

# NASA Langley's Tailored Dielectric Materials

With Metal and Metal Oxide Nanoparticles

NASA Langley has developed a novel method of depositing metal and metal oxide nanoparticles onto various substrates (see ACS Nano, 3(4), 871–884 [2009]). It is rapid, scalable, and green since it does not require reducing agents or solvents. The process involves first mixing and then heating a metal salt (usually an acetate) with the desired substrate. Heating can be done by conventional thermal or microwave ovens. Conventional thermal processing takes several hours and requires an inert atmosphere, usually nitrogen. With microwave heating, the process is complete in a matter of seconds. The metal or metal oxide nanoparticles have potential use in electromagnetic applications. The nanoparticles have been evaluated for electromagnetic properties at high frequencies for potential antenna applications (S. Ghose, et al. SAMPE Electronic Conference Proceedings, [2009]).

## 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 for a variety of metal salts and substrates
- Uncomplicated processing: readily available compounds and standard lab equipment used, no reducing agent required

partnership opportunity



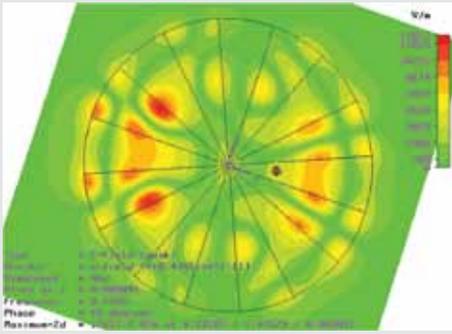


Figure 2: The NASA method was used to produce these fractal and geometric patterns of metal nanoparticles on antenna substrates

## Applications

Tailorability of the materials allows for innovation of new products:

- Low-mass, ultra-thin microstrip antennas with enhanced performance
- Fractal antennas for cell phones
- Radio frequency identification antennas
- Very thin, low-profile substrates for high frequency electronics
- Higher capacity low-volume capacitors
- High-Q dielectric resonators useful in high frequency oscillators and filters
- New anode/cathode materials for efficient low-resistance, low-loss battery components
- Components of various multifunctional material systems, particularly as materials for High-K gate dielectrics in complementary metal-oxide-semiconductor (CMOS) technology

## 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:

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## The Technology

NASA's technology involves the development of tailorable dielectric materials by the deposition of metal nanoparticles on carbon nanotubes using a solvent-free method. The novel materials consist of aligned nanotubes decorated with nanometer dimension metal particles distributed in a polymer matrix. The tailorable complex permittivity parameters allow for an increased dielectric constant ( $\epsilon'$ ) with a decreased loss factor ( $\epsilon''$ ) (Figure 1). In addition, varying the amount of metal particles attached to the substrate surface can control the disconnection between the dielectric constant and the loss factor. The decoupling and independent control of these fundamental electrical material parameters afford a class of materials useful in a variety of applications in electronics, electromagnetics, and microwave engineering, with potential future applications in the optical frequency regime. Specific applications include the fabrication of fractal and geometric patterns (Figure 2) in antenna substrates, thereby improving antenna performance. The technology is described in patent application 20090022977, US Patent 7,704,553, and in NASA disclosures LAR-17638-1 and LAR-17427-1.

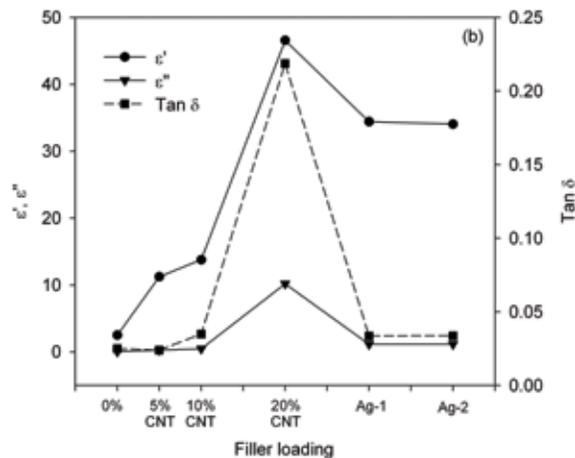


Figure 1: Dielectric constant and loss factor values as a function of filler loading for nanoparticle/substrates made with the NASA method



LAR-17427-1, LAR-17638-1