Renewable, Biocompatibe MEMS Devices Made From Cellulose (2013-015)

Cellulose-based films replace silicon in MEMS devices for a safer, cost-effective alternative

Market Overview

This cellulose-based film offers a more environmentally friendly and cost-effective alternative to silicon for microelectromechanical systems (MEMS). To date, silicon has been the material of choice for MEMS devices, with a current market of $14 billion that is expected to grow to $20 billion by 2020. However, silicon MEMS have significant disadvantages. Silicon is facing increasing supply constraints and is generally regarded as expensive and environmentally detrimental due to energy intensive processing with harsh chemicals. To overcome the disadvantages of silicon, Clemson University and Auburn University researchers collaborated to develop cellulose films as an alternative material for MEMS devices and sensors. Films derived from cellulose are considered an environmentally friendly alternative to traditional MEMS materials based on the benign nature of the material, similarities in surface chemistry to that of hydrophilic silicon oxide and similar mechanical properties to that of silicon.

Application

MEMS, sensors, consumer electronics, defense and communications

Stage of Development

Proof-of-concept

Advantages

- Requires less energy for production, decreasing manufacturing costs
- Reduces the use of harsh chemicals, providing a safer alternative to silicon
- Uses abundantly available, biocompatible materials, reducing environmental impact while decreasing production costs

Technical Summary

Cellulose is a naturally abundant, renewable, and biodegradable material. Cellulose nanocrystal (CNC) films can be fabricated into MEMS devices with novel properties using simple fabrication techniques. With reduced process temperatures ranging from 25-80^{o}C and the use of solvents such as isopropanol to replace hazardous reagents, CNC films are lower cost and greener than silicon. Additionally, CNC MEMS combine the advantages of silicon and polymer MEMS while also providing new potential functionalities. This approach has more desirable physical properties (e.g., intrinsic elastic modulus and thermal stability) then polymer materials and can be processed using conventional lithography and wet etching techniques (unlike polymers).

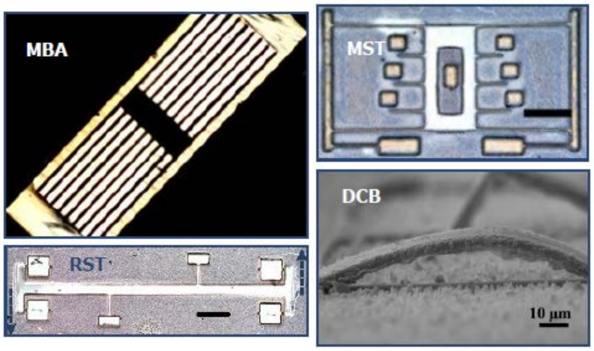

Figure 1:Numerous functional MEMS devices have been created and demonstrated, including microcantilever beam arrays (MBA), mechanical strength testers (MST), residual stress testers (RST), doubly clamped beam arrays (DCB), and circular diaphragm resonators.

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App Type	Country	Serial No.	Patent No.	CURF Ref. Number	Inventors
Utility	United States	13/963,709	9,353,313	2013-015	Christopher Kitchens, William Ashurst, Virginia Davis

About the Inventor

Dr. Christopher Kitchens is an Associate Professor of Nanotechnology, Surface Science and Advanced Materials at Clemson University. 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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