45. Title: Highly ordered poly-high internal phase emulsions using co-flow microfluidic device

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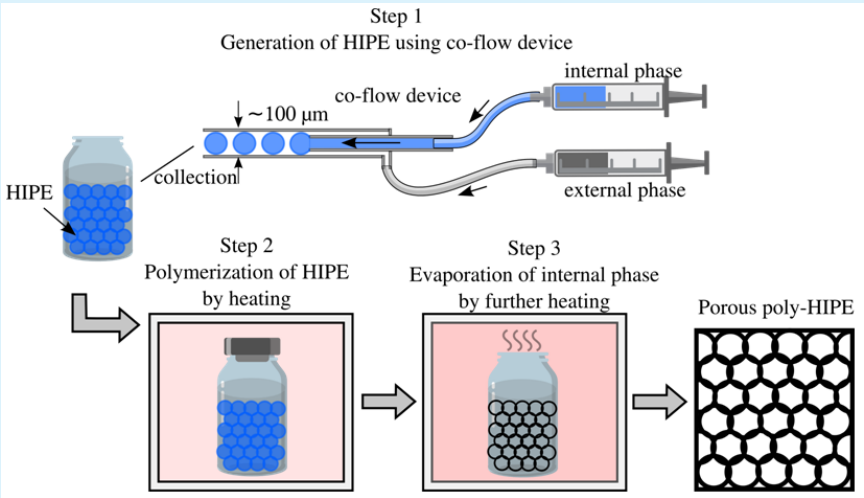
Keywords: High internal phase emulsion, microfluidics, Co-flow geometry, porous constructs, monodisperse emulsions, free radical chain-growth polymerization, emulsion templating

Domain: Material Science (Polymer)

Summary: Conventional methods of generating polyHIPEs involve formation of an emulsion with shear-based methods followed by polymerisation of the external phase and evaporation of the internal phase. Shear based methods for making emulsions lead to large dispersity in the pores and interconnects of polyHIPEs. Moreover, it is difficult to precisely tune the morphology of the porous polymer. Non-uniformity in polymer constructs have adverse effects, such as inhomogeneous cell growth inside a tissue scaffold. Therefore, a technique is devised to control and tune the morphology of polyHIPEs. High internal phase emulsions (HIPEs) are among complex biphasic fluids that expand on the traditional emulsion compositions, for instance, for the preparation of macroporous polymers by emulsion templating. A new technique based on co-flow device is developed to produce three-dimensional (3D) highly porous and interconnected poly high internal phase emulsions (polyHIPEs) with controllable pore size and porosity. The pore size and porosity can be tuned precisely by varying the device geometry and the flow rates of internal and external phases in the co-flow device.



Process steps for preparation of highly ordered polyHIPE

- This method generates a monodisperse high internal phase emulsion (HIPE) with volume fraction of the internal phase greater than 74%, followed by polymerization of the external phase of HIPE to obtain a polyHIPE.
- The method enables fabrication of polyHIPEs using a low-cost co-flow device costing less than USD 5.
- This process can be scaled up by using several devices running in parallel to produce HIPE continuously in relatively large quantities.

Advantages:

» Highly-ordered 3D porous polymeric constructs of desired porosity and pore size can be produced. In contrast with conventional shear-based methods, our method yields minimal dispersity in sizes of pores and interconnects.

» The co-flow device is of significantly lower cost compared with microfluidic flow-focusing devices reported previously for making monodisperse HIPEs.

» Simple and economical design of the device enables large scale continuous production of polyHIPEs through parallelization.

Applications: Highly porous polymers such as polyHIPEs have wide ranging applications, such as scaffolds in tissue engineering, separation media and catalyst support

Scale of development: A functional prototype polymer is developed and validated by testing in Laboratory environment.

Technology Readiness Level: 5

IP Status: Granted Indian Patent 355686