Thin-Film $LiNbO_3$ Pyroelectric Detectors Coated with Multiwalled CNTs Enhance Sensitivity

The current generated by a pyroelectric detector is inversely proportional to its thermal mass. Therefore, a practical limit for building more sensitive pyroelectric detectors is imposed by conventional lapping and polishing of the detector plate. Thin-film pyroelectric detectors fabricated by crystal ion slicing show higher sensitivity than those prepared by conventional lapping and polishing while maintaining the pyroelectric properties of the bulk material. By coating the detectors with a low mass thermal absorber, such as carbon nanotubes (CNTs), the sensitivity of the devices can be further enhanced, with a uniform spectral responsivity. J.H. Lehman and K.E. Hurst from the National Institute of Standards and Technology, Colorado, A.M. Radojevic from The Charles Stark Draper Laboratory, Mass., A.C. Dillon from National Renewable Energy Laboratory, Colorado, and R.M. Osgood Jr. from Columbia University, New York, reported such improvements in this type of pyroelectric detector when compared to a nickel-coated detector, in the April 1 issue of *Optics Letters* (p. 772).

The detector consisted of a 10-µm thick freestanding film of $LiNbO_3$, fabricated by crystal ion slicing by bombardment of the parent material with high-energy helium ions. The detector film is separated by acid etch or thermal shock at a depth where the ions run out of momentum. The film is then coated with 250-nm thick nickel electrodes on each face and packaged as a freestanding detector. The researchers coated the freestanding detector with a 5–10-µm thick layer of commercially available multiwalled CNTs (MWNTs) by spraying it with a dispersion of 0.33 g of these nanotubes in 13.4 ml of chloroform by an airbush technique. MWNTs were chosen over single-wall CNTs (SWNTs) to avoid the spectral features characteristic of interband transitions of metallic and semiconducting materials, which SWNTs readily exhibit.

The MWNT-coated detector, black due to the optical properties of the individual tubes and the topology of the bulk, appeared like "a mat of bundled ropes with various clumps interspersed" under the scanning electron microscope. The clumps are believed to be catalyst metals and non-nanotube carbons. The MWNT coating is attached to the electrode surface by van der Waals forces and by interactions with pi electrons in the orbital perpendicular to the axis of the tubes. The coating is robust: it can be scratched with a rigid stylus, but it is not removed by forced air or water. The increase in spectral responsivity of the MWNT-coated detector is about four times over the spectral region from 600 nm to 1800 nm compared to a Ni-coated detector, with minimal penalty to the frequency response. According to the researchers, the enhanced performance, along with the facile and inexpensive application of the coating, is immediately achievable and is promising for other types of radiometric detectors and thermal detector arrays.

JOAN J. CARVAJAL

Superconductivity and Relativity Meet in a Monolayer of Graphene

Until recently, superconductivity and the theory of relativity had very little to do with each other. However, H. Heersche, P. Jarillo-Herrero, and their colleagues at Delft University of Technology's Kavli Institute for Nanoscience and the FOM Foundation have detected superconducting properties in a material "in which charge carriers behave as massless chiral relativistic particles." Their device—which consists of graphene attached to superconductors—also functions as a bipolar transistor for superconducting currents.

As reported in the March 1 issue of *Nature* (p. 56; DOI: 10.1038/nature05555) the researchers attached graphene to oxidized silicon substrates by mechanical exfoliation. They inspected the samples with an optical microscope to determine the thinnest graphene flakes, and then used electron beam lithography to fabricate metal contacts. The superconducting contacts are formed from a Ti/Al bilayer (10/70 nm thick, see Figure 1). In a superconductor, the electrical resistance completely disappears at very low temperatures. This means that an electrical current can continue to flow without a voltage being applied, known as a supercurrent. When graphene—which itself has no superconducting properties—is joined together with a superconductor, it can behave like a superconductor. This effect has been identified in many other nonsuperconducting materials and is known as the Josephson-effect. The researchers at Kavli Institute were able to measure the relativistic Josephson effect. They observed the quantum Hall effect (QHE) and demonstrated that the QHE can be used to identify single-layer devices even in mesoscopic samples.

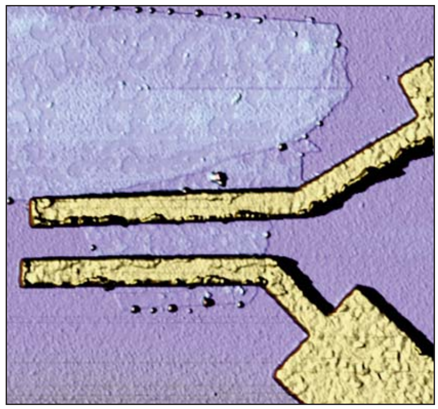

Figure 1. Image of a layer of graphene attached to superconductors, captured with an atomic force microscope. The distance between each of the superconductors is 300 nm.

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