Applied mathematical modelling in nanotechnology

Professor James M. Hill

Nanomechanics Group, School of Mathematics and Applied Statistics, University of Wollongong, Wollongong, NSW 2522, Australia E-mail: jhill@uow.edu.au

Abstract: In this talk we survey some recent results arising from applied mathematical modelling in nanotechnology, and in particular for the geometry and mechanics of carbon nanotubes and gigahertz nano-oscillators Fullerenes and carbon nanotubes are of considerable interest due to their unique properties, such as low weight, high strength, flexibility, high thermal conductivity and chemical stability and they have many potential applications in nano-devices. Here we present a new geometric structure for carbon nanotubes and a new approach for related nanostructures. One concept that has attracted much attention is the creation of nano-oscillators, to produce frequencies in the gigahertz range, for applications such as ultra-fast optical filters and nano-antennae. The sliding of an inner shell inside an outer shell of a multi-walled carbon nanotube can generate oscillatory frequencies up to several gigahertz, and the shorter the inner tube the higher the frequency. A C60-nanotube oscillator generates high frequencies by oscillating a C60 fullerene inside a single-walled carbon nanotube. Here we discuss the underlying mechanisms of nano-oscillators and we survey some recent results using the Lennard-Jones potential together with the continuum approach to mathematically model various types of nano-oscillators including double-walled carbon nanotubes, C60-nanotube, C60-nanotorus and carbon nanotube bundle oscillators.