Dimensionality, feedback and carbon nanotube thermionics

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Abstract: When a beam of light strikes a bulk conductor, the heat generated at the point of incidence dissipates into a wide area; no significant temperature increase takes place unless a very high optical intensity is used. I will discuss how the situation is different in carbon nanotube arrays: although they are understood to be good conductors, the generated heat can become trapped in them. This enables their efficient heating to very high temperatures – leading to thermionic electron emission – using a low-power optical beam, and opens the door to applications in vacuum electronics, electron-beam systems, thermionic solar energy conversion and more. We explain this "Heat Trap" effect based on the quasi-one-dimensional nature of heat transfer and the strong temperature dependence of thermal conductivity in these materials, and we have seen that this might, in fact, not be limited to nanotubes and be a property of one-dimensional systems in general. This effect also creates interesting opportunities for combining the photoelectric and thermionic phenomena. Time permitting, I will then slightly change the topic to the interaction of energetic electrons with carbon nanotubes, discuss differences and similarities with such interactions with bulk materials, and describe some of the surprises in this context and their possible applications.

Speaker biography: Alireza Nojeh received his B.S. and M. S. degrees in electrical engineering from Sharif University of Technology. His work there focused on optoelectronic modulators based on interface charge layers. He went on to receive a D.E.A. degree in electronics/optoelectronics from the University of Paris XI - Orsay, where he worked on high electron mobility transistors, and a Ph.D. degree in electrical engineering from Stanford University (2006). There, he worked on carbon nanotubes, focusing on nanoscale electron emitters. He then joined the University of British Columbia, where he is currently an associate professor of electrical and computer engineering. His research interests are still in nanotechnology, in particular in carbon nanotube devices; interaction of light with nanostructures; electron sources, vacuum electronics and electron microscopy; solid-state electronics; micro/nanofabrication; and modeling and simulation of nanoscale structures.