'Nano violin string' made of vibrating carbon nanotube (w/ Video)

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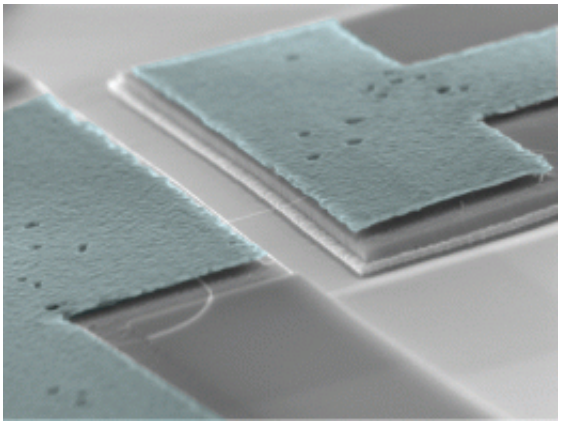

The tiny string in this electron microscope image is 800 nanometer long, which is 800 millionths of a millimeter.

Researchers at TU Delft, The Netherlands, have succeeded in measuring the influence of a single electron on a vibrating carbon nanotube. This research can be important for work such as the development of ultra-small measuring instruments. The scientists have published their results on Thursday 23 July in the online version of the scientific journal *Science*.

The scientists of the Kavli Institute for Nanoscience at TU Delft based their project on a suspended vibrating carbon nanotube, comparable to an ultra-small violin string. They then applied an alternating electric field to the nanotube using an antenna.

As a result of the alternating electric field, the suspended nanotube begins to vibrate at a certain frequency. Moreover, the nanotechnologists were able to vary the number of electrons on the nanotube. The number of electrons 'allowed' on the nanotube causes very slight changes in the vibration behaviour of the tube. Thus the frequency at which the nanotube vibrates shifts very slightly each time an electron is added. The scientists have succeeded in charting the influence of the presence of just a single electron. The entire process took place in a measurement environment that was cooled to almost absolute zero.

Suspended nanotubes vibrate at an extremely high frequency and thus exhibit new quantum effects. These suspended nanotubes thus form an interesting field of research; moreover, it has recently become possible to manufacture these items to a high quality.

In addition, the researchers of the Kavli Institute for Nanoscience in Delft have managed for the first time to capture a single electron in a carbon nanotube (this also led to a publication in *Nature Nanotechnology)*. It was made possible by a new method of making ultra-clean nanotubes.

The research being conducted at TU Delft is, apart from the acquired theoretical knowledge, also important for work such as the development of NEMS (Nano Electro Mechanical Systems). These are extremely small electromechanical systems such as tiny switches and measuring instruments. NEMS are regarded as the logical successors to the slightly larger MEMS (Micro Electro Mechanical Systems) that already constitute a sector of industry that is worth billions. These MEMS are already found, for example, in the acceleration sensors of airbags in cars. In the course of time, a breakthrough to the nano-level can be expected.

The research took place at the Kavli Institute for Nanoscience at TU Delft, headed by Prof. Leo Kouwenhoven and Prof. Herre van der Zant.

The primary author of the article in *Science* is Dr Gary Steele.

More information: Strong Coupling Between Single-Electron Tunneling and Nanomechanical Motion
G. A. Steele, A. K. Hüttel, B. Witkamp, M. Poot, H. B. Meerwaldt, L. P. Kouwenhoven, and H. S. J. van der Zant
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