

Universitat Autònoma de Barcelona (UAB) and Centro Nacional de Microelectrónica (CNM) invites you to the seminar that will be held on

**Tuesday, 23rd September, 2014, 11:30 h**

Facultat de Ciències. Sala de Graus (C1/070-1), Edifici C, Campus UAB

## **Nanoscale thermal transport and thermoelectric energy conversion**

**Ali Shakouri.** Birck Nanotechnology Center, Purdue University.

Latest research on nanostructured thermoelectrics will be presented. A direct conversion of heat into electricity which has the potential to reach MW and GW scale is the use of thermoelectrics as a topping cycle between the combustion temperature and the steam used in the mechanical engines. We show that power plant efficiencies can be increased by 5-7% with a cost below ~\$0.3/W with today's TE materials [1]. Next, we describe some of the recent studies of quasi ballistic heat conduction. Nearly all micro/nanoscale heat transport experiments are interpreted using phenomenologically adjusted Fourier theory. We show this can misrepresent the internal processes. The energy dynamics are much better described as truncated superdiffusive Levy flights instead of conventional Brownian motion. All essential physics of the nondiffusive transport are captured by the fractal dimension and exponential decay length of the stochastic process. We determine these two new material parameters experimentally for several semiconductors using transient laser thermoreflectometry. This new formalism enables more accurate characterization of thermal interface resistances. This has important implications in the design of high power and high speed electronic and optoelectronic devices. We finally present some of the latest full field transient thermal imaging with submicron spatial and 800ps time resolution. This is used to study localized heating in metal/insulator vanadium oxide nanowires and in high power GaN high electron mobility transistors.

[1] Thermoelectricity: from Atoms to Systems (<https://nanohub.org/courses/TEAS>) a nanoHUB-U course.

Ali Shakouri is the Mary Jo and Robert L. Kirk Director of the Birck Nanotechnology Center and a Professor of Electrical and Computer Engineering at Purdue University. He received his Engineering degree from Telecom Paris, France in 1990 and Ph.D. from California Institute of Technology in 1995. His current research is on nanoscale heat and current transport in semiconductor devices, high resolution thermal imaging and waste heat recovery systems. He is also working on a new interdisciplinary sustainability curriculum in collaboration with colleagues in engineering and social sciences. He received the Packard Fellowship in Science and Engineering in 1999, the NSF Career award in 2000 and the Thermi Award in 2014.