CARBON NANOTUBE BASED MASS SENSOR USING ATOMIC-RESOLUTION NANOMECHANICAL RESONATORS

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Introduction:

The contamination with small molecule was a main problem in vacuum microelectronics devices and hence tracking these small molecule is mandatory. The main objective of this work is to design and simulate Single Walled Carbon-Nanotube (SWCNT) based mass sensor using COMSOL Multiphysics 4.4. The frequency of the resonator changes due to mass. The fundamental frequency of SWCNT is in the range of 10 GHz-1.5 THz, which is much higher than other traditional resonators made from silicon carbide.

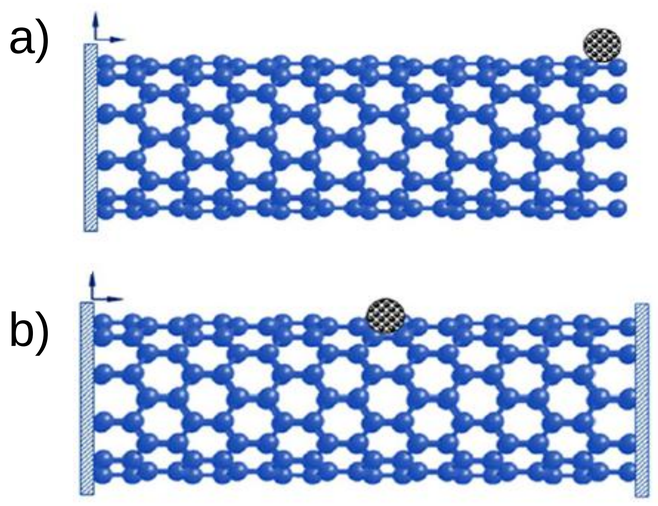

Figure 1: a) cantilever and b) bridged nanotube resonator

Computational Methods: A simple relation between the value of an attached mass and the corresponding measured resonant frequency

$$\log m = \alpha \log f + \beta \quad (m > 10^{-5}\ fg) \qquad (1)$$

Where m is attached mass, f is resonant frequency, α and β are dimensions of the tube.

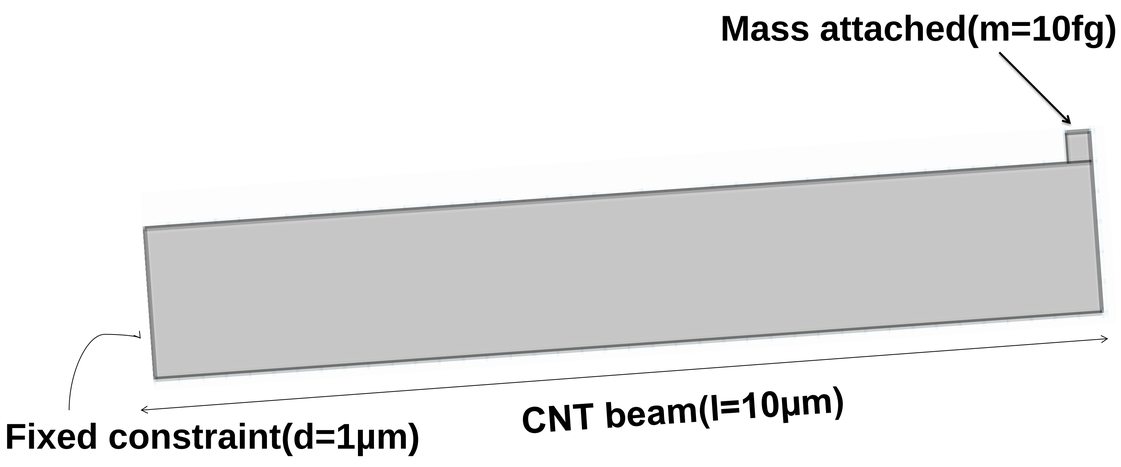

Figure 2: Cantilever based CNT sensor

Results: The results indicate that mass sensitivity of carbon nanotube-based nanobalances can reach 10^{-21} g and a logarithmically linear relationship exists between the resonant frequency and the attached mass when the mass is larger than 10^{-20} g

