National Aeronautics and Space Administration

NASA Langley's

Carbon Nanotube-based Sensors

Expertise in manipulating carbon nanotube-based sensors for structural health monitoring

NASA Langley researchers are expert at producing carbon nanotube (CNT)-based sensors for structural health monitoring (SHM). The sensors can be embedded in structures of all geometries to monitor conditions both inside and at the surface of the structure to continuously sense changes. Having accumulated a body of knowledge on how to deposit and align CNTs, NASA is adept at manipulating the CNTs into specific orientations to create small, powerful, and flexible sensors. One of the sensors created by NASA is a highly flexible sensor for crack growth detection and strain field mapping that features a very dense and highly ordered array of single-walled CNTs. NASA is seeking companies that are interested in licensing technology or engaging NASA in joint research in the area of CNT sensors.

Benefits

NASA's CNT structural health monitoring sensors:

- Can be mass produced
- Are inexpensive
- Can be packaged in small sizes (0.5 micron2)
- Require less power than electronic or piezoelectric transducers
- Produce less waste heat per square centimeter than electronic or piezoelectric transducers

partnership opportunity

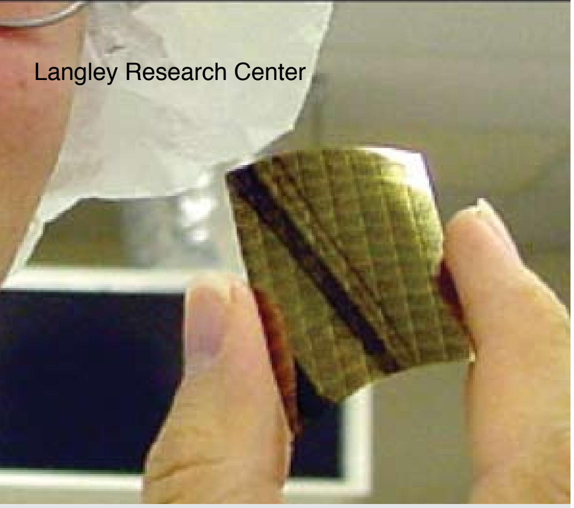

Figure 1: Schematic of a wing leading edge test article showing location of pressure sensors

The Technology

Global, real-time structural health monitoring systems for air and space vehicles require new strategies for the development of extremely small and lightweight sensors that are embeddable and scalable to arrays. Geometries with very thin regions (e.g., leading edges), sharp changes (e.g., wing/fuselage junctions) or areas of extremely high curvature are often impossible to instrument. NASA solves this issue with a flexible CNT-based structural health monitoring sensor for measuring the induced strain, pressure, and temperature both within and at the surface of a structure—an attractive candidate for "smart skin" technologies.

NASA's process for the deposition and alignment of CNTs onto metallic electrodes uses chemically functionalized lithographic patterns. This method consistently produces aligned CNTs in the defined locations. Using photo- and electron-beam lithography, NASA patterns simple Cr/Au thin film circuits on oxidized silicon substrates. The samples are then re-patterned with a CNT-attracting self-assembled monolayer of 3-aminopropyltriethoxysilane (APTES) to delineate the desired CNT locations between electrodes. During the deposition of the solution-suspended, single-wall carbon nanotubes, the application of an electric field to the metallic contacts causes alignment of the CNTs along the field direction.

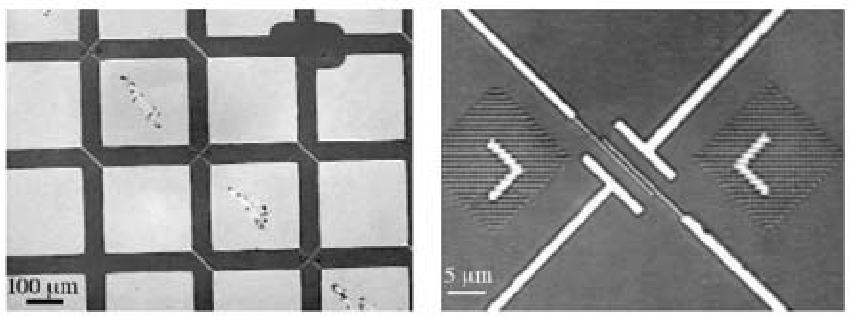

Figure 2: Optical micrograph of CNT alignment sample. Left figure shows section of three junctions from upper left to lower right corner. Square grid in the micrograph deposited through UV lithography using 100 mesh TEM grid mask. Finer features deposited through electron beam litohgraphy. Right figure displays close-up view of single junction.

Applications

The technology enables improved products for a variety of commercial and military applications:

- Civil structures: CNT sensors embedded in bridges, roads, tunnels, and other structures to monitor strain, wear, and tear
- Turbines: crack growth monitoring
- Aerospace structures: smart skin to monitor strain, pressure, and temperature conditions; monitor fatigue and exposure both inside and at the surface of the aircraft skin

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

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