Three-dimensional Microelectronics for in situ Monitoring of Milk Spoilage

Liwei Lin
James Marshall Wells Professor, Department of Mechanical Engineering
Co-Director, Berkeley Sensor and Actuator Center
University of California, Berkeley, California 947201 USA
E-mail: lwlin@me.berkeley.edu

Major advances in the three-dimensional (3D) printing technologies have enabled the creation of a wide array of 3D-printed products, such as prosthetics, medical implants, airplane parts, building materials and food. While 3D printing technologies can make possible arbitrary-shaped structures, one challenging is the integration of microelectronic components and circuitry for various applications. Specifically, customizing the layer-by-layer 3D manufacturing process with the combination of both polymeric and metallic materials is an attractive proposition. However, the state-of-art 3D printers can only produce either polymer structures with poor conductivity or fully connected metal structures - making them unsuitable for microelectronic device applications. We have been working to address this problem by printing 3D-shaped resistor, capacitor, and inductor devices composed of hollow polymer tubes. By injecting silver paste into the tubes and curing the metal, they are able to generate intricate yet functional 3D circuits. One demonstration example is a "smart cap"—a working wireless sensing system incorporated into a milk carton lid without the need of battery power. The sensor detects the changes in the liquid dielectric constant due to the possible spoilage via the mechanism of a varying capacitor. By monitoring the resonant frequency shifts of a 3D microelectronics made of a resistor-inductor-capacitor circuitry, the in situ monitoring of milk quality can be achieved wirelessly. I will also discuss our efforts on 3D-printed metal conductors toward the fully integrated production of 3D microelectronics as a new class of manufacturing methodology for a variety of potential applications.

Biographical Sketch

Professor Liwei Lin is the James Marshall Wells Professor at the Mechanical Engineering Department and Co-Director at Berkeley Sensor and Actuator Center (BSAC) at UC Berkeley, and Co-Deputy Director of Tsinghua-Berkeley Shenzhen Institute. His research interests are in design, modeling and fabrication of micro/nano structures; sensors and actuators; as well as mechanical issues in micro/nano systems including heat transfer, solid/fluid mechanics and dynamics. Dr. Lin is the recipient of the 1998 NSF CAREER Award for research in MEMS Packaging and the 1999 ASME Journal of Heat Transfer best paper award for his work on micro scale bubble formation. He led the effort to establish the MEMS division in ASME and served as the founding Chairman of the Executive Committee from 2004~2005. He is an ASME Fellow and has 20 issued US patents in the area of MEMS. He was the general co-chair of the 24th international conference on Micro Electro Mechanical Systems at Cancun, Mexico. Currently, he serves as a subject editor for the IEEE/ASME Journal of Microelectromechanical Systems and the North and South America Editor of Sensors and Actuators –A Physical.