Nanotechnology may lead to more energy-efficient electronics

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Forests of carbon nanotubes can be grown in various forms. Closer inspection using an electron microscope enables you to see how individual nanotubes hold each other upright. In a transmission electron microscope it is possible to count the number of walls in individual nanotubes. The scale bar is 100 µm, 1 µm and 20 nm. Credit: Photo: Daniel Dahlin

Carbon nanotubes and graphene consist of just a couple of layers of carbon atoms, but they are lighter than aluminium, stronger than steel and can bend like spring-coils. Physicist Niklas Lindahl at the University of Gothenburg, Sweden, has been studying the unique properties of the

materials, which in future may result in improved electronics and light, strong material.

Nanotechnology could revolutionise the manufacture of new types of materials. Niklas Lindahl has studied carbon nanotubes and graphene, which are tubes and flat sheets consisting of a thin layer of carbon atoms . Their unique properties make them interesting to use in everything from composite materials in bicycles, to electronic computer components.

In his thesis, Niklas Lindahl demonstrates how carbon nanotubes can be made, and their mechanical properties. Under the right conditions, he used a carbonaceous gas to get carbon nanotubes to grow like forests, atom by atom. The "forests" consist of millions of carbon nanotubes that, despite being just a few nanometres in diameter, hold each other upright like stalks in a field of corn. The tubes, which are lighter than aluminium and stronger than steel when stretched, could be bent like spring-coils.

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Niklas Lindahl also demonstrates how membranes of graphene can be bent. Despite the fact that the membranes were made up of just a couple of layers of atoms, their bending rigidity could be determined using the

same equations as those used to calculate deformations in large steel spheres. Graphene membranes have many uses, including variable frequency generators in mobile phones, and mass sensors with the ability to measure individual atoms.

The thesis also demonstrates how similar graphene membranes can provide more energy-efficient electronics in the future. For example, suspended graphene electrodes can change the current more effectively through carbon nanotube transistors by combining both mechanical and electrical control of the current.

More information: The thesis "Nanoelectromechanical systems from carbon nanotubes and graphene" was successfully defended on 27 January at the University of Gothenburg.

Provided by University of Gothenburg