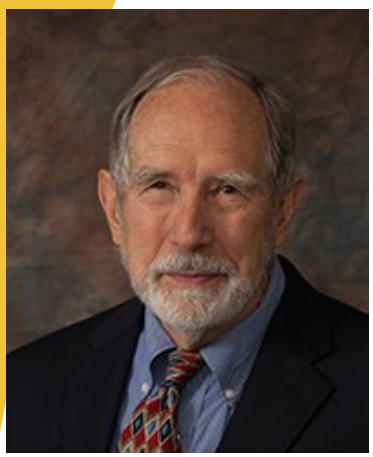
College of Engineering
Department of
Mechanical & Industrial Engineering

The Sidney E. Fuchs Seminar Series

3:30-4:30pm, Friday, November 2, 2012
Frank H. Walk Design Presentation Room



Solar Cell Performance Improvement Using Optimized Surface Nanopatterns

by John R. Howell, Ph.D.*

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Nano- to micrometer scale geometric features (grooves, rectangular patterns) on the surface of certain materials cause thermal radiation emission or absorption to have pronounced directional and wavelength characteristics. Such tailored surfaces have been studied and their characteristics predicted and experimentally verified. In the design of radiating devices, however, it is useful to first identify the desired directional and wavelength characteristics needed for a particular application, and then determine the surface texture and device geometry that will provide these characteristics. This is an inverse problem.

This research studies the inverse mathematics that must be solved for such design, with its well-known mathematical difficulties. Solving this class of problems gives a design method for identifying the specific micro- and nano-scale surface structures that will provide desired directional and spectral radiative emissive and absorptive properties. The research describes the results of inverse analysis applied at the micro -nano scale and validation through comparison with experiment.

A robust inverse design method for optimizing radiative properties has important applications including improving the efficiency of solar collectors, photovoltaic arrays, lighting systems and radiant heaters.

* Jack Howell is the Ernest Cockrell, Jr. Memorial Chair Emeritus at The University of Texas at Austin, in the Department of Mechanical Engineering. He is retired from teaching, but continues an active research program. Previously he was a heat transfer researcher at the NASA Lewis (now Glenn) Research Center, and associate and full professor at the University of Houston. He joined The University of Texas at Austin Cockrell School of Engineering in 1978. He served as Department Chairman in Mechanical Engineering from 1986 to 1990 and as Associate Dean for Research from 1996 to 1999. He was Program Director, Thermal Transport and Thermal Processing Program with the National Science Foundation (1994-5). He received the ASME/AIChE Max Jakob Award (1997), the ASME Heat Transfer Memorial Award (1991) and the AIAA Thermophysics Award (1990) for his work in radiative transfer, and the ASEE Ralph Coats Roe Award in 1987 as Outstanding Mechanical Engineering Educator. He is a Life Fellow of ASME, a Fellow of AIAA, and was elected a Foreign Member of the Russian Academy of Science (1999) and a member of the US National Academy of Engineering (2005). He coauthored Thermal Radiation Heat Transfer, Taylor and Francis, now in 5th ed (2010) (with Robert Siegel and M. Pinar Menguc), Fundamentals of Engineering Thermodynamics, McGraw Hill, 2nd ed. 1992 (with Richard Buckius), Solar Thermal Energy Systems, with Gary Vliet and Richard Bannerot, McGraw-Hill, 1982, Thermodynamics: An Integrated Learning System (with Phil Schmidt, Dike Ezekoye and Derek Baker, Wiley, 2006) and has published over 200 articles, papers and reports. His research has centered on developing solution techniques for radiative transfer in participating media (particularly the Monte Carlo method), solutions of highly non-linear combined mode heat transfer problems, and, most recently, inverse design and control of thermal systems with combined-mode (non-linear) heat transfer.