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Carbon Nanotube Sheet- and Fiber Electrochemical Artificial Muscles

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ABSTRACT OF THE TALK

A considerable effort is being devoted to the design of processing strategies to fabricate macroscopic articles that efficiently utilize the outstanding properties of carbon nanotubes (CNTs). Thus, remarkable progress has been achieved in the fabrication of “neat” CNT sheets and fibers whose useful mechanical properties, high electrical conductivity, and porous structure result in interesting electrode materials. In this seminar the fabrication of these CNT-based electrodes and practical issues related to their use as electrochemical actuators are discussed. Stress generation values of up to 100 times those corresponding to the peak skeletal muscle of mammals have been reported for these CNT artificial muscles, which can lead to interesting developments in micro-mechanics, robotics, and prosthetics. However, serious drawbacks such as the use of liquid electrolytes and the degradation of the mechanical properties of the employed CNT electrodes need to be overcome before advanced technological applications for these artificial muscles are possible. Fulfilling the actuator capabilities of CNTs might come through the efficient utilization of recent CNT supercapacitor developments, and will require innovative solutions in materials design and device fabrication.

Bio:

Edgar Muñoz earned a PhD in Chemistry from the University of Zaragoza (Spain) for his work on laser ablation production of carbon nanotubes. In October, 2000, he joined Ray H. Baughman's group at Honeywell International (Morristown, NJ), and later at the UTD NanoTech Institute of the University of Texas at Dallas, where he worked on the preparation and optimization of carbon nanotube sheets and fibers for electromechanical actuator applications. Additionally, he was a founding member of the "nano-bio" effort at UTD. Dr. Muñoz is currently leading the Functional NanoHybrid Materials Group at the Instituto de Carboquímica of the Spanish National Research Council (CSIC), where he explores nanostructured materials and nanocomposites for electronic, electrochemical, and electromechanical applications, as well as new frontiers in solid-state chemistry involving laser-assisted processes for the rational design of multifunctional nanostructured materials.

Selected Publications

"Production of High-Density Single-Walled Carbon Nanotube Material by a Simple Laser-Ablation Method", *Chem. Phys. Lett.* (1998) **292**, 587.
"Super-Tough Carbon-Nanotube Fibres-These Extraordinary Composite Fibres can be woven into Electronic Textiles", *Nature* (2003) **423**, 703.
"Controlled Assembly of Carbon Nanotubes by Designed Amphiphilic Peptide Helices", *J. Am. Chem. Soc.* (2003) **125**, 1770.
"V_2O_5 Nanofibre Sheet Actuators", *Nature Mater.* (2003) **2**, 316.
"Fabrication and characterization of thin films of single-walled carbon nanotube bundles on flexible plastic substrates", *J. Am. Chem. Soc.* (2004) **126**, 4462.
"Highly conducting carbon nanotube/polyethyleneimine composite fibers", *Adv. Mater.* (2005) **17**, 1067.
"Gold/Carbon Nanocomposite Foam", *Chem. Phys. Lett.* (2006) **420**, 86.
"Carbon Nanotube Networks as Gas Sensors for NO_2 Detection", *Talanta (2008)* **77**, 758.
"Electrochemically tuned properties of electrolyte-free carbon nanotube sheets", *Adv. Funct. Mater.* (2009) **19**, 2266.