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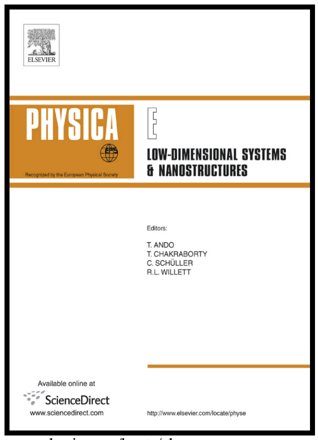

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Geometrical influence of a deposited particle on the performance of bridged carbon nanotube-based mass detectors

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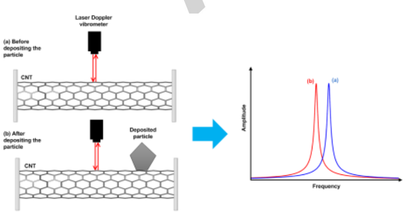
Abstract

A nonlocal continuum-based model is derived to simulate the dynamic behavior of bridged carbon nanotube-based nano-scale mass detectors. The carbon nanotube (CNT) is modeled as an elastic Euler-Bernoulli beam considering von-Kármán type geometric nonlinearity. In order to achieve better accuracy in characterization of the CNTs, the geometrical properties of an attached nano-scale particle are introduced into the model by its moment of inertia with respect to the central axis of the beam. The inter-atomic long-range interactions within the structure of the CNT are incorporated into the model using Eringen's nonlocal elastic field theory. In this model, the mass can be deposited along an arbitrary length of the CNT. After deriving the full nonlinear equations of motion, the natural frequencies and corresponding mode shapes are extracted based on a linear eigenvalue problem analysis. The results show that the geometry of the attached particle has a significant impact on the dynamic behavior of the CNT-based mechanical resonator, especially, for those with small aspect ratios. The developed model and analysis are beneficial for nano-scale mass identification when a CNT-based mechanical resonator is utilized as a small-scale bio-mass sensor and the deposited particles are those, such as proteins, enzymes, cancer cells, DNA and other nano-scale biological objects with different and complex shapes.

Graphical Abstract



Keywords: mass identification, carbon nanotubes, chiral angle, nonlocal elasticity, complex geometries, performance enhancement