Nanotubes in global warming: From dynamic topology in superplasticity to hyperthermia in cancer treatment

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Two phenomena involving carbon nanotubes (NT) will be discussed. One occurs at very high temperature near 2000°C. Another takes place upon relatively minor yet biologically significant warming by just 10-50°C. Early considerations of dynamic topology of NT at high temperatures have predicted the possibility of plastic flow and quantized necking accompanied by the change of the electronic band gap. Past two years have brought spectacular experimental confirmations to those predictions, while also revealed new intriguing features of superplasticity. The glide of pentagon-heptagon defects and a particular type of their pseudo-climb, act concurrently to maintain the tube perfection, even in spite of great mass loss in sublimation [1-2]. Their dynamics disobey the Frank's rule, showing fundamental difference of dislocation theory in "non-Euclidean" 2D lattice of NT from the traditional 3D crystals.

Recently, our collaborators have discovered the ability of NT to heat up in a radiofrequency (RF) electromagnetic field, which can be used to locally induce hyperthermia to kill cancer cells and tumors [3]. One working hypothesis of RF-induced Joule heating emphasizes the role of large aspect ratio (length/diameter) and allows us to reconcile the high power deposition (<100,000 W/g of NT) with very low NT concentrations ($>10^{-5}$) in aqueous solution.

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[2] J. Huang, et al., Phys. Rev. Lett. **99**, 175503 (2007); Phys. Rev. Lett. **100**, 035503 (2008).
[3] C. Gannon, P. Cherukuri, et al., Cancer **110**, 2654 (2007).