Recent Advances in Carbon Nanotubes and Nanosensors

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ABSTRACT

In this general lecture we deal with the theoretical framework for the single-walled carbon nanotube, serving as the virus or bacterium sensor, with complicating influences of non-locality and surface effects taken into account. In many cases a virus can be identified quite accurately by its mass and details of its shape, and the particular scheme that we address in this paper is the determination of its mass by noting the change in vibrational frequency of a cantilevered carbon nanotube when the virus is attached to its tip. It is demonstrated that the complicating effects are not negligible as is often done in literature; they may influence greatly both the vibration behavior as well as the identification process of the virus or bacterium.

As Tibbals [1] writes, "nanomedicine and medical nanotechnology are taking an interesting and promising direction. The terms 'nanomedicine" and 'medical nanotechnology" have been formally established since their adoption into major program initiatives by the National Institutes of health and other leading medical bodies worldwide" (see also a book by Koprowski [2]). In this respect the contribution of nanotechnology to mitigation of serious virus outbreaks that may develop into pandemics lies, in part, in development of nanosensors, that may detect the presence of a virus. The interested readers may consult the books by Jha [3], Khanna [4] and Lim [5], for example. Current advent of nanotechnology offers several new possibilities of development of sensing possibilities with a view of detecting a virus or bacterium. Several authors utilized refined theory to describe vibrations of short carbon nanotubes, including the effects of shear deformation and rotary inertia leading to application of the refined Bresse-Timoshenko theory rather than the classical Bernoulli-Euler theory. However, at the small scale there are additional effects that ought to be taken into account. In this respect one has to mention the non-local continuum mechanics that allows one to account for the small length scale effects that become quite important when dealing with nanostructures. Considerable interest has been demonstrated recently in the application of non-local continuum mechanics for proper modeling of microbeams and nanobeams. This work gives a comprehensive review of recent developments [6-15], exposed in the monograph [16].

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