Graduate Seminar Series

The Department of Mechanical Engineering – Engineering Mechanics

Proudly Presents

**Professor Mark Shannon**

University of Illinois, Urbana-Champaign

Mark A. Shannon is the Director of a NSF STC the WaterCAMPWS, which is a multiple university and government laboratory center for advancing the science and engineering of materials and systems for revolutionary improvements in water purification for human use. He is also the Director of the Micro-Nano-Mechanical Systems (MNMS) Laboratory at the University of Illinois at Urbana-Champaign, a 2000 sq. ft class 10 and 100 cleanroom laboratory devoted to research and education in the design and fabrication of micro- and nanoelectromechanical systems (MEMS & NEMS), microscale fuel cells and gas sensors, high-temperature microchemical reactors, micro-fluidic sensors for biological fluids. He chairs the Instrument Systems Development Study Session for the National Institutes of Health. He is the James W. Bayne Professor of Mechanical Engineering at UIUC, and received his B.S. (1989) M.S. (1991) and Ph.D. (1993) degrees in Mechanical Engineering from the University of California at Berkeley. He received the NSF Career Award in 1997 to advance microfabrication technologies, the Xerox Award for Excellence in Research (2004), the Kritzer Scholar (2003-2006), the Willet Faculty Scholar (2004-2007), and received the BP Innovation in Education Award in 2006.

**Thursday, Dec. 13, 2007  3:00 – 4:00 p.m.  Room 112, ME-EM Bldg.**

“Microcombustion for Small Scale Power Sources and Fuel Cells”

In the past few years, there has been an intense interest in building very small engines, power plants, and high temperature microchemical reactors, all running on the combustion of hydrocarbon fuels (due to their high inherent energy densities). In particular, there is interest in creating small-scale fuel reformers to produce hydrogen and/or syngas for fuel cells. While most systems employ catalytic and heterogeneous combustion processes, we wished to create and study high-temperature (near adiabatic flame temperature) homogeneous flames confined within burners with the smallest gap below 1 mm in length. Such high temperature microburners can have high power densities (>10^3 W/cm^3). The problem we immediately confronted is that flames either could not be created within narrow confined structures, or quenched quickly, similar to that which occurs in flame arrestors. We hypothesized that if we could have hot enough walls with low enough radical recombination probabilities, we could create and sustain homogeneous combustion in burners with sub-millimeter gaps. Therefore, we investigated a number of different wall materials and burner configurations, and found that flames of hydrogen, methane, propane, butane, and acetylene mixed with oxygen can be sustained in cavities as small as 100 microns, provided that the walls are sufficiently “quenchless.” In addition, we have observed unusual flame structures at this scale, and flame dynamics that strongly vary with changes in temperature profiles. Homogeneously burning hydrocarbons in air at this scale has proved to be more difficult, requiring even higher wall temperatures and better thermal management. In this talk, I will present the experiments that we have conducted towards developing microcombustion-based systems, some of the observations I find interesting, what we now know is happening within the structures, and the many open questions that remain to be answered by many of the excellent researchers working throughout the U.S. and world on these problems.