Design and Manufacturing of Stimuli-Responsive Microcapsules

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Over the last decade, there has been a large interest in designing encapsulating structures that can control the delivery of actives in response to changes in their environment. For this purpose, the properties of stimuli-responsive polymers are of great interest as part of the design of the capsule shells. Here, we present our recent work related to the preparation of core-shell nanoparticles, where the solid core is coated with a responsive polymer. These particles are subsequently used for the stabilisation of oil-in-water emulsions as part of a procedure to use solid-stabilised emulsions as templates for the preparation of responsive microcapsules. Polystyrene nanoparticles with a 'soft', responsive shell of poly methylmethacrylate -b- poly [2-(dimethylamino) ethyl methacrylate (PMMA-b-PDMAEMA) were prepared using emulsion polymerisation and dispersion polymerisation. The PDMAEMA polymer is both responsive to pH and temperature and we demonstrate a responsive behaviour of the core-shell particles in suspension with respect to those stimuli. Subsequently, we show how we can use these particles as emulsifiers for the production of oil-water emulsions in large-scale. Responsive polystyrene particles will be used in this case to demonstrate the possibility to produce such emulsions from a membrane emulsification apparatus. In this process the oil phase is pushed through a membrane into the continuous phase containing a dispersion of the particles. As the droplets grow from the pores the particles adsorb to the oil-water interface precipitating the responsive polymer and provide colloidal stability to the emulsion. This method produces stable emulsion droplets in the range of 100 microns. We show a systematic study of this process demonstrating that not only pH and salt concentration but also the mechanical parameters of emulsification have a large effect on the stability of the emulsion droplets.