Nano@Tech Virtual Seminar
March 23, 2021 | 12PM EST

WHAT'S SO HARD ABOUT SOFT INTERCONNECTS?

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Link: https://tinyurl.com/NanoTechFedder

Abstract: Skin wearables are a compelling concept as an extension of today's commercial wearables, having broad applications in health monitoring, as sensory and haptic interfaces, and even for electronic fashion. What is sometimes lost amongst the substantial amount of research in this area is the importance of reliable interconnect. My research group began its journey on soft interconnect by tackling a related series of challenging applications: ultra-compliant cortical probes, which later led to intrafascicular probes and then soft cuff electrodes for the vagus nerve. Chronically implanted probes require strategies to forestall erosion of interfaces and materials that occurs from immersion in the body. The leakage requirements led to development of atomic layer deposited coatings to seal the wiring. The experience with neural probes, combined with the compelling potential impact of skin wearables inspired my recent exploration of a class of sub-mm-thick stretchable systems (a.k.a. electronic skin or e-decals) that can reliably interconnect rigid electronic and sensor microchips. Both mechanical and electrical interconnect in such systems must survive under relatively high applied strain from skin wrinkling, stretching and bending. Generally, rigid microchips embedded in stretchable substrates, like polydimethylsiloxane (PDMS), will delaminate at their interface to the substrate (and to interconnect) when subjected to even small applied strain. Design of stiffness gradients directly in the surrounding PDMS material is one approach to help prevent delamination. Building on this past work, I will describe our latest progress toward the vision of direct-print "stretchable circuit boards", leveraging in-house collaboration in aerosol-jet printing technology. Interconnect survival shows great promise with these merged technologies, all while iterating between tackling issues of delamination and cracking and finding robust engineering solutions.

Bio: Gary K. Fedder is the Howard M. Wilkoff Professor of Electrical and Computer Engineering at Carnegie Mellon University, with courtesy appointments in Mechanical Engineering, Biomedical Engineering and the Robotics Institute. He is also the faculty director of the university's Manufacturing Futures Initiative. He received his B.S. and M.S. degrees in EECS from MIT and his Ph.D. in EECS from the University of California at Berkeley. He is an IEEE Fellow for contributions to integrated MEMS. He has served in administrative roles at Carnegie Mellon as Vice Provost for Research, Director of the Institute for Complex Engineered Systems, and Associate Dean for Research in the College of Engineering. From 2011 to 2012, Dr. Fedder served as a technical co-lead in the U.S. Advanced Manufacturing Partnership where he worked with industry, academia and government to generate recommendations that motivated the launch of the National Network for Manufacturing Innovation, now called Manufacturing USA. He was founding president and served as interim CEO of the Advanced Robotics for Manufacturing (ARM) Institute in 2017 and 2020.

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