials this is because electrons in nanowires are quantum confined laterally and thus occupy energy levels that are different from the traditional continuum of energy levels or bands found in bulk materials.

Peculiar features of this quantum confinement exhibited by certain nanowires such as carbon nanotubes manifest themselves in discrete values of the electrical conductance. Such discrete values arise from a quantum mechanical restraint on the number of electrons that can travel through the wire at the nanometer scale. these discrete values are often referred to as the quantum of conductance and are integer values of

$$\frac{2e^2}{h} \approx 12.9\ k\Omega^{-1}$$

They are inverse of the well-known resistance unit h/e^2, which is roughly equal to 25812.8 ohms, and ~~is~~ referred to as the von klitzing constant R_K (after Klaus von Klitzing, the discover of exact quantization). Since 1990, a fixed conventional value R_{K-90} is accepted.

Examples of nanowires include inorganic molecular nanowires ($Mo_6S_{9-x}I_x$, $Li_2Mo_6Se_6$) which have a diameter of 0.9nm and can be hundreds of micrometers long. other important examples are based on semiconductors such as InP, Si, GaN etc, dielectrics (e.g.; SiO_2, TiO_2) or metals (eg. Ni, Pt)

There are many applications where nanowires may become important in electronic, opto-electronic and nanoelectro-mechanical devices, as additives in advanced composites, for metallic interconnects in nanoscale quantum devices, as field-emitters and as leads for biomolecular nanosensors.

Synthesis of ~~Pro~~ nanowires

* Nanowires are not observed spontaneously in nature and must be produced in a laboratory.

* Nanowires can be suspended, deposited or synthesized from the elements

A suspended nanowire is a wire in vacuum chamber held at the extremities. A deposited nanowire is a wire deposited on a surface of different nature. eg. it could even be a single strip of metallic atoms over a non-conducting surface. A suspended nanowire can be produced by chemical etching of a bigger wire, or bombarding a bigger wire with some highly energetic particles (atoms or molecules).

Another way to produce suspended nanowires is to indent the tip of an STM in the surface, of a metal near the melting point and retract it.

A common technique for creating a nanowire is the vapour-liquid-solid (VLS) synthesis method. This technique uses as source material either laser ablated particles or a feed gas (such as silane). The source is then exposed to a catalyst. For nanowires, the best catalysts are liquid metal (such as gold) nanoclusters, which can either be purchased in colloidal form and deposited on a substrate or self-assembled from a thin film by dewetting. This process can often produce crystalline nanowires in the case of semiconductor materials.

The source enters these nanoclusters and begins to saturate in. Once supersaturation is reached, the source solidifies and grows outward from the nanocluster. The final product's length can be adjusted by simply turning off the source. Compound nanowires with super-lattices of alternating materials can be created by switching sources while still in the growth phase.

Inorganic nanowires such as $Mo_6S_{9-x}I_x$ (which are alternatively viewed as cluster polymers) are synthesized in a single-step vapour phase reaction at elevated temperature