Carbon Nanotubes

by Martha Crowland.

Carbon Nanotubes (CNTs) are allotropes of carbon and refer to single- wall carbon nanotubes (SWCNTs) as well as multi-wall carbon nanotubes (MWCNTs). The structure of carbon nanotubes can be thought of as a 2D hexagonal lattice rolled to form a hollow cylinder that have a radius in the range of nanometres. The lattice resembling that of graphene as the carbon atoms have three covalent bonds also leaving a spare electron. The spare electrons form a sea of delocalised electrons that enables the nanotubes to conduct electricity much like graphene.

Along with the ability to conduct electricity, nanotubes are very good thermal conductors due to their nanostructure. The strong covalent bonds between the carbon atoms also result in the exceptional tensile strength nanotubes possess, so strong that is the strongest material yet discovered in terms of the elastic modulus. In 2008 a MWCNTs was tested and had a tensile strength value of 63GPa which means that it could endure the weight equivalent to 6,422 kilograms-force on a cable with a cross sectional area of one square millimetre. [1] Although nanotubes are very high tensile strength, under compressive forces the hollow structure inhibits the strength quite significantly causing the tubes to buckle under high compressive stress. Further research of carbon nanotubes has resulted in the discovery that they are indeed quite soft in the radial directions.

The wide range of properties qualify nanotubes to have multiple uses and applications. The ability to conduct electricity and size has enabled growth in industries such as nanotechnology as they are the best suited material for connections between molecular electronics. CNTS mechanical properties such as strength and stiffness widen their applications further potentially being used in advance composites that require these properties in high value. Moreover, CNTs can be spun into extremely strong fibres that have practical applications in woven fabrics and textiles, transmission cables and other materials that require great strength. Nanotubes can also be used to reinforce other materials such as ceramics. Ceramics are resistant to heat and chemical attacks and are also very hard but are also very brittle. Reinforcing the ceramic with nanotubes does not only eliminate the brittleness of the material but also expands the limit of its properties. A fascinating property includes the ability to conduct heat in one direction and also reflecting heat at right angles to the nanotubes.