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Mathematical modelling for nanotube bundle oscillators

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Abstract

Fullerenes C60 and carbon nanotubes are of considerable interest to researchers from many scientific areas due to their unique electronic and mechanical properties. One application of these carbon nanostructures that has recently attracted much attention is the creation of an oscillator that operates in the gigahertz range frequency. A number of studies have found that the sliding of the inner-shell inside the outer-shell of a multi-walled carbon nanotube can generate gigahertz oscillatory frequencies. In this presentation, we investigate the mechanics of a gigahertz oscillator comprising a carbon nanotube oscillating within the centre of a uniform concentric ring or bundle of carbon nanotubes. Since much higher frequencies can be generated from a C60 fullerene oscillating inside a nanotube, we also consider the case of a C60 fullerene oscillating within a bundle of carbon nanotubes. Using the Lennard-Jones potential and the continuum approach, we obtain a relation between the bundle radius and the radii of the nanotubes forming the bundle, as well as the optimum bundle size which gives rise to the maximum oscillatory frequency for both the C60 and the nanotube bundle oscillators. While previous studies in this area have been undertaken through molecular dynamics simulations, we emphasize the use of applied mathematical modelling techniques which provides considerable insight into the underlying mechanisms.

Disciplines

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Mathematical Modelling for Carbon Nanotube Bundle Oscillators

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Fullerenes C_{60} and carbon nanotubes are of considerable interest to researchers from many scientific areas due to their unique electronic and mechanical properties. One application of these carbon nanostructures that has recently attracted much attention is the creation of an oscillator that operates in the gigahertz range frequency. A number of studies have found that the sliding of the inner-shell inside the outer-shell of a multi-walled carbon nanotube can generate gigahertz oscillatory frequencies. In this presentation, we investigate the mechanics of a gigahertz oscillator comprising a carbon nanotube oscillating within the centre of a uniform concentric ring or bundle of carbon nanotubes. Since much higher frequencies can be generated from a C_{60} fullerene oscillating inside a nanotube, we also consider the case of a C_{60} fullerene oscillating within a bundle of carbon nanotubes. Using the Lennard-Jones potential and the continuum approach, we obtain a relation between the bundle radius and the radii of the nanotubes forming the bundle, as well as the optimum bundle size which gives rise to the maximum oscillatory frequency for both the C_{60} and the nanotube bundle oscillators. While previous studies in this area have been undertaken through molecular dynamics simulations, we emphasize the use of applied mathematical modelling techniques which provides considerable insight into the underlying mechanisms.