

# Carbon Nanotube Composite For Use In Conductive MEMS Devices (2016-031)

Provides safer substitute for silicon in conductive microelectromechanical devices and electronics

## Market Overview

This composite, made of multi-walled carbon nanotubes (MWNT) and cellulose nanocrystals (CNC), provides a safer substitute for silicon in microelectromechanical system (MEMS) devices. The global MEMS market was \$11.9 billion in 2015, and is expected to grow to \$18 billion by 2020 due to increased interest in wearable technology and the automotive industry. Traditionally MEMS devices are made out of doped-silicon. However, the use of doped-silicon poses safety, economic and environmental hazards due to high energy costs, particle waste left in the air and use of harmful chemicals in the manufacturing process. To provide a safer alternative, Clemson University researchers have developed a composite film that lowers environmental and health concerns while maintaining the necessary electrical conductivity of the film for MEMS device production. By combining the outstanding strength and biocompatibility of cellulose nanocrystals with the stiffness, strength and electrical properties of carbon nanotubes, a safer alternative is achieved.

## Technical Summary

This biocompatible composite was created by preparing an aqueous mixture of CNC and MWNT. CNC is used due to similar mechanical properties and surface chemistry to silicon, and can be manufactured into MEMS devices by photolithography. MWNT provide high conductivity, strength, and stiffness to the composite. The aqueous mixture is sonicated to create a uniform dispersion, which is processed into a film by blade coating. The addition of MWNT to CNC is shown to greatly increase the elastic modulus and conductivity. The composite exhibits anisotropic properties, where the conductivity is sufficient for static charge dissipation in the semiconductive range in the machine direction.

### Application

MEMS device manufacturing

### Development Stage

Proof of Concept

### Advantages

- Utilizes carbon nanotubes added to cellulose, creating a composite with a conductivity at the semiconductor level
- Provides film with anisotropic properties, providing increased utility compared to current silicon based MEMS devices
- Eliminates need for silicon in the MEMS manufacturing process, reducing workplace and environmental hazards

App Type	Country	Serial No.	Patent No.	CURF Ref. No.	Inventors
Provisional	United States	NA	NA	2016-031	Dr. Christopher Kitchens, Mingzhe Jiang, Byron Villacorta

## About the Inventor



### Dr. Christopher Kitchens

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He earned his Ph.D. in Chemical Engineering from Auburn University. Prior to joining Clemson faculty, Dr. Kitchens was a Postdoctoral Researcher of Chemical and Biomolecular Engineering at Georgia Institute of Technology. His research interests involve advanced materials development for technological advancement in the fields of nanotechnology, renewable resources, membranes and smart materials.

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