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Carbon Nanotube Mechanical Resonators for Mass Sensing

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We demonstrated the application of a mechanical resonantor of a nanotube cantilever to minute mass detection in vacuum and at atmospheric pressure. For a vacuum environment, a method for measuring the oscillation amplitude of a nanotube cantilever using an electron beam of a scanning electron microscope was proposed. A quality factor of ~1,000 for the nanotube resonator in vacuum was revealed and a resolution of the resonant frequency of ~10 Hz was achieved, which corresponds to a mass range of less than 100 zg at room temperature in vacuum. We also performed *in situ* measurements of densities of electron-beam-induced amorphous carbon with sizes of less than 100 nm. Furthermore, an optical detection method for detecting the vibration of nanotube resonators in air was also proposed. The motion of the nanotube resonator was detected by the fluctuation of scattered light. A higher sensitivity for the detection of the vibration was achieved by using the interference induced by multiple scattered lights. We demonstrated that a quality factor of ~40 for the nanotube resonator corresponds to a resolution of a mass range of approximately 1 ag at room temperature in air.

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