Ultra Permeable Macroporous Polymers from Pickering-High Internal Phase Emulsions

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Emulsion templating offers effective control over the porosity, foam density and pore dimensions of synthesized polymer foams. We have recently shown that it is possible to eliminate surfactants completely from formulations used as emulsion template and yet successfully prepared highly porous polymer monoliths. We have used various suitably functionalized nanoparticles, such as carbon nanotubes, titania and silica particles, as emulsifiers to prepare Pickering emulsion templates. Using particulate emulsifiers provides a number of processing advantages; it removes the need for structurally parasitic surfactant and allows to prepare macroporous polymers with much larger pores (up to 1500 µm in diameter) as commonly observed in polyHIPEs made from surfactant stabilized emulsions and always leading to nanocomposite foams. However, the major disadvantage of the concentrated Pickering emulsion or Pickering-HIPE templating method is that the polymerization of the continuous monomer phase of such emulsions always results in (mainly) closed-celled macroporous polymers and thus the polymer foams are impermeable. According to Biassetto et al.[1], the permeability of microcellular foams is limited by the pore throat size. Hence large pores and pore throats with dimensions greater than that seen in conventional polyHIPEs will be required to increase the permeability of polyHIPEs.

We will show it is possible to manufacture open porous poly-Pickering-HIPEs from emulsions consisting of varying phase volume fractions of water in styrene/DVB or in styrene/PEGDMA. The emulsion templates have been stabilized by suitably functionalized particles and polymerized. The permeability of the porous polymers to gas was determined by gas flow measurements. Our macroporous polymers possess permeabilities of up to 3.5 Darcy, which is an improvement by one order of magnitude if compared to conventional polyHIPEs (460 milliDarcy).

References:

[1] L. Biasetto, P. Colombo, M.D.M. Innocentini, S. Mullens, *Ind. Eng. Chem. Res.* **2007**, *46*, 3366.