NANO HIGHLIGHT
Nanomechanical Sensors Based on Carbon Nanotube Arrays

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Resonance-based sensors offer the potential of meeting the high-performance requirements of many mass-sensing applications, such as chemical or biological detection sensors. Traditional microsensors based on quartz or silicon resonators are approaching theoretical limitations, and further miniaturization of mass sensors is required to meet requirements for chemical and virus detection. Nanomechanical resonators made from carbon nanotubes may result in a new generation of sensors can be expected to meet the high-performance requirements of many sensing applications, including chemical reaction monitors, biomedical sensors, mass detectors, pressure sensors, temperature sensors and nano-accelerometers.

In the present research program, the investigators have examined the use of single and double-walled carbon nanotubes as nanosized mass sensors. Computational results show that the fundamental frequencies of cantilevered or bridged single-walled carbon nanotubes could reach the level of 10 GHz–1.5 THz, depending on the nanotube diameter and length [2]. This frequency is much higher than the highest attainable frequencies for existing nanomechanical resonators.

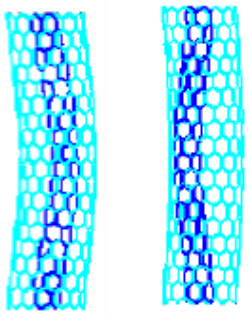

Figure 1 Vibration modes of a bridged double-walled carbon nanotube.

The fundamental frequencies of double-walled carbon nanotubes are about 10% lower than single-walled nanotubes of the same outer diameter. Noncoaxial vibration of double-walled nanotubes (Fig. 1) begins at the third resonant frequency and does not diminish the value of double-walled nanotubes as high frequency nanoresonators. The mass sensitivity of single-walled nanotube-based mass nanosensors can reach 10^{-21} gram and a logarithmically linear relationship exists between the resonant frequency and the attached mass when the mass is larger than 10^{-20} gram (Fig. 2).

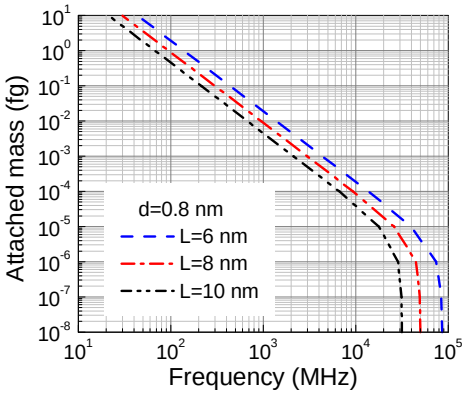

Figure 2 Frequency of cantilevered nanotube resonators versus attached mass [3].

Understanding the fundamental influence of nanotube atomic structure on their resonant properties may facilitate the nanoscale design of new sensors.

References

[1] For further information about this project email **<chou@me.udel.edu>**
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[3] C.Y. Li and T.-W. Chou. Mass detection using carbon nanotube-based nanomechanical resonators (submitted).