High-throughput microfluidic screening of bacterial libraries and enzymes

Keywords: Cell encapsulation, Microfluidics, High-throughput screening, Hydrogels

Project Description

A 3-year PhD studentship is available in the Department of Chemical Engineering of Loughborough University to work in collaboration with the University of Belgrade and Imperial College London on the development of microfluidic strategies for encapsulation of single bacterial cells within hydrogel particles for the purpose of their high-throughput screening.

Natural enzymes evolved over billions of years to allow for their nearly perfect catalytic activity in living organisms. Despite their wide structural diversity, relatively few natural enzymes have been successfully applied to industrial processes. The reason for this is that natural enzymes are adopted to work under physiological conditions, while industrial processes often require enzymes that are stable and active under harsh conditions. Directed evolution is the process by which biological entities such as cells and enzymes with improved properties are created over a short period of time (compared to natural evolution) by mimicking Darwinian evolution principles in the lab through iterative rounds of random mutagenesis and library screening. The conventional methods for enzyme screening are time consuming and often regarded as a bottleneck in directed evolution. Recently, droplet microfluidic methods have been developed for an efficient *in-vitro* compartmentalisation and fast evaluation of millions of enzyme variants in their bacterial hosts.

In this PhD project, novel microfluidic strategies for the encapsulation of single bacteria in monodispersed microdroplets will be developed, which is a crucial first step in the process of directed evolution. Generated droplets will be transformed into gel beads using various gelation strategies that will be developed in the project. After incubation, the cells will grow into monoclonal colonies inside the beads and can be sorted based on their fluorescence, isolated from the beads, and used for the next round of the process. Particle Microfluidic Group is well equipped with various devices for generation of monodispersed droplets.

The project will benefit from a direct access to a wide range of state-of-the-art materials characterisation facilities available in the Loughborough Materials Characterisation Centre. The hydrogel microparticles will be characterised using Confocal Laser Scanning Microscopy (CLSM), Focused Ion Beam Scanning Electron Microscopy (FIB-SEM), continuous online Fourier transform infrared (FT-IR) spectrometry and other characterisation techniques.

Entry Requirements

Applicants should have, or expect to achieve, at least a 2:1 Honours degree (or equivalent) in Chemical Engineering, Chemistry, Materials Engineering, Pharmaceutical Engineering or a related subject. A relevant Master's degree and/or experience will be an advantage.

Supervisors

Primary supervisor: Dr Goran Vladisavljevic
Secondary supervisor: Dr Guido Bolognesi