Microfluidic production of monodispersed microspheres and microcapsules for photocatalytic water treatment and CO2 capture

Microfluidic production of monodispersed microspheres and microcapsules for photocatalytic water treatment and CO_2 capture

Ruqaiya Al nuumani, Goran T. Vladisavljević, Guido Bolognesi, Chemical Engineering Department, Loughborough University, Loughborough, UK

r.alnuumani@lboro.ac.uk

Drop microfluidics is a highly promising technique for production of monodispersed droplets and particles with tuneable size and morphology. In this work, polymeric particles with tailored properties were produced continuously, in a single step, using microfluidic emulsification and subsequent on-the-fly photopolymerization (Figure 1). (Solid-in-oil)-in-water (S/O)/W, water-in-(solid-in-oil)-in-water W/(S/O)/W, and water-in-oil-in-water (W/O/W) emulsions were used as a template for particle synthesis.

The fabricated particles include acrylate microspheres embedded with TiO_2 for photocatalytic water treatment, polymeric microcapsules consisting of a controlled number of liquid cores embedded in a polymer matrix, and core-shell microcapsules comprised of a thin polymer shell and a CO_2-selective liquid core for CO_2 capture.

For photocatalysis, TiO_2 nanoparticles were dispersed in a UV-curable monomer to form a S/O phase, which was then dispersed in an aqueous solution consisting of 4 wt% PVA and 40 wt %glycerol. The droplets were polymerized with a UV-lamp and characterized using SEM, TGA, XRD, and FT-IR. The photocatalytic activity of the particles was confirmed by measuring the degradation rate of methylene blue as a module contaminant with a UV-visible spectrophotometer at λ_{max} = 664 nm.

For CO_2 capture, the inner fluid was 5 wt% K_2CO_3 solution, the middle fluid was a 3 wt% PGPR solution in a UV-curable liquid acrylate monomer, and the outer fluid was an aqueous solution of glycerol and PVA. The saturation of the liquid core with CO_2 was visualised by adding m-cresol purple, a pH indicator, in the inner fluid.

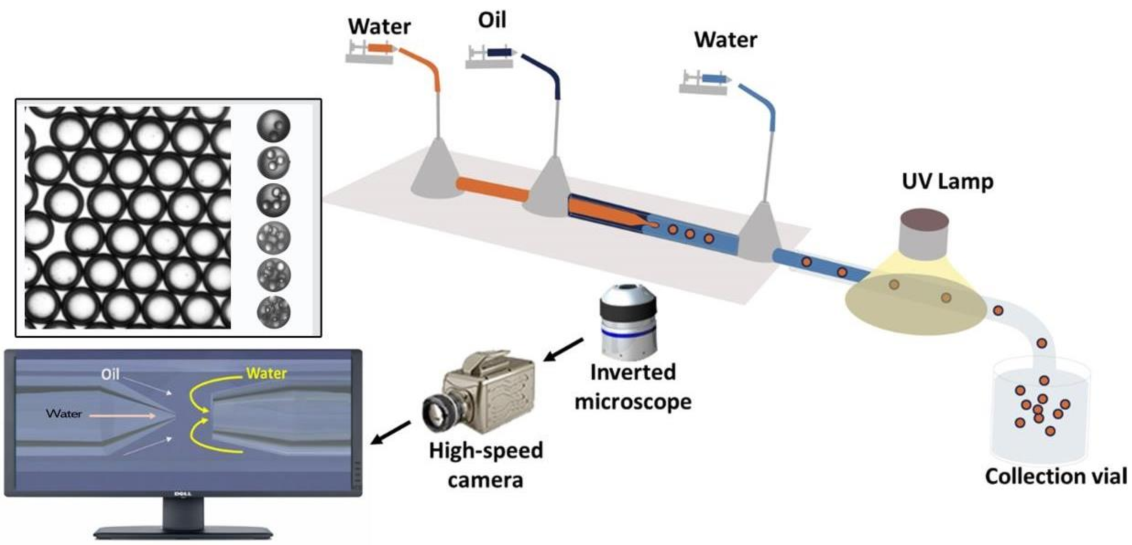

Fig 1. Schematic view of the experimental set-up used for the production and monitoring of emulsion droplets generation and on-the-fly photopolymerisation. The inset figure shows monodisperse core-shell droplets and multi-core droplets with controlled number of monodispersed inner drops generated in microfluidic device.