From the design of polymeric surfactants to obtain nanoemulsions by phase inversion temperature

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Nanoemulsions are remarkable for their high specific area and kinetic stability among others. They have many pharmaceutical or cosmetic applications for their high performances in drug delivery [1] and are often required as an intermediate for the formulation of nanocapsules [2]. Nevertheless, their making requires high mechanical energy input through traditional emulsification methods also called "high energy methods" [3]. Therefore, low-energy methods such as Phase Inversion Temperature (PIT) can be cost-effective alternatives for the production of nanoemulsions [4]. The principle of the PIT relies on the ability of a temperature-sensitive surfactant to shift its overall affinity from the aqueous phase of the emulsion [5] to the hydrophobic one with increasing temperature. Examples of PIT are reported with small commercially available surfactants but almost never for polymeric surfactants [6].

After a short introduction on the design of nanoobjects and on emulsification processes, this talk will focus on our studies on PIT process to emulsify a dodecane/water system using various polystyrene-b-poly(oligo(ethylene glycol) methyl ether methacrylate) as surfactants. A two-step synthetic pathway using the Atom Transfer Radical Polymerisation was adapted from the literature [6, 7] to synthesize the copolymers with various molecular weights and POEGMA/PS weight ratios. To monitor PIT process, emulsification was carried out under a constant temperature rise in a rheoreactor equipped with a helical ribbon as well as with conductivity and temperature probes (figure 1) as set up before in our laboratory [8]. The potential of such surfactants in PIT process and to produce nanoemulsions was investigated and compared to a model small surfactant. The design of the copolymer (molecular weight, hydrophilic/hydrophobic ratio) and the number of cycles have shown to be crucial to control the performances of the PIT process.

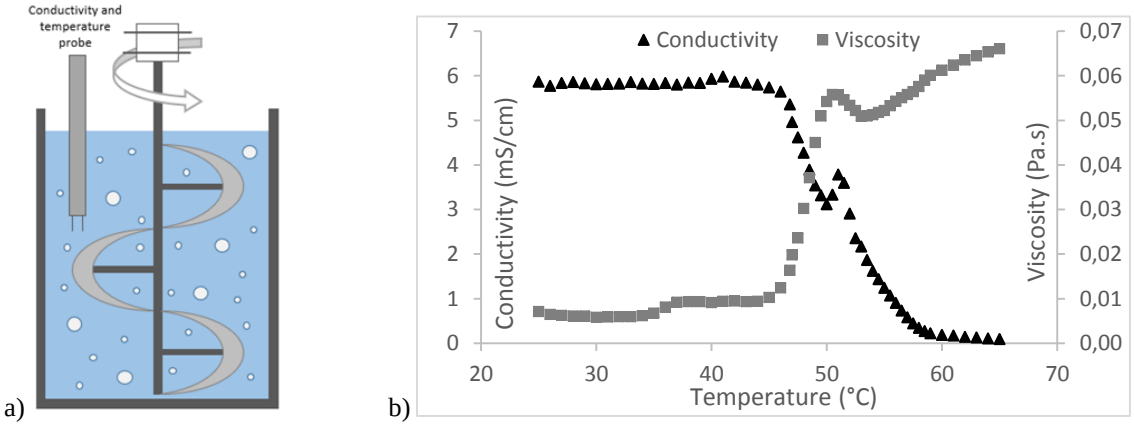

Figure 1. Conductivity and viscosity monitoring of the PIT a) Experimental setup b) Example of results with dodecane/water system using one of copolymer surfactant (Mw = 17 500 g/mol, D=1.4).

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