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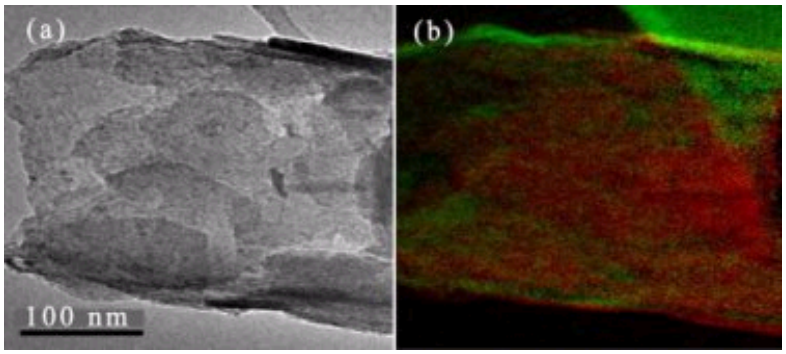
Aug 5, 2009

Coaxial cobalt-in-carbon nanotubes set optical-limiting benchmark

Carbon nanotube-metal hybrid nanostructures are being investigated for their novel optical properties. Magnetic heterostructures based on carbon nanotubes with multiple functionalities are fascinating materials, which can be manipulated by means of an external magnetic field.



Coaxial cobalt-in-carbon nanotube

The successful fabrication and use of photonic devices depends on the availability of good non-linear optical materials. Nanotubes and nanowires are attractive in this regard, because they possess a unique one-dimensional physical geometry. These one-dimensional nanomaterials are found to have a characteristic behaviour in the optical as well as in the electrical regimes, arising from their peculiar geometry. Nanotubes in general have high thermal and chemical stability, along with high electrical conductivity and a fast optical non-linearity. Carbon nanotubes can be suitably functionalized to serve as versatile one-dimensional nanostructures for various optical limiting applications.

Researchers in India and the US are studying a novel and hybrid nano system called a cobalt-in-carbon nanotube. To fabricate the structure, the team grows cobalt nanotubes co-axially inside multiwalled carbon nanotubes using electrodeposition. Testing reveals that these hybrid nanostructures exhibit enhanced non-linear optical limiting properties when benchmarked against carbon nanotubes.

The group compared the non-linear optical limiting properties of carbon nanotubes, cobalt nanotubes and cobalt-in-carbon nanotubes. Such a comparison is appropriate, because these

tubular structures will induce a similar kind of geometrical field distortion in the incident electromagnetic radiation. Moreover, the cobalt-in-carbon nanotubes exhibit interesting transmission behaviour, where effective two-photon and effective three-photon absorption non-linearities are present simultaneously.

In addition to potential applications in safety devices for sensitive optical detectors and human eyes, the multifunctional nanomaterial could find use in various other fields, such as high-power super capacitor electrodes, sensors and catalysis.

The researchers presented their work in *Nanotechnology*.

About the author

This work is the result of a joint investigation involving researchers from three institutions: Cochin University of Science and Technology, Kochi, Kerala, India; Raman Research Institute, Bangalore, India; and Rice University, Houston, Texas, US. T N Narayanan is a PhD student at the Department of Physics, Cochin University of Science and Technology under the supervision of Prof. M R Anantharaman. C S Suchand Sandeep is pursuing his PhD at Raman Research Institute under the supervision of Dr Reji Philip. M M Shaijumon was a postdoctoral fellow at Rice University and is now based at CIRIMAT-LCMIE Tolouse, France. P M Ajayan is the Benjamin M and Mary Greenwood Anderson Professor of Engineering at the Department of Mechanical Engineering and Materials Science, Rice University. Prof. M R Anantharaman is head of the Department of Physics, Cochin University of Science and Technology. This work was financially supported by Interconnect Focus Centre at Rensselaer Polytechnic Institute, Troy, New York, US, and Kerala State Council for Science, Technology, and Environment, Kerala, India.