Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Effective reaction rate for porous surfaces under strong shear: Beyond Damkohler ERIC S.G. SHAQFEH, PREYAS SHAH, Stanford Univ — Traditonally, surface reactive porous media are modeled via an effective reaction/mass transfer rate based on the original ansatz of Damkohler, i.e, reaction limited transport at the microscale in the absence of flow. We are interested in modeling the microscale mass transfer to porous surfaces occuring in leaky tumor vasculature, where the Damkohler number can be O(1) and the Peclet number may be large. We model it as a uniform bath of a species in unbound shear flow over a wall with first order reactive circular patches (pores). We analyze the flux through a single pore using both analytic and boundary element simulations and observe the formation of a 3-D depletion region (wake) downstream of the pore. Wake sharing between adjacent pores in a multibody setting such as 2 pores aligned in the shear direction leads to a smaller flux per pore. Obtaining this interaction length scale and using the renormalized periodic Green's function, we study the flux through a periodic and disordered distribution of pores. This flux appears as the reaction rate in an effective boundary condition, valid up to non-dilute pore area fractions, and applicable at a wall-normal effective slip distance. It replaces the details of the surface and can be used directly in large scale physics simulations.

Preyas Shah
Stanford Univ

Date submitted: 01 Aug 2014 Electronic form version 1.4