Scientists from Northwestern University have demonstrated a novel carbon nanotube-based nanoelectromechanical switch. Carbon nanotubes (CNT) have been under intense study by scientists all over the world for more than a decade and are being thought of as ideal building blocks for nanoelectromechanical systems (NEMS). A type of one-dimensional structure with high-aspect ratio, carbon nanotubes have emerged as a promising material because of their many impressive mechanical, electrical and chemical properties.

Now scientists from Northwestern University have demonstrated a novel carbon nanotube-based nanoelectromechanical switch exhibiting bistability based on current tunneling. The device could help advance technological developments in memory chips and electronic sensing devices.

The research is published online by the scientific journal *Small*.

"We believe the unique characteristics of this nano device will likely lead to many high-impact applications in the field of nanoelectronics and nanosensors," said Horacio Espinosa, professor of mechanical engineering in the McCormick School of Engineering and Applied Science. Espinosa and Changhong Ke, a former graduate student of Espinosa's, co-authored the paper.

Since the invention of the integrated circuit (IC), the...
Scientists from Northwestern University have demonstrated a novel carbon nanotube-based NEMS device. The device is made of a free suspended multiwalled carbon nanotube interacting electrostatically with an underlying electrode. In the device circuit, there is a resistor in series with the nanotube, which plays an important role in the functioning of the device by adjusting the voltage drop between the nanotube and the underlying electrode.

"The design of the device looks very simple, but the theories behind it are very complex and span several disciplines, including quantum mechanics, electronics and mechanics," said co-inventor Ke, now a post-doctoral fellow at Duke University. "Also, a major advantage of our device is its geometry, which is fully compatible with current manufacturing techniques for mass production."

Espinosa and Ke demonstrated the behaviors of the device by mounting individual carbon nanotubes to the tip of a tungsten probe using a nanomanipulator inside a scanning electron microscope. Then the nanotube was actuated by applying a potential to an adjustable micron-size gap between the nanotube and an electrode. The motion of the nanotube was recorded by the electron microscope, and the current in the circuit was recorded by a source-measurement unit.

Northwestern has filed a patent application covering the concept of the bistable tunneling device and its application and is seeking commercial partners to develop applications.
the technology. The potential applications of the device include NEMS switches, random-access memory elements and logic devices.

The research was supported by the Federal Aviation Administration and the National Science Foundation.

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