MASS TRANSFER TO STRUCTURED REACTIVE BOUNDARIES FROM STEADY 3-D FLOWS IN MICROCHANNELS

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Microfluidic systems are generally characterized by laminar, axial flow and slow, purely diffusive mixing in the cross section, resulting in poor bulk mixing and limited mass transfer to boundaries. Methods have been developed to produce transverse flows that efficiently mix fluid in the bulk of a microchannel [1], but little attention has been given to the use of these flows to enhance mass transfer from the bulk to the channel walls. Transfer between the bulk and a reactive boundary is essential in such areas as microfuel cells and biochemical sensors.

Work presented recently and submitted for publication has allowed for the development of a theoretical framework that can explain the increases in mass transfer due to transverse flows; it also raises questions as to the role of chaotic advection in increasing rates of mass transfer over similar nonchaotic transverse flows. This work has employed the Staggered Herringbone Mixer (SHM), a chaotic laminar micromixer that induces mixing through lithographic patterning of grooves along the channel floor [2], and investigates the effect that the transverse flow produces at the wall opposite the patterned surface. This geometry is especially relevant to surface based biochemical sensors, but less relevant to systems like the planar membraneless microchannel fuel cell (PM_2FC) [3].

The work to be presented will extend the system to include reactions at the patterned surface, which should offer larger increases in transfer. Systems with reactions at a single patterned wall (as in an electrochemical half-cell) and opposing symmetrically patterned walls (as in an SHM inspired PM_2FC) will be presented. Results on the further elucidation of the importance of chaotic mixing in these systems will also be presented.

References

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