National Aeronautics and Space Administration

NASA Langley's

Decorated Carbon Nanotubes

For novel materials with tailorable electrical properties

NASA Langley has created a new class of materials based on depositing nanometer-sized metal particles onto carbon allotropes. The method is scalable and relatively simple, and allows for control over the size and distribution of the metal particles in the substrate, adjusting the surface area to optimize specific thermal or electrical properties of the material. One promising nanocomposite material created consists of multi-walled carbon nanotubes (MWCNTs) decorated with metal particles dispersed in a polymer matrix. Ribbons, tubes, and moldings of the nanocomposite were found to have novel intrinsic electrical characteristics that enable tunable dielectric constants with low loss factors. The decoupling and independent control of the two fundamental parameters offer a class of materials with the potential for finely tailored electronic properties. The novel methods enable materials that show promise for a variety of applications in electronics, communications, catalysis, and optics.

Benefits

- Increased control and customization of thermal, mechanical, or electrical properties (e.g., increased bandwidth, enhanced gain, improved radiation patterns), compared to current technology
- Ability to decouple dielectric constant from loss factor
- Smaller antennas possible because of higher energy
- Wide applicability to a variety of metal and carbon allotropes
- Uncomplicated processing: readily available compounds and standard lab equipment used, no reducing agent required

partnership opportunity

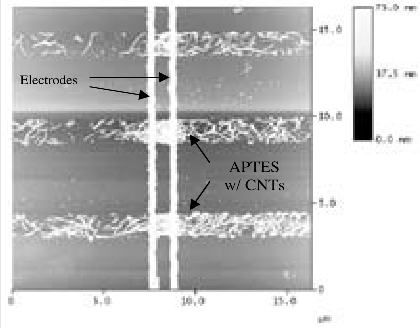

Figure 1: Applied field alignment of SWCNTs between electrodes and located only within the patterned locations

Applications

The technology has multiple applications in the general area of improving the thermal or electrical properties of polymeric materials and as catalysts for chemical reactions. Specific uses include:

- All-dielectric antennas, including low mass ultra-thin micro strip antennas with enhanced performance characteristics (early results indicate a 10% bandwidth increase is achievable)
- Fractal antennas for cell phones, low-profile substrates for high frequency electronics
- Radio frequency identification (RFID) antennas
- Improved thermal conductivity of polymeric materials as emitters
- Higher power (lower volume) capacitors
- Low-loss battery components
- Membrane electrode assemblies
- Complementary metal-oxide-semiconductor (CMOS) technology – materials for High-K gate dielectrics
- Catalysts for a variety of chemical reactions

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

The Technology Gateway

National Aeronautics and Space Administration

Langley Research Center
Mail Stop 218
Hampton, VA 23681
757.864.1178
LARC-DL-technologygateway@mail.nasa.gov
technologygateway.nasa.gov

www.nasa.gov

Vol 1, Issue 50
NP-2008-04-77-LaRC

The Technology

NASA's technology is a process for depositing nanometer-sized metal particles onto a substrate in the absence of aqueous solvents, organic solvents, and reducing agents, and without any required pretreatment of the substrate. It involves first mixing carbon and an organometallic compound (silver, gold, platinum, palladium, cobolt, nickel) at specific concentrations followed by a thermal treatment. The resulting materials are novel structures that consist of the carbon allotrope with zero valence metallic particles distributed on the surface of the carbon allotrope. In the case of the antenna application, the conducting elements are placed directly into the substrate. Other applications such as catalysts for chemical reactions and polymerizations are possible. The technology is described in patent application 20070292699.

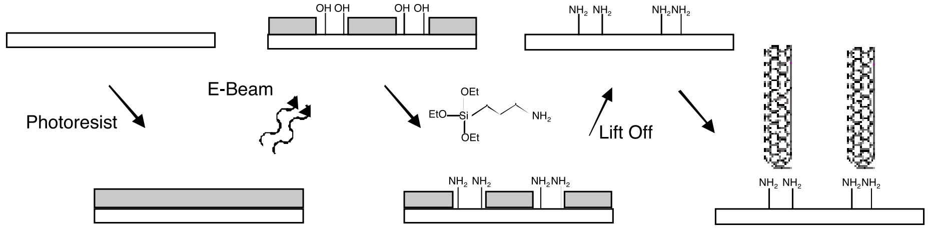

Figure 2: Lithographic patterns are created in e-beam photoresist. Amino terminated groups are then deposited into nanotube attracting patterns. The remaining photoresist is removed, nanotubes are deposited with the applied field present, and the excess nanotubes are lifted off.

LAR-17267-1, LAR-17427-1, LAR-17638-1