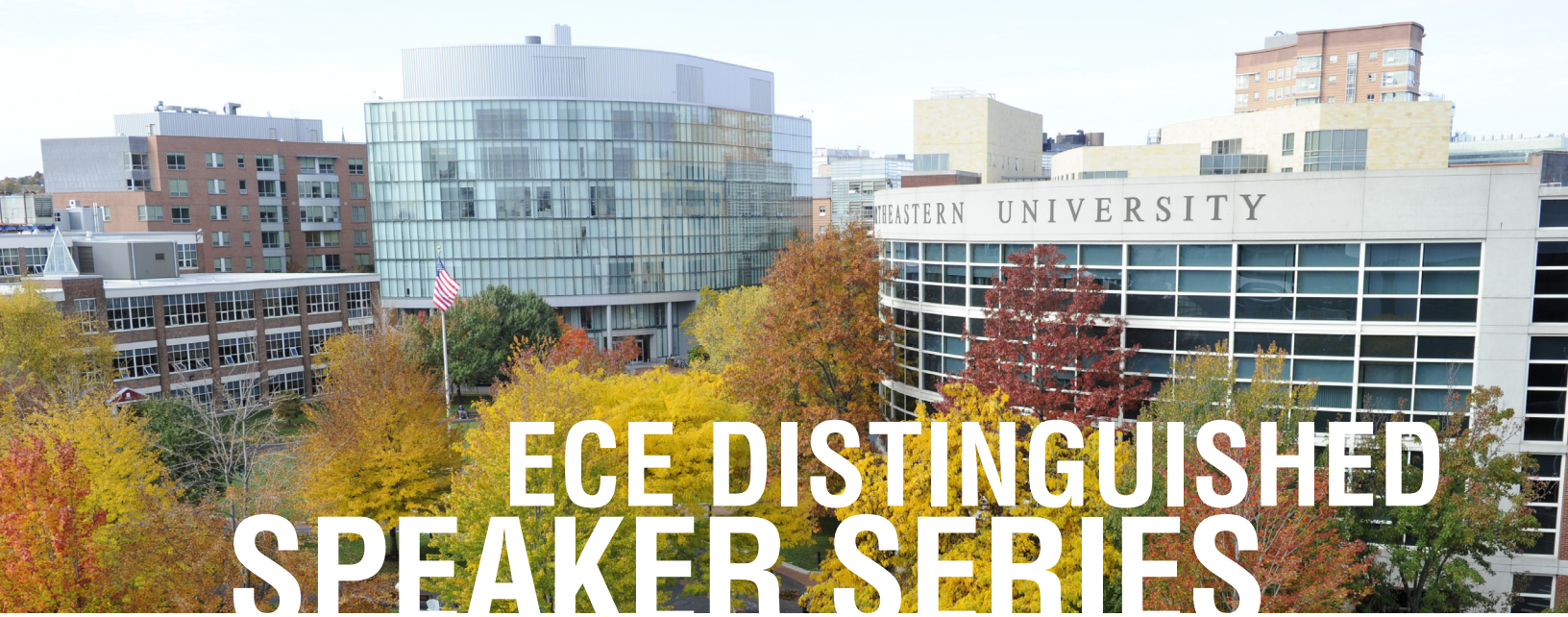

ECE DISTINGUISHED SPEAKER SERIES

Prof. Roger T. Howe
Dept. of Electrical Engineering
Stanford University

Host: Prof. Matteo Rinaldi
(rinaldi@ece.neu.edu)

Vacuum Nanosystems for Energy Conversion

Thursday
October 18th, 2012
Room 378 in 140 The Fenway
4:00-5:00 pm
Reception to follow

Sponsored by the Department of Electrical and Computer Engineering

Micro and nano-fabricated sensors (e.g., accelerometers and gyroscopes) and actuators (e.g., light valve chips for projection and cell-phone displays) have become commonplace in recent years. Some of these devices must operate in a hermetically sealed, low pressure ambient, a need that motivated the development of low-cost, wafer-scale vacuum encapsulation technologies. In this talk, I'll identify a promising direction for nanotechnology, in which vacuum is more than simply the ambient surrounding a microstructure, but rather is a critical element in device operation. Thermionic energy converters were conceived in 1915, demonstrated in 1939, and were the focus of astronomical investments during the space race by NASA and the Soviet Union. A 6 kW thermionic converter, fabricated using precision machining and vacuum tube technology, was flown in the late 1980s by the Soviets. Thermionic converters can be fabricated using extensions of MEMS technology, in which advances in materials, micromachining, and vacuum encapsulation processes can be used to enhance performance and reduce fabrication costs. Potential commercial applications include topping cycles in small-scale co-generation. Recently, a new conversion concept has been demonstrated at Stanford, in which a semiconductor photocathode replaces the conventional metal cathode. This photon-enhanced thermionic energy (PETE) converter harvests photon energies above the bandgap, as well as broad-spectrum radiation through heating of the photocathode. It is attractive as the high-temperature topping cycle for solar-thermal power stations. Micro- and nano-structured, high-temperature materials and micromachining processes are also essential to fabricating wafer-scale, cost-effective PETE converters. I will conclude by summarizing the research directions that are needed to bring thermionic and PETE conversions into the mix of energy conversion options.

Roger T. Howe is the William E. Ayer Professor in the Department of Electrical Engineering at Stanford University. He received a B.S. degree in physics from Harvey Mudd College and an M.S. and Ph.D. in electrical engineering from the University of California, Berkeley in 1981 and 1984. After faculty positions at CMU and MIT from 1984-1987, he returned to Berkeley where he was a Professor until 2005. His research interests include nano electromechanical system design, nanofabrication technologies, with applications in energy conversion and biomolecular sensing. A focus of his research has been processes to fabricate integrated microsystems, which incorporate both silicon integrated circuits and MEMS. Prof. Howe has made contributions to the design of MEMS accelerometers, gyroscopes, electrostatic actuators, and microresonators. He was elected an IEEE Fellow in 1996, was co-recipient of the IEEE Cledo Brunetti Award in 1998, and was elected to the U.S. National Academy of Engineering in 2005. He co-founded Silicon Clocks, Inc., a start-up company commercializing integrated MEMS resonator-based timing products, which was acquired in April 2010 by Silicon Laboratories, Inc. He is the Faculty Director of the Stanford Nanofabrication Facility and in September 2011, became Director of the National Nanotechnology Infrastructure Network (NNIN).

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