Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Particle collision dynamics in periodic asymmetric microfluidic obstacle arrays for rare cell capture JAMES SMITH, JASON GLEGHORN[1], BRIAN KIRBY, Sibley School of Mechanical and Aerospace Engineering, Cornell University — Particle–obstacle collision dynamics in periodic microfluidic obstacle arrays are presented in the context of microfluidic devices for the capture of rare cells, such as circulating tumor cells (CTCs). A coupled CFD–particle advection simulation was used to calculate particle trajectories for low Reynolds number, low Stokes number flows. A rich range of deterministic transport modes was identified as a function of array geometry, and the resulting particle size-dependent collision rate highlights the usefulness of these arrays for high-efficiency, high-purity rare cell capture. A reduced-order model, assuming unidirectional flow and infinitesimal obstacles, captures most of the details of transport in these systems with an $O(10^4)$ computational saving; this model is a useful tool for rapidly exploring a large design space and optimizing geometries for a specific rare cell capture application. Results of the CFD simulations, reduced-order ballistic models, and experiments with polystyrene particles and cancer cells indicate that array geometry is central to rare cell capture and that simple models can be used to inform the design of these microfluidic devices.

[1]Present affiliation: Department of Chemical and Biological Engineering, Princeton University

James Smith
Sibley School of Mechanical and Aerospace Engineering, Cornell University

Date submitted: 02 Aug 2012 Electronic form version 1.4