Microfluidic enzymatic reactors using -transaminases

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In recent years, miniaturizing reaction formats has gained interest since the productivities of some chemical reactions can be enhanced by orders of magnitude. Miniaturization helps diffusion-limited reactions to occur significantly faster than they would at the larger scale. Of particular interest is the potential for high throughput experimentation for rapid screening of reactions, determining kinetics, exploring hazardous chemistry and developing chemical reactions[1]. The aim of this study is to evaluate the effect of miniaturization, if we can improve or gain better insight, on biochemical enzymatic reactions using biocatalytic transamination as a model reaction.

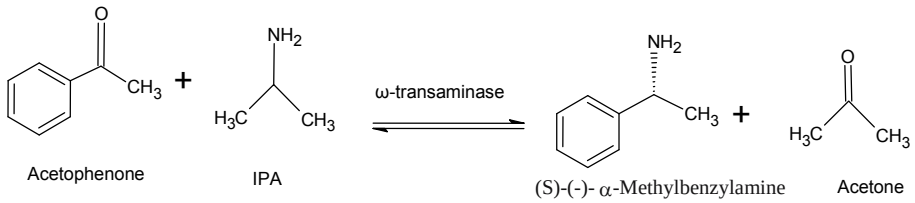

Fig 1: Biocatalytic transamination

The main challenges are: (1) an unfavourable thermodynamic equilibrium position, necessitating processes to shift the equilibrium; (2) substrate and product inhibition; (3) low substrate solubility, giving low volumetric productivities; (4) high biocatalyst cost[2].

Here we attempt to study the performance of this reaction in an aqueous/organic segmented flow capillary microreactor. A simple Y shaped micro-mixer has been fabricated where two inlet fluids, organic and aqueous phase, join at a junction creating alternate fluid segments. Different reaction conditions have been studied simultaneously due to a micro-milling based parallel fabrication of the flow system. The focus has been on the user friendliness of the system in order to perform rapid screenings. Some specific issues requiring careful consideration while developing such microsystems for biocatalytic reactions will be discussed: surface modifications, control of fluid behaviour in micro-channels and detection limitations[1].

The micro-mixer is to be used for a) screening of various organic solvents; b) studying the reaction rate - mass transfer rate limitations (Damköhler number); c) conducting experiments with varying process conditions like flow velocity, enzyme concentration and phase ratio. Further, CFD (computational fluid dynamics) modelling has been used to study the different reactor formats. This system is expected to give better understanding of the rate limitations, rapid screening of organic solvents and process conditions.

[1] Matosevic S., Szita N., Baganz F.; J Chem Tech and Biotechnol., (2011) 86, 325–471.
[2] Tufvesson P.; Lima-Ramos J.; Jensen SJ.; Al-Haque N.; Neto W.; Woodley JM.; Biotechnol. Bioeng., (2011) 108, 1479-1493.