

World's first tool for low-temperature carbon nanotube growth starts trials

November 29 2005



CEVP has developed a fabrication tool to commercialise the revolutionary low temperature carbon nanotube growth process developed by the University of Surrey's Advanced Technology Institute (ATI). The new tool - NanoGrowth - is currently being trialled and characterised, and the two partners anticipate releasing the technology for commercial use in March 2006.

The exploitation of the incredible mechanical and electrical properties of carbon nanotubes in precision applications such as integrated circuits and flat panel displays has been hindered by current growth techniques, which can elevate substrate temperatures to 1000 degrees C or more, resulting in damage or material compatibility issues. In contrast, the NanoGrowth tool, which is designed to deliver nanomaterial growth across areas up to three inches in diameter, employs a unique thermal control system to maintain the growth substrate at room temperature.

"The goal of this tool is to make precision carbon nanotube fabrication possible at low temperatures, together with a scale of growth area that is suitable for many high technology applications," says Ben Jensen of CEVP. "We believe it will be the first platform for making carbon nanotubes and nanowires a practical proposition in commercial high technology applications."

The equipment is a joint venture between CEVP - a leader in the provision of plasma process tools to research institutions and semiconductor manufacturers - and ATI at the University of Surrey, one of the UK's leading professional, scientific and technological universities. The partners have collaborated to develop a plasma-enhanced chemical vapour deposition (PECVD) and vacuum process that is optimised for the growth of carbon nanotubes with highly controlled properties such as density, length and position. Special control sequences are also provided to make carbon nanotubes 'flower', for large surface area applications.

The integrated thermal control system maintains the work area substrate at room temperatures during processing, allowing carbon nanotube materials to be grown with precision - even on highly heat sensitive materials such as plastic. The tool may also be used to grow related nanomaterials including doped silicon nanowires and metal oxide nanowires on suitable substrates.

"The high degree of thermal control and automation offered by this tool allows more precise control of growth parameters, for accurate and repeatable processing," says Professor Ravi Silva, Director of the Advanced Technology Institute (ATI).

Processing capability is highly programmable, providing great flexibility for research or development use. User-friendly software - a version of CEVP's field-proven SCADA (supervisory control and data acquisition) package - gives fine control over all stages of processing via graphical MIMIC-style displays. As part of the beta testing phase, ATI and CEVP will be creating generic nanotube and nanowire recipes that will be provided with the tool, which offer ready-to-use growth processes. Users will also have full manual control, and will be able to adapt these recipes, or create their own custom processes using a menu-driven user interface to control gas flow rates, voltage and current levels, RF power, temperatures, etc. Sophisticated data-logging, trending and batch tracking facilities help users to develop and document their own processes, to optimise recipes for commercial production. Remote monitoring is also possible.

The tool has also been constructed using modular design principles, which is helpful to R&D work as it facilitates customisation and upgradeability.

The University of Surrey's ATI has been active in the nanotechnology field for some eight years, working for sponsors in areas including defence. It first described its ground-breaking room temperature growth process in *Nature Materials* in 2002, and this has subsequently been patented. ATI's work since then has improved the process, and made it capable of growing material across much larger substrate areas. During the development of this tool, the collaboration with CEVP has also resulted in numerous refinements that have helped to convert the laboratory technique into a practical manufacturing process, and CEVP

is in the process of patenting these techniques.

The precision control and scale of growth offered by the new tool is expected to be of considerable use in both academic and commercial laboratories, for the development of practical nanomaterial production techniques for high technology applications. Likely applications include low-resistance nanowires in integrated circuits, semiconducting nanotubes for fabricating high performance transistors, micro-miniature heatsinks, ultra-tough polymer composites, gas sensors, and light sources for flat panel displays - which because of the lower processing temperatures could now be fabricated on low-cost soda lime glass.

More information:

NanoGrowth datasheet: www.cevp.co.uk/nanogrowth ; CEVP: www.cevp.co.uk ; ATI: www.ati.surrey.ac.uk

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Citation: World's first tool for low-temperature carbon nanotube growth starts trials (2005, November 29) retrieved 20 April 2024 from <https://phys.org/news/2005-11-world-tool-low-temperature-carbon-nanotube.html>

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