PC 38

SINGLE AND MULTIPLE EMULSION DROPLETS IN FLOW; FABRICATION OF 'CLICKABLE' PARTICLES VIA A SIMPLE MICROFLUIDIC SYSTEM

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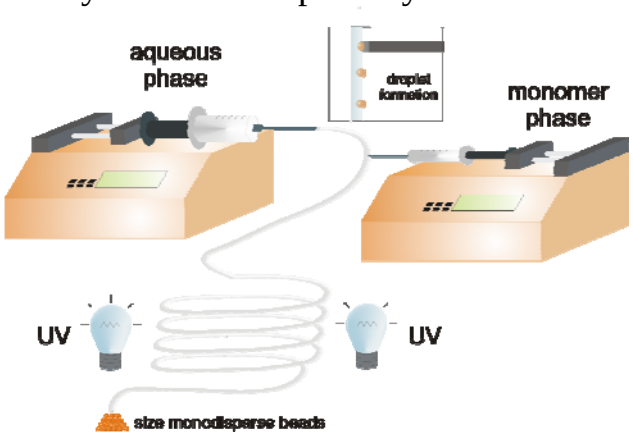
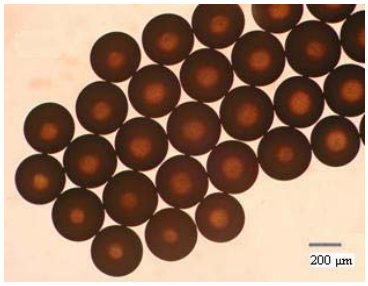
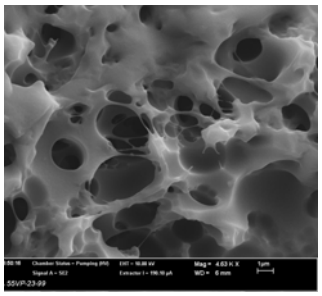
Polymer beads have been manufactured for decades with variation in particle size, chemical functionality, crosslink density and porosity. We would like to develop an easy and versatile strategy with maximum control to manufacture beads which can be used in solid-phase synthesis and/or solid-phase extraction cartridges. Traditionally bead synthesis is performed via heterophase polymerizations. These conventional methods have drawbacks such as the lack of control in particle size and distribution, and a restricted ability to introduce porosity and functional groups.



a) Schematic drawing of microfluidic set-up



b) Image of fabricated monodisperse beads



c) FEG-SEM of internal HIPE structure

To improve bead fabrication, we utilized microfluidics. This is a rapidly growing research field in which liquid systems can be studied and the flow patterns controlled using small channels arranged into devices. Our simple microfluidic set-up[1] is consisted of two syringe pumps, a flexible tube of mm sized diameter, an imbedded needle for droplet generation, and a series of UV lamps (see Fig. a). Droplets are generated at the tip of the needle by controlling the flow rates of both phases. Monomer phase either consisted of (metha)crylates and/or styrenes potentially with a porogen, or a High Internal Phase Water-in-Oil Emulsion (HIPE). Solidification of droplets in the downstream part of the tube was performed via photopolymerization. The overall residence time and thus monomer conversion was controlled by varying the tube length. Monodisperse microbeads with controlled porosity were easily produced via this approach. Since azide monomers did not survive UV irradiation, a post-modification step was carried out. Heterogeneous click functionalization of these particles by fluorophores is under investigation.

1. Quevedo, E.; Steinbacher, J.; McQuade, D. T. *J. Am. Chem. Soc.* **2005,** 127 (30), 10498.