NANO HIGHLIGHT
Antenna Effect in Arrays of Aligned Carbon Nanotubes

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In recent years arrays of vertically aligned multi-walled carbon nanotubes (MWCNTs) have been synthesized on various substrates using the plasma-enhanced chemical vapor deposition (PECVD) process.2 Such arrays are particularly attractive for the development of nanoscale devices, such as field-emission displays and nanoelectomechanical devices and sensors.

In a nanotube array, each nanotube is like a tiny metallic rod 50 nm in diameter and 200–1000 long. For antennas, the highest efficiency occurs at antenna lengths that are similar in length to the incoming radiation. A unique consequence of their small size is that nanotubes can interact with wavelengths in the spectrum of visible light, and therefore it is possible to send and receive light waves just like a radio. We have demonstrated for the first time the antenna effect for light.

Figure 1a shows an aligned array of multi-walled carbon nanotubes. In Figure 1b we see the length of the carbon nanotubes after scratching the surface of the aligned array. On average, each nanotube is about 400 to 800 nm long, depending on the location on the sample. Because of wavelength matching of the nanotubes, we can, quite literally, see the optical antenna effect as shown in Figure 2. The colors in the sample are the radiation from nanotubes. Here, light has matched with the length of nanotubes and excites electrons inside the nanotube.

This type of device may have wide-ranging applications in high-efficiency solar energy conversion and optical computing. This discovery has generated significant media attention, including reports by CNN, MSNBC, ABC, Nature, and Science News.

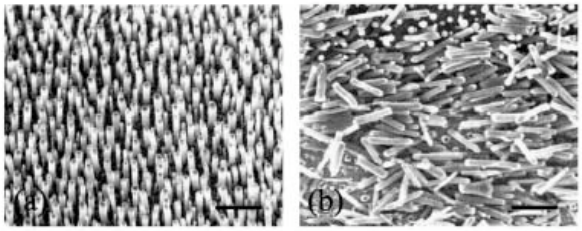

Figure 1: Aligned (a) and scratched (b) random arrays of carbon nanotubes – scale bar equal to one micron.

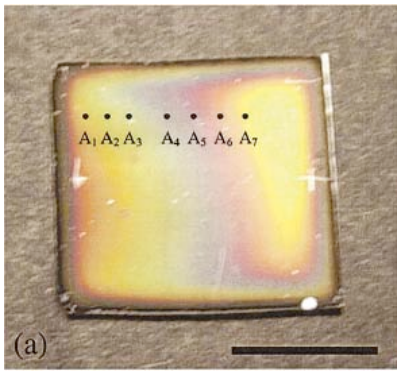

Figure 2: Interference colors from nanotube array. Scale bar equal to 1 cm.

References

[1] For further information about this project link to **<http://www.me.udel.edu/chou/nirt>**
[2] Ren ZF, Huang ZP, Xu JW, Wang JH, Bush P, Siegal MP, Provencio PN, "Synthesis of large arrays of well-aligned carbon nanotubes on glass," *Science,* 282(5391): 1105-1107 (1998).
[3] Wang Y, Kempa K, Kimball B, Carlson JB, Benham G, Li WZ, Kempa T, Rybczynski J, Herczynski A, Ren ZF "Receiving and transmitting light-like radio waves: Antenna effect in arrays of aligned carbon nanotubes," *Applied Physics Letters,* 85(13): 2607-2609 (2004).