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

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We are developing nanotechnology enabled platforms for enhancing cooling, sensing, energy storage and safety systems (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/nano-scales, which are termed as “cold-spots” and can transmit over 60-90% of the total heat transfer. Using *Carbon-Nanotube (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: molten salt nanofluids for concentrated solar power/ CSP (thermal energy storage/ TES), nuclear, oil and gas (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 bio-nanotechnology, and *nano-sensors* for homeland security and **explosives detection** (“*nano-nose*”). We invented a gasless process for synthesis of nanoparticles (e.g., graphene, CNT, etc.) under ambient conditions with synthesis temperature less than 300 °C (US Patent 8470285).

Biography

Debjyoti Banerjee received his Ph.D. in Mechanical Engineering from UCLA (with minor in MEMS). He received 3 M.S. degrees and was invited to 4 national honor societies. He attended the Indian Institute of Technology (IIT), Kharagpur for his Bachelor of Technology (Honors). Prior to TAMU, He worked as a *Manager of Advanced Research & Technology (ART) group* at *Applied Biosystems Inc. (ABI)*, CA, (currently merged into *Life Technologies*). Also as a *Hiring Manager* at *ABI* he hired ~ 30 Ph.Ds in ~6 months and managed a group of 10~15 Ph.D. engineers / scientists. Previously in a singular capacity, he developed from concept to a commercial product at *Nanolnk Inc.* (called “*InkWells™*”, which are microfluidic platforms used for bio/nano-lithography of proteins, nucleic acids, etc.). He has 13 US patents, from his work at *ABI*, *Ciphergen Biosystems*, *Nanolnk*, *Coventor Inc.* and *TAMU*.

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