
Image credit: NASA

National Aeronautics and
Space Administration

TECHNOLOGY SOLUTION

Electrical and Electronics

All-Organic Electroactive Device

High performance electroactive device using novel single-wall carbon nanotube film electrode

NASA's Langley Research Center offers you an all-organic electroactive device system fabricated with single-wall carbon nanotube (SWCNT). The enhanced design offers higher electroactive performance in comparison with conventional electroactive device systems fabricated with metal electrodes or other conducting polymers. The new structure allows for significant improvement of the electroactive strain due to relief of the constraint on the electroactive layer. It exhibits superb actuation properties and can withstand high temperatures with improved mechanical integrity and chemical stability. In addition, the electroactive device can be made transparent, allowing for use in optical devices. NASA is seeking development partners and potential licensees.

BENEFITS

- Superb electroactive performance
- Good thermal stability
- Transparency
- All-organic construction
- Flexibility and toughness
- Functional over a broad range of temperatures and frequencies
- Lightweight

APPLICATIONS

The technology has several potential applications:

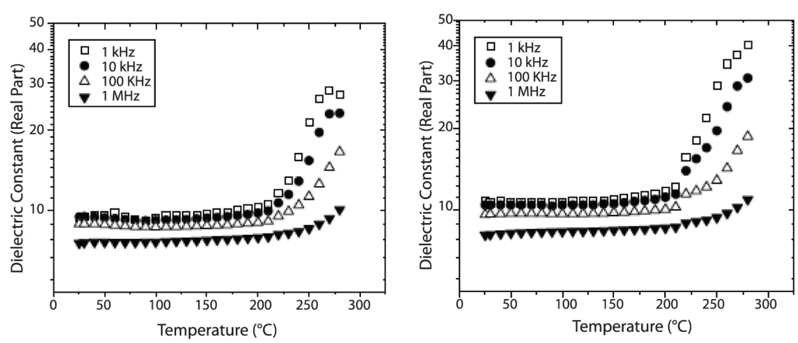
- Optical devices - switches and modulators
- Electromechanical energy conversion - sensors and actuators
- Medical devices - prosthetics, artificial muscles, artificial diaphragms and valves, active Braille displays, and chiropractic patches
- Engineering - reduced vibration and noise control due to flexibility of material
- Sonar
- Transducers

THE TECHNOLOGY

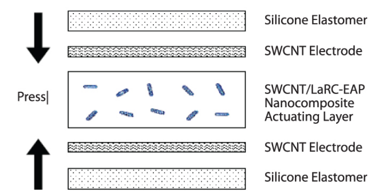
NASA Langley developed a novel all-organic actuator with SWCNT film electrode because commonly used metal electrodes such as silver and gold tend to constrain displacement (elongation or contraction) of an electroactive polymer at the interface. The actual output strain of the metal devices is smaller than what they can intrinsically provide. Many alternative electrode materials that could relieve the strain of movement, such as conducting polymers, have been proposed, but they are usually not thermally stable enough for most applications.

The innovation is the new method for creating the all-organic flexible SWCNT film electrode, which has high conductivity and good thermal stability. SWCNTs are first dispersed into a solution and then filtered onto the surface of a porous anodized alumina membrane to form a SWCNT film. The SWCNT film is separated by breaking the brittle alumina membrane and delaminating the film. Adjusting the concentration and quantity of SWCNT solution used allows for a wide range of width and thickness for SWCNT films. The SWCNT film has the potential to be made thin enough to be transparent.

The SWCNT film is then used to form the all-organic electroactive device system that can be used as an actuator. An electroactive polymer (LaRC-EAP) sandwiched by the SWCNT electrodes is fabricated by pressing the layers together at 600, 3000, and 6000 psi. By controlling the fabrication pressure, the level of physical properties, which can match with the electroactive polymers, can be adjusted and tailored appropriately.



The dielectric constant of (left image) SWCNT/LaRC-EAP nanocomposite with SWCNT electrodes and (right image) SWCNT/LaRC-EAP nanocomposite with metal electrodes as a function of temperature and frequency. Image credit: NASA



Schematic diagram of preparing an all-organic actuator (cross-section view). Image credit: NASA

PUBLICATIONS

Patent No: 9,579,867; 10,124,569

All-Organic Actuator Fabricated with Single Wall Carbon Nanotube Electrodes, Jin Ho Kang, Cheol Park, Sharon E. Lowther, Joycelyn S. Harris, and Chan Eon Park, Journal of Polymer Science - Part B: Polymer Physics, Vol. 46, Issue 23, January 1, 2008, https://ntrs.nasa.gov/citations/20090026514

More Information

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NP-2014-09-1214-HQ

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LAR-17455-3, LAR-17455-4, LAR-TOPS-48