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TECHNOLOGY UPDATE

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CNT arrays for photonics

Carbon nanotube arrays could be employed in photonic devices like deep-UV photonic crystals and total visible light absorbers. So say researchers at the University of Ioannina in Greece and the University of Cambridge in the UK who have investigated the photonic properties of two-dimensional nanotube arrays.

Carbon nanotubes (CNTs) have excellent electronic and mechanical properties and so might be used in a host of applications, such as transistors, sensors, actuators and nanocomposites. They are also expected to have good photonic properties. For example, researchers have already shown that nanotubes are ideal saturable absorbers in ultrafast lasers, or nanoantennas for optical frequencies. The new work shows that regular arrays of CNTs could serve as photonic crystals too.

A photonic crystal can be thought of as a semiconductor for photons. Like its electronic counterpart, it has a photonic bandgap – a range of frequencies for which photon propagation is prohibited. "Typically, a photonic crystal consists of a periodic arrangement of dielectric material, with a periodicity that is on the order of the wavelength we want to manipulate," explained team member Elefterios Lidorikis. Until now, most research in this field has focused on near infrared and optical frequencies.

Strong Bragg scattering

Lidorikis and colleague Andrea Ferrari have now performed the first theoretical study of full photonic bandgaps in periodic arrays of aligned CNTs. In particular, the researchers studied the photonic response of 2D multiwalled nanotube square arrays under transverse magnetic polarized light – that is, when the CNTs are illuminated with polarized light along their lengths. The duo found strong Bragg scattering when the nanotubes in the array were spaced between about 20 and 30 nm apart and photonic band gaps appeared in the deep-UV range of around 25 to 35 eV.

According to the duo, the finding means that all types of light manipulation in photonic crystals in the visible part of the electromagnetic spectrum (such as light localization, spontaneous emission inhibition, light guidance and manipulation, super-lensing and meta-materials exhibiting negative refraction) could potentially be applied to the deep-UV range too using MWNT arrays.

Exploiting light absorption

"At visible frequencies MWNTs absorb light and are thus no good for making photonic crystals," Ferrari told *nanotechweb.org*. "However, this high absorptivity can be exploited to design a new material, which instead of having a photonic band gap that reflects all light, exhibits a photonic absorption band that totally absorbs all incident optical light."

Such behaviour could also find use in solar collectors, he adds.

The work was published in *ACS Nano*.

About the author

Belle Dumé is contributing editor at *nanotechweb.org*