

Nanomachines : From Atomic Lattice Gears to Cystic Fibrosis

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The promise of nanotechnology will be realized through the interplay of new tools and the appreciation of the lessons from biological systems. The challenge of nanomachines ranges from the understanding of the interactions between atomic scale systems to the harnessing of the force generation capabilities of biological systems. We are developing a suite of tools for nanoscale science including the combination of force measurement and manipulation systems in conjunction with scanning probe, electron and optical microscopy. For the basic elements of nanomachines, we have studied gears, springs and electrical contacts of carbon nanotubes. Through the study of carbon nanotube dynamics we have observed that atomic lattices can act like gears in promoting the rolling of nanotubes. Most recently, we have begun a study of nanotubes as torsional springs, have measured the torsional spring constants in freely suspended paddles and have observed strain hardening in individual nanotubes. Finally, biology has developed its own nanomachines and microfluidic systems that include beating cilia to produce flow and complex closed loop feedback mechanisms. We have begun to study this system within a cell culture using a new 3D manipulation system, and will discuss our early results in quantifying the forces applied by beating cilia and studies of the resulting flow.