MBSTP seminar Monday March 25, 2013

1180 Duderstadt at 12:30 pm (Lunch time)

Fluid handling operations in droplet microreactors: optical tweezing, sorting, particle segregation, and label free sensing in picoliter volumes

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Multiphase microfluidics utilizes water-in-oil droplets as containers for biochemical reactions. With nL-pL volumes, they provide a hundred to million-fold smaller reaction volumes than conventional microplates or single-phase microfluidic channels. As modern biology evolves from studies of single genes and proteins to systematic, high-throughput studies involving of thousands of biomolecules, drop-based fluidics can provide compelling benefits to the fields of '-omics' and drug discovery, including: dramatic cost reductions by conserving expensive reagents, high throughput due to lower diffusion times, and novel ways to query single cells in small volumes. To be able to reap these benefits, however, one must be able to emulate typical benchtop fluid handling operations in the droplet format. Multiphase fluidics can be considerably more complex than single-phase microfluidics as they involve coupled flow interactions between two immiscible phases, interfacial tension, Laplace pressures, shape deformation, and other phenomena acting in cohort with the standard flow profiles. Rather than work against these phenomena, we exploit them in novel ways in order to perform key fluid handling operations. Several examples will be discussed in this talk: 1) the formation of heterogeneous screening libraries using microfractionation-in-droplets (μFD); 2) Particle concentration using hydrodynamic microvortices and sedimentation in plug flow; 3) Optical droplet manipulation using optofluidic tweezers (OFT), a novel technique which uses laser-induced thermocapillary microvortices to trap droplets with μN forces (100,000X larger than traditional optical tweezers); 4) Sorting droplets by size using tensiophoresis, the cross-stream migration of droplets in interfacial tension (IFT) gradients; and 5) Detecting femtomoles of proteins in droplets using interfacial adsorption phenomena. Computational modeling and experimental image velocimetry methods will also be discussed.

Bio: Amar Basu received a BSE and MSE in electrical engineering in 2001 and 2003, an MS in biomedical engineering in 2005, and a Ph.D. in electrical engineering in 2008, all with honors from the University of Michigan Ann Arbor. His dissertation, under Prof. Yogesh Gianchandani, was in the area of microscale fluidic actuation and programmable actuation of microdroplets. Amar worked with Intel's Advanced Technology group, General Motors, Silicon Graphics, and served as an adjunct faculty at the University of Michigan. He is currently assistant professor at the electrical engineering and biomedical engineering departments at Wayne State University. His research, supported primarily by the National Science Foundation, focuses on developing microfluidic and microelectronic technologies for high throughput screening in research and clinical settings. Amar received the IEEE Professor of the Year (voted by students) in 2009 and the Whitaker Foundation Fellowship in 2003. His work as a consultant with Mobius Microsystems and Picocal has resulted in several US patents.