442a Laminar Flow Based Microreactor for Efficient Regeneration of Nicotinamide Cofactors for Biocatalysis

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One of the longstanding challenges in biocatalysis is the search for methods to continuously regenerate essential cofactors such as NADH that would enable the use of a wide range of enzymes to be used in the more environmentally friendly synthesis of chiral fine chemicals including pharmaceuticals, cosmetics, and food additives. In this work, we present a microreactor-based cofactor regeneration method that exploits the microfluidic phenomenon of laminar flow: a reactant stream and a buffer stream are introduced in a microchannel and continue to flow side by side without turbulent mixing between two electrodes that cover opposing channel walls. Adjustment of the flow rate ratio of the two streams in laminar flow enables focusing of the reactant stream closely to the cathode, thereby reversing a normally unfavorable reaction equilibrium essential for cofactor regeneration. The absence of a bulk phase in these microreactors prevents the undesired reverse reaction to take place, which has prevented the use of electrochemical cofactor regeneration in macroscale processes. Here, we demonstrate the regeneration of NADH with conversion efficiencies as high as 31%. We also show the subsequent in situ conversion of an achiral substrate, pyruvate, into a chiral product, L-lactate, within this microreactor. Moreover, our efforts to scale these microreactors into a multi-reactor system for higher throughput and an overall efficient biocatalytic process will be presented.