Performance improvement and sensitivity of carbon nanotube-based sensors for medical applications

S. Ceballes[1] and A. Abdelkefi[1]

[1]Department of Mechanical and Aerospace Engineering, New Mexico State University, Las Cruces, 88003, USA.

In recent years, the research of carbon nanotubes (CNTs) has significantly increased due to their unique material properties. These properties can include high strength and stiffness, high thermal conductivity, and high flexibility. Specifically, for their high stiffness, CNTs are considered as target candidates in medical applications, such as the detection of cancer cells. In this application, the goal is to be able to detect and identify the mass of nanoparticles in the zeptogram range deposited on a CNT based upon a frequency shift and conversion to an equivalent mass. Because experiments in this field are time consuming, difficult, and expensive, the goal is rather to develop accurate reduced-order models that capture phenomena occurring at nanoscale and eventually lead to the detection and characterization of nanoparticles. In developing these models, several different theories, their assumptions, and challenges should be considered including beam theories, shell theories, theories in nonclassical continuum mechanics, and more. In addition, different environments should be considered to most accurately reflect experimental results, i.e. CNTs in a thermal environment. In addition, the geometry of the particle should be considered for specific cases. Considering each of these factors, the limits of applicability of various theories will be discussed, along with their corresponding assumptions and formulation. In doing so, mathematical models reflecting the true behavior of CNTs as biomass sensors can be developed, along with methods for detecting the mass based upon the inherent frequency shift.