Microfluidic bioreactors for cascade reactions

Proposers

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Microfluidics technology has the potential of bringing chemical and biosensing to the point-of-care, with additional advantages beyond portability such as multiplexing, speed, sensitivity and low cost. More recently, microfluidics has been studied intensively also as a platform for cell culture. This is because microfluidics allows a very precise control of the cellular microenvironment which is a key factor for applications in tissue engineering and for the development of tissues, organs and organisms on the chip for medical and pharmaceutical applications. Less developed is the use of microfluidics for chemical and biological synthesis. There are several aspects that motivate this research direction: (i) the high level control of mass and thermal transport in microfluidic systems should allow higher reaction yields and smaller production of byproducts; (ii) the small volumes of reactants used and the small cost for an individual reactor are perfect for process screening; (iii) continuous production is possible.

The objective of this project is to study the implementation of continuous microfluidic microreactors for complex cascade reactions using a series of enzymatic and chemical reactions. The initial system that will be studied is the synthesis of 5-hydroxymethyl furfural from glucose, a process that involves the enzymatic isomerization of glucose to fructose, followed by chemical dehydration of fructose to the intended product. Issues to be addressed are: (i) the design of the individual microreactors; (ii) the materials required for the fabrication of the microfluidic system; (iii) the integration of pumping and valving for flow control; (iv) the integration of the different microreactors in the cascade; (v) the on-line control of the process; and (vi) the overall performance of the microreactor. Although the cascade microfluidic reactor system will be developed for a particular cascade reaction, it is hoped that the concepts developed will be general for the design of continuous microreactors both for process screening and for scaling-out for high-value added product synthesis.

Profile sought: preference, but not limited, to students with a background in Biological Engineering or Biotechnology with an interest in exploring microfluidics and microreactors.