Infrared Nanotube Films Offer Advantages for Solar Cells and More

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Researchers have found that nanotube films have very good infrared transmission that could improve the efficiency of infrared solar cells. Image credit: Royal Society of Chemistry.

(PhysOrg.com) -- Researchers have already known that carbon nanotube thin films have mechanical and conductive advantages that could make them useful as electrodes in solar cells, solid state lighting, and electronic displays. However, studies so far have focused on how well nanotube films transmit light in the visible range, but have not explored the films' infrared properties.

In a recent study, physicists Liangbing Hu, David Hecht, and George Grüner from the University of California, Los Angeles, have investigated the infrared properties of single-walled carbon nanotube thin films that are optically transparent and electrically conductive. They

found that the nanotube films have an outstanding ability for transmitting infrared waves. In experiments, nanotube electrodes and graphene electrodes outperformed various other materials in several key categories, opening up a variety of infrared applications for the nanotube films.

“This is the first time that the infrared properties of conductive CNT films are fully studied through measurement and calculations,” Hu told *PhysOrg.com*.

To fabricate the nanotube films, the scientists dispersed nanotubes in water with the help of a surfactant, and then sprayed the substance onto heated substrates to create films. When shining an infrared light on the nanotube films, the scientists found that the films maintained an average transmittance rate of more than 90% over a wide infrared wavelength range (450 nanometers - 20 micrometers).

Because of the nanotube films’ high infrared transmittance, the scientists explain that they would make poor candidates for blocking heat, but would be useful for applications that require heat dissipation. One prominent example is solar cells. Since a large portion of solar energy is above a wavelength of 1 micrometer (longer than optical wavelengths), transparent nanotube thin films could be used to capture excess heat in infrared solar cells, making the solar cells more efficient.

“One major application is the infrared solar cells, where transparent CNT films as well graphene films would allow the transmission of infrared energy to the active layer, which allows the fabrication of infrared solar cells,” Hu said.

Compared with other materials known to transmit infrared waves, the nanotube films have the lowest reflection rate (less than 10%) of those addressed in the study. This advantage means that nanotube films might

not require an antireflective coating like the others. In addition, nanotube films have high cutoff wavelengths (they transmit longer infrared wavelengths) compared with the other materials. This property could make the films especially useful for applications in the far infrared range.

The films could also serve as electrodes for a variety of industrial and military applications, such as infrared imaging, sensing, and emission, as well as modulators for fiber communications. Hu added that, in the future, the researchers plan to investigate using the films for an infrared camera.

More information: Hu, Liangbing; Hecht, David S.; Grüner, George. "Infrared transparent carbon nanotube thin films." *Applied Physics Letters* 94, 081103 (2009).