Taming carbon nanotubes

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Carbon nanotubes have many attractive properties, and their structure and areas of application can be compared with those of graphene, the material for whose discovery the most recent Nobel Prize was awarded. In order to be able to exploit these properties, however, it is necessary to have full control of the manufacturing process. Scientists at the University of Gothenburg (Sweden) are closing in on the answer.

"Our results show that the metal particles that form the basis of the manufacture of carbon nanotubes must have a certain minimum size, in order for growth to start and to continue. It is also probable that the particles are in liquid form at a manufacturing temperature of around 800 C, even though the metals used may have much higher melting points", says Anders Börjesson from the Department of Physics at the University of Gothenburg.

The scientists have used various computer models to study in detail properties that are difficult or impossible to examine in experimental conditions. Only when we fully understand the manufacturing process will we be able to exploit this material fully.

The diameter of the nanotubes is of the order of one billionth of a metre, and they can be as thin as a single carbon layer. The length of the tubes, in contrast, can extend from the nanometre scale up to several decimetres. Carbon nanotubes can be regarded, quite simply, as thin threads of pure carbon, whose length can be a billion times greater than their thickness.

Interest for nanotubes is based on their outstanding properties: they are among the strongest materials known and have extremely high conductivity for both electric current and heat.

The strength can be used to reinforce other materials, just as the strength of glass and carbon fibres is used in plastics, and steel reinforcement is used in concrete. Carbon nanotubes, however, would enable plastics to be manufactured that are ten times stronger than the strongest materials available today. Such materials could be used not only in exclusive sports equipment but also in the construction of buildings that appear to come from science fiction: a lift between the Earth and space could be anchored using a material based on nanotubes.

The carbon nanotubes may also replace other material when it comes to conducting very high electrical currents, since they do not become hot, nor do they catch fire. Certain nanotubes have semiconducting properties and could be used to build nanoelectronic circuits, giving much smaller and faster processors to be used in computers.

One way of combining the strength and electrical properties of the carbon nanotubes would be to mix them with polymer material, and by weaving threads that also contain electronic circuits. It would be possible, for example, to weave instruments for monitoring heart function directly into clothes.

Provided by University of Gothenburg