

IOWA STATE UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING

**Nano-devices for enhanced thermal energy storage,
cooling and sensing**

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2004 Black

Abstract:

We are developing nanotechnology enabled platforms for enhancing cooling, sensing and energy storage (involving both experimental and computational studies). Coupling of thermal and hydrodynamic features during phase change (boiling, condensation) causes spatio-temporal fluctuations of surface temperature at the micro/nanoscales, which are termed as “cold-spots” and can transmit over 60-90% of the total heat transfer. Using CarbonNanotube (CNT) nanocoatings - cooling was enhanced by 60~300% by leveraging cold-spots and the “nano-fin” effect (enhanced surface area). Using silicon nanofins - cooling was enhanced by ~120%. Nano-thermocouples and diode temperature nano-sensors integrated with the nanocoatings enabled the study of chaos/ fractal structures in boiling. Specific heat capacity was enhanced by ~120% using nanofluids. This has applications in the energy technologies, such as: concentrated solar power/ CSP (thermal energy storage/ TES), nuclear, oil and gas exploration (deep drilling, reservoir engineering using nanotracers). Microchannel experiments using nanofluids showed that the precipitated nanoparticles behaved as nanofins (enhanced surface area) that dominate heat transfer for micro/nanoscale flows. DPN™ (Dip Pen Nanolithography™) leverages Scanning Probe Microscopy using microfluidics. Commercial microfluidic devices called “Inkwells™” were developed earlier. The next generation microfluidic devices are being developed for DPN (e.g., Fountain Pen Nanolithography, “centiwells”). The applications are in nano-catalysis, bionanotechnology, mask-less-lithography and nano-sensors for homeland security, bio-security and explosives detection (e.g., “nano-nose”/ “nano-tongue”).

Biography:

Dr. Banerjee received his Ph.D. in Mechanical Engineering from UCLA (with minor in MEMS). He attended the Indian Institute of Technology (IIT), Kharagpur for his Bachelor of Technology (Honors). Dr. Banerjee has 9 US patents from his work at ABI, CIPHERGEN Biosystems, NanoInk, Coventor Inc. and TAMU. He received the “Morris Foster Fellowship (2007-2008)” from Mechanical Engineering Department, the “TEES Select Young Faculty Fellowship (2008-2009)” from the D. Look College of Engineering and was designated as a Faculty Fellow at the Mary Kay O'Connor Process Safety Center at TAMU. He received the “New Investigator Award (2005)” from the Texas Space Grants Consortium (TSGC), “3M Non-Tenured Faculty” award ('09-'12), the “ASEE/ AFOSR Summer Faculty Fellowship ('06, '07)” at AFRL, and the “ASEE/ ONR Summer Faculty Fellowship ('09)” at SPAWAR.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.