Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Boundary layer enrichment for reversible surface reactions in stirred microfluidic flows JOSEPH KIRTLAND, LENNON MCCARTNEY, Division of Physics and Astronomy, Alfred University — The local rate of scalar transport from a fluid stream to a reactive surface depends on the concentration of scalar in the fluid elements incident on the surface and the character of the flow. Unstirred, uniaxial flows tend to develop thick depleted regions adjacent to the reactive surface (concentration boundary layers) that grow to the full scale of the flow, resulting in low rates of scalar transport. In the case of an irreversible surface reaction, this effect can be mitigated through the introduction of a three-dimensional flow to achieve mixing in the bulk: efficient mixing will result in the consistent presentation of fluid with the average scalar concentration to the reactive surface and the three-dimensional flow will maintain a thinner concentration boundary layer. Coupled reversible surface reactions, such as the oxidation and reduction of a single species occurring at opposite surfaces of an electrochemical flow cell, will complicate the analysis of such a system: depletion of the reactant of the forward reaction is accompanied by enrichment of the product of the forward reaction, which is necessarily the reactant of the reverse reaction. In certain flows, this fluid enriched with reactant for the reverse reaction can bypass the stirred bulk, leading to increased scalar transport, even in cases of inefficient bulk mixing. We present numerical and experimental results in several such flows and discuss situations where this enrichment can be beneficial or detrimental.

Joseph Kirtland
Alfred Univ

Date submitted: 02 Aug 2014 Electronic form version 1.4