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3D-Printing Compressible Macroporous Polymer Using Poly-Pickering-High Internal Phase Emulsions as Micromixer

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Abstract : Microfluidic mixing technology grew rapidly in the past few years due to its many advantages over the macro-scale mixing, especially the ability to use small amounts of internal volume and also very high surface-to-volume ratio. The Reynold number identify whether the mixing is operated by the laminar or turbulence flow. Therefore, mixing with very fast kinetic can be achieved by diminishing the channel dimensions to decrease Reynold number and the laminar flow can be accomplished. Moreover, by using obstacles in the micromixer, the mixing length and the contact area between the species have been increased. Therefore, the channel geometry and its surface property have great importance to reach satisfactory mixing results. Since poly(-merised) High Internal Phase Emulsions (polyHIPEs) have more than 74% porosity and their pores are connected each other with pore throats, which cause high permeability, they are ideal candidate to build a micromixer. The HIPE precursor is commonly produced by using an overhead stirrer to obtain relatively large amount of emulsion in batch process. However, we will demonstrate that a desired amount of emulsion can be prepared continuously with micromixer build from polyHIPE, and such HIPE can subsequently be employed as ink in 3D printing process. In order to produce the micromixer a poly-Pickering(St-co-DVB)HIPE with 80% porosity was prepared with modified silica particles as stabilizer and surfactant Hypermer 2296 to obtain open porous structure and after coating of the surface, the three 1/16' ' PTFE tubes to transfer continuous (CP) and internal phases (IP) and the other is to collect the emulsion were placed. Afterwards, the two phases were injected in the ratio 1:3 CP:IP with syringe dispensers, respectively, and highly viscoelastic H(M)IPE, which can be used as an ink in 3D printing process, was gathered continuously. After the polymerisation of the resultant emulsion, polyH(M)IPE has interconnected porous structure identical to the monolithic polyH(M)IPE indicating that the emulsion can be prepared constantly with poly-Pickering-HIPE as micromixer and it can be used to prepare desired pattern with a 3D printer. Moreover, the morphological properties of the emulsion can be adjustable by changing flow ratio, flow speed and structure of the micromixer.

Keywords : 3D-Printing, emulsification, macroporous polymer, micromixer, polyHIPE
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