Physics Colloquium
Michigan Technological University

October 21 (Thursday), 4:00 to 5:00 pm, Room 139, Fisher Hall

From MEMS to NEMS with Carbon

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Abstract

Our work in carbon-microelectromechanical systems (C-MEMS) suggests that C-MEMS might provide a very interesting material and microfabrication solution to the battery miniaturization problem, active DNA arrays and a wide variety of chemical and biological sensors. We established that it is possible to use C-MEMS to create carbon posts with very high aspect ratio (>10), suspended carbon plates and carbon nano-wires (C-NEMS). In C-MEMS, photoresist is patterned by photolithography and subsequently pyrolyzed at high temperatures in an oxygen free environment. By changing the processing conditions, C-MEMS permits a many interesting applications that employ structures that having a wide variety of shapes, resistivity and mechanical properties. The advantages of using photoresists as the starting material for carbon electrodes include the fact that photoresists can be patterned in much finer features than possible with the traditional silkscreening of carbon inks. Also, photoresists are very reproducible materials, carbon electrode with more reproducible behavior can be expected. We found that C-MEMS electrodes have excellent electrochemical kinetics comparable to that of glassy carbon. Arrays of C-MEMS carbon posts can be charged and discharged with Li and enables the fabrication of a smart switchable array of batteries (each individual battery is called a baxel). We will also show that C-MEMS can be used in DNA micro-arrays and in a wide variety of novel electrochemical sensors.

Biography

Before joining UCI as the Chancellor's Professor in Mechanical and Aerospace Engineering (MEA), Dr. Madou was the Vice President of Advanced Technology at Nanogen in San Diego, California. He specializes in the application of miniaturization technology to chemical and biological problems (BIO-MEMS). He is the author of several books in this burgeoning field and helped pioneer both in Academia and in Industry. He founded several micromachining companies and has been on the board of many more.

Many of his colleagues became well know in their own right in academia and through successful MEMS start-ups. Madou was the founder of the SRI International's Microsensor Department, founder and President of Teknekron Sensor Development Corporation (TSDC), Visiting Miller Professor at UC Berkeley and Endowed Chair at the Ohio State University (Professor in Chemistry and Materials Science and Engineering). He has just started the third edition of "Fundamentals of Microfabrication, " an introduction to MEMS which has become known as the "bible" of micromachining.

Some of Dr. Madou's recent research work involves artificial muscle for responsive drug delivery, a compact disc-based fluidic platform and a solid-state pH electrode based on IrO_x. To find out more about those recent research projects, visit www.biomems.net. At UCI, Dr. Madou will work on carbon-MEMS, a CD based fluidic platform, solid state pH electrodes, artificial muscle for responsive drug delivery and integrating fluidics with DNA arrays as well as researching labelñfree assays for the Molecular Diagnostics platform of the future.