Carbon Nanotube based Variable Frequency Patch-Antenna

Tech ID: 32191 / UC Case 2007-540-0

BRIEF DESCRIPTION

Researchers at UCI have developed a patch antenna constructed from carbon nanotubes, whose transmission frequency can be tuned entirely electronically. Additionally, the antenna can be made operable in the microwave to visible frequency regime by simply varying the device dimensions and composition.

FULL DESCRIPTION

Patch antennas are flat, rectangular antenna arrays often used in portable wireless devices due to their low profile and straightforward fabrication. Typically, they consist of small rectangular sheets (“patches”) of metal mounted on top of larger metal sheets, called ground planes. Together, these metal plates form a resonant transmission line which transmits waves approximately twice the length of the antenna. In this way, such patch antennas are constructed to transmit only one frequency efficiently. In addition to fixed transmission frequencies, typical patch antennas are also limited in terms of their radiation, with the resonant frequency radiated nearly isotropically from the surface of the device. Patch antennas are most commonly used to transmit microwave frequencies, which puts average device sizes on the order of a few centimeters. Though they have promising applications in the visible range, most notably in solar cells and windshield technology, patch antennas have found much more limited use here due to their low optical transparency.

To overcome these limitations, researchers at UCI have developed a novel patch antenna with patches constructed from dense networks of semiconducting carbon nanotubes (CNTs) rather than metal sheets. The CNTs offer several advantages over the standard metal patches, most notably that the antenna properties can be tuned entirely electronically. Here, the resonant frequency of the antenna can be controlled by varying the back-gate voltage applied across the device. Depending on the back gate applied, the conduction in sections of the patch antenna can be turned “off” (reducing the effective antenna size) or “on” (increasing size), thus tuning the resonant frequency the antenna transmits. This biasing of back-gate electrodes also can be used to control the direction of radiation of the antenna. Finally, researchers posit that the antenna can be made entirely transparent in the visible regime by tuning the thickness of the CNTs and the chemical composition of the metallic ground plane. This would allow the CNT patch antennas to be used in devices ranging from the microwave to the visible regime, a feat not currently possible under any other method.

SUGGESTED USES

» For applications in wireless and portable electronic devices
» For the variable transmission of radio or visible frequencies in devices

FEATURES/BENEFITS

» Simple construction: Antenna are made from dense arrays carbon nanotubes deposited onto metal sheets, which are straightforward to fabricate.
» Variable: The resonant frequency and direction of radiation of the antenna are controlled entirely electronically.
» Broad: Based on the thickness of the nanotubes and the chemical composition of the underlying metal sheet on which they reside, the antenna can be constructed for use from the microwave to visible regime.

PATENT STATUS

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CATEGORIZED AS

» Optics and Photonics
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KEYWORDS
Carbon, Nanotube, Frequency, Variable, Patch, Antenna, Transmission, Microwave, Portable, Electronic, Resonant, Direction, Electronically, Patch, Antenna, Rectangular, Array, Wireless CNT, Semiconductor, Back-Gate Voltage, Transparent, Metallic, Optic