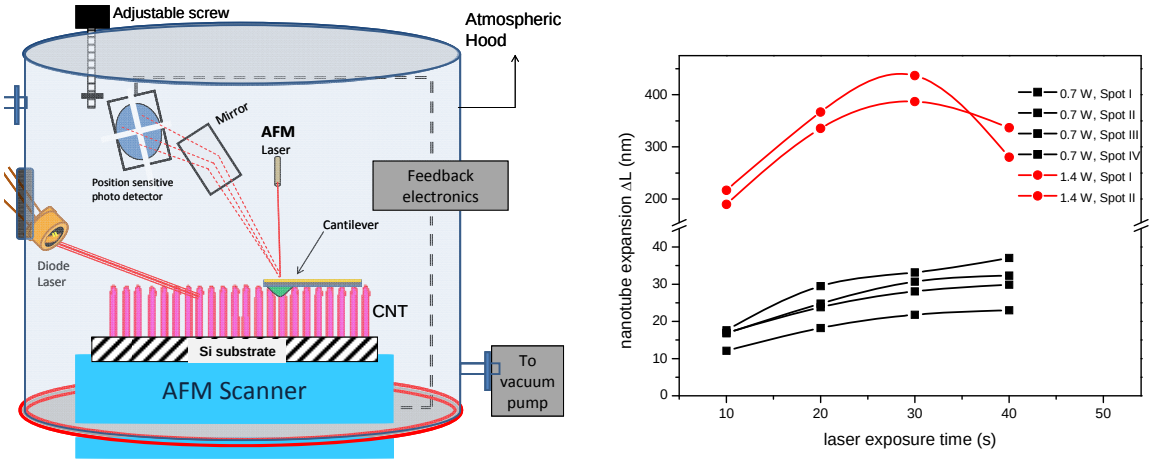
Carbon Nanotubes for Photo-Thermo-Mechanical Actuators

Nikhil Koratkar of Rensselaer Polytechnic Institute and colleagues have shown that low-power (of only a few watts), near-infrared light from a simple laser diode can be used to heat an array of aligned carbon nanotubes to temperatures in excess of 700° K. These high temperatures arise from local confinement of the heat wave in the one-dimensional nanotubes. The research team has demonstrated that the high trapped thermal energy density then causes a thermal relaxation of the nanotubes along the axial direction and can result in very large extensional strains (several percent of the tube length as shown in the figure below). Such novel thermo-mechanical nanotube actuators that can be conveniently driven by light show potential to offer order-of-magnitude larger work output and energy density than traditional actuator materials.



(Left) Schematic of photo-actuation experiment showing laser diode used to heat an aligned carbon nanotube array; the displacement and force output of the array is measured using an atomic force microscope. (Right) Real-time response of the nanotubes to the light input showing ~500 nm expansion (2.5% extension) in tube length.

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