Thermoelectric Energy Conversion and Printed Sensors: From Nanoscale Materials to Systems

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Microfabrication and nano devices have revolutionized computing and communication in the last couple of decades. There are many efforts to use similar principles to help solve societal grand challenges in energy, water and food. Two examples include waste heat recovery using solid-state thermoelectrics and low cost sensors for digital agriculture. Breakdown of classical physics, such as Fourier diffusion equation for nanoscale heat transport, provide exciting opportunities to engineer new materials. Experimental evidence for fractal phonon random walk and hydrodynamic heat transport in semiconductors at room temperature will be presented. Challenges for the overall electrothermal energy conversion system optimization and its cost/efficiency trade off will be discussed. In the second example, roll-to-roll manufacturing for electrochemical sensors will be presented. Here the challenge is to achieve part per million sensitivity and stable operations in a harsh environment over weeks to months at low costs. Efforts to develop community internet-of-things testbeds in digital agriculture in the ten counties surrounding Purdue will be described.

Bio: Ali Shakouri is the Mary Jo and Robert L. Kirk Director of the Birck Nanotechnology Center at Purdue University. He received his diplome d'Ingenieur in 1990 from Ecole Nationale Superiere des Telecommunications in Paris, France and his Ph.D. in 1995 from California Institute of Technology in Pasadena, USA. He was a faculty at the University of California in Santa Cruz before moving to Purdue in 2011. His group studies nanoscale heat transport and electrothermal energy conversion to improve electronic and optoelectronic devices. They have also developed novel imaging techniques to obtain thermal maps with sub diffraction-limit spatial resolution and 800ps time resolution. He is applying similar methods to enable real-time monitoring of functional film continuous manufacturing. He is working with two dozen faculty at Purdue from Colleges of Engineering, Science, Agriculture, Polytechnic and Pharmacy to manufacture low-cost smart internet of thing (IoT) devices and sensor network. As a part of Wabash Heartland Innovation Network (WHIN), they are developing community IoT testbeds in advanced manufacturing and high tech agriculture.