Clemson University Research Foundation

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.

Application

MEMS device manufacturing

Stage of Development

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

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 semi-conductive range in the machine direction.

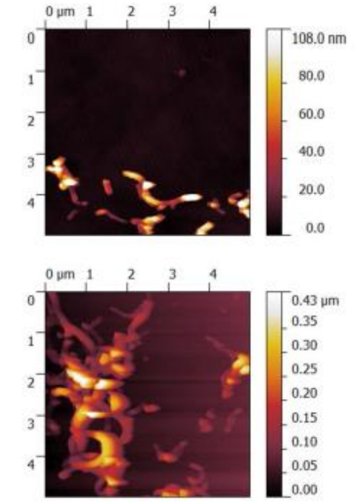

Figure 1: Atomic Force Microscopy (AFM) micrographs of MWNT

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

About the Inventor

Dr. Christopher Kitchens is an Associate Professor of Chemical and Biomolecular Engineering at Clemson University. He earned his Ph.D. in Chemical Engineering from Auburn University and completed his post-doctoral studies at the Georgia Institute of Technology. Dr. Kitchens holds three issued patents related to microdevices and methods to manufacture them. His research interests focus on the design of advanced materials for efficient and clean energy application through development in renewable resources, membranes, and nanotechnology.

For More Information

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