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New method of growing carbon nanotubes to revolutionise electronics

A new method of growing carbon nanotubes is predicted to revolutionise the implementation of nanotechnology and the future of electronics. Researchers at the University of Cambridge have successfully grown nanotubes at a temperature which permits their full integration into present complementary metal-oxide semiconductor (CMOS) technology (350 ºC).

Carbon nanotubes are the driving force for current advances in nanotechnology; they have excellent mechanical and electronic properties, the latter making them extremely attractive for new-generation electronics.

Increasing efficiency through smaller components is the key towards miniaturisation of technology. The use of carbon nanotubes could find successful use from sophisticated, niche applications to everyday electronics (mobile phones, computers).

Thus far the growth of nanotubes has been carried out at very high temperatures, and growth below 500 °C was believed impossible. This made the direct implementation of nanotubes into electronic devices unthinkable. Trying to integrate nanotubes above 400–450 °C would in fact damage the inter-metal dielectrics commonly employed in CMOS device fabrication.

A group of researchers at the Department of Engineering at the University of Cambridge, led by Mirco Cantoro, Stephan Hofmann, Andrea Ferrari and John Robertson, in collaboration with colleagues at the Cambridge Hitachi Laboratory and the Department of Materials Science, University of Cambridge, succeeded in growing single-wall carbon nanotubes at temperatures as low as 350 ºC.

These nanotubes, grown by thermal Chemical Vapour Deposition (a chemical process often used in the semiconductor industry), are promising candidates for integration into existing nanoelectronic devices.

This result also sheds new light on the possible mechanisms that occur during carbon nanotube growth. Previously, the assumption that the catalyst has to be liquid often dominated

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carbon nanotube growth model considerations, but at these lower temperatures evidence has been found of a solid catalyst. These findings extend to the catalytic growth of other nanostructures in general.

Notes:

1. This work has been recently published in Nano Letters.1, M. Cantoro et al. "Catalytic chemical vapor deposition of single-wall carbon nanotubes at low temperatures", Nano Letters 6, 1107 (2006). A full copy of the article can be found at: http://pubs3.acs.org/acs/journals/doilookup?in_doi=10.1021/nl060068y

2. Chemical Vapor Deposition (CVD) is a chemical process often used especially in the semiconductor industry for the deposition of thin films of various materials, and successfully employed to grow carbon nanotubes at low temperatures. In a typical CVD process, the substrate is exposed to one or more volatile precursors, which react and decompose on the substrate surface to produce the desired deposit. In contrast to higher temperature growth methods, it is possible to scale up CVD, with the advantage that purity can be controlled by careful process control.

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