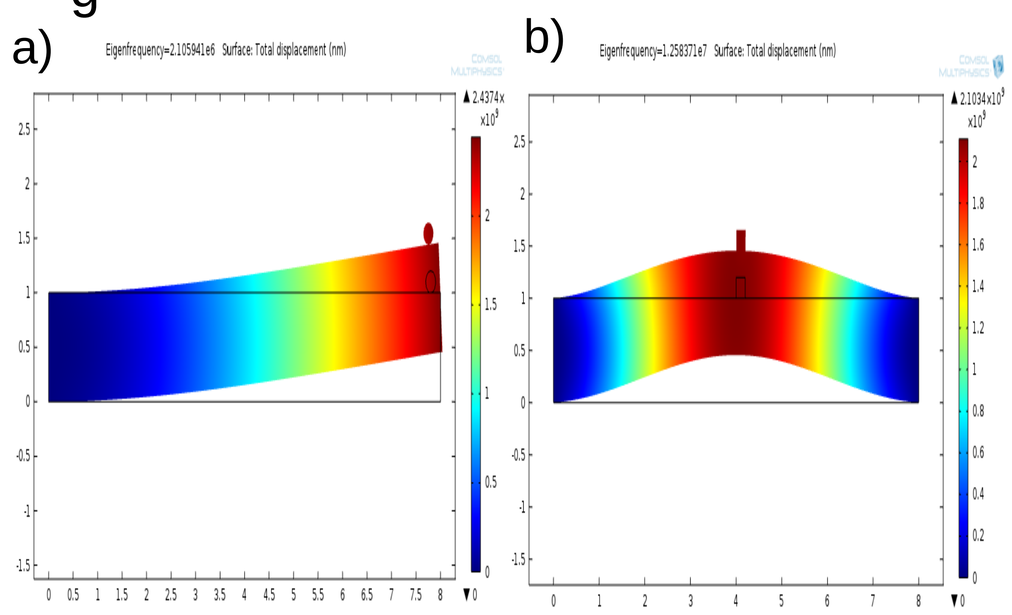

Figure 3: Displacement of a) Bridge based b) Cantilever based SWCNT

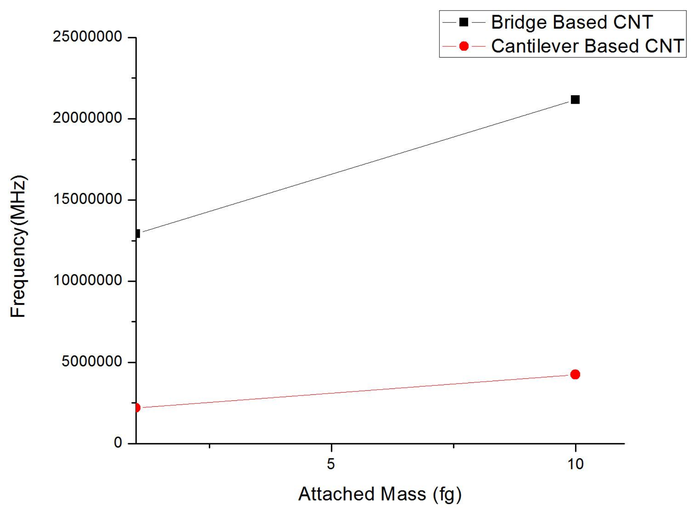

Figure 4: Fundamental frequency of bridge based and cantilever based nanotube resonators Vs attached mass.

Conclusions: MEMS technology exploits the existing microelctronic fabrication techniques to create a defect free devices. It is concluded that for SWCNT based mass sensors, Bridge based sensors vibrates at a very high frequency even for small molecules

References:

1) Ankit Gupta, Satish C. sharma "Vibration Analysis of Carbon nanotube based mass sensor using different boundary conditions" International Journal of Mechanical Engineering, vol 2, No.1, Jan 2012.
2) Chunyu Li and Tsu-wei Chou "Mass detection using carbon nanotube-based nanomechanical resonators" APPLIED PHYSICS LETTERS, volume 84, Number 25, June 2004