Enzymatic Reactions in Microfluidic Devices W.D. RISTENPART, Univ. California Davis, J. WAN, H.A. STONE, Harvard Univ. — We establish simple scaling laws for enzymatic reactions in microfluidic devices, and we demonstrate that kinetic parameters obtained conventionally using multiple stop-flow experiments may instead be extracted from a single microfluidic experiment. Introduction of an enzyme and substrate species in different arms of a Y-shaped channel allows the two species to diffuse across the parallel streamlines and to begin reacting. Measurements of the product concentration versus distance down the channel provide information about the kinetics of the reaction. In the limit where the enzyme is much larger (and thus less diffusive) than the substrate, we show that near the entrance the total amount of product (P) formed varies as a power law in the distance x down the channel. For reactions that follow standard Michaelis-Menten kinetics, the power law takes the form $P \sim (V_{max}/K_m)x^{5/2}$, where V_{max} and K_m are the maximum reaction rate and Michaelis constant respectively. If a large excess of substrate is used, then K_m is identified by measuring V_{max} far downstream where the different species are completely mixed by diffusion. Numerical simulations and experiments using the bioluminescent reaction between luciferase and ATP as a model system are both shown to accord with the model. We discuss the implications for significant savings in the amount of time and enzyme required for determination of kinetic parameters.

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