Experimental report

01/02/2016

Proposal: 9-10-1427 **Council:** 10/2014

Title: Worm-like reversed micelles with aCO2-philic surfactant

Research area: Chemistry

This proposal is a new proposal

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Samples: water-alkane-surfactant-hydrotrope-phenols

Instrument	Requested days	Allocated days	From	To
D22	2			
D11	2	0		
D33	2	2	13/05/2015	15/05/2015

Abstract:

Hydrotropes (Figure 3 A-C) are known viscosifying agents with surfactants in organic solvents1 and interestingly now in supercritical CO2 (scCO2)5. The mechanism is hydrotrope-induced micelle growth to generate worm-like reverse micelles (WLRMs) 1,3,5. This experiment is to develop new surfactant+hydrotrope (or phenol) gelator combinations which are not only organophilic, but are also at same time CO2-philic. These would be unique WLRM systems, able to viscosify/gelate both oils and scCO2. In this initial phase the ILL experiment will study organogelation, and these results will inform future studies with the same mixtures in scCO2 under high pressure conditions at ISIS (to be submitted Oct 14). A new approach taken here is to combine hydrotropes and phenols with a known CO2-phillic surfactant (TC14, Figure 2). This research has received external publicity through the UK government agency UK trade and Investment (UKTI)7 and is supported by the G8 Research Councils Initiative on Multilateral Research Funding - G8-2012 (Bristol, Nice and Hirosaki) - EP/K020676/1 and an STFC funded studentship ‘Controlling fluid properties of dense CO2’

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Recent work has shown that the addition of low molecular weight organogelators (LMOGs) in the form of p-substituted phenols (p-methyl phenol) can induce the formation of surfactant based thermo-responsive organogels using hydrocarbon based sulfosuccinate surfactant Aerosol-OT (Na(AOT)) (**figure 1**). Contrast variation Small-angle neutron scattering (CV-SANS) has been employed to try and further understand the location of the phenol and surfactant in the gelled system (**figure 2)**.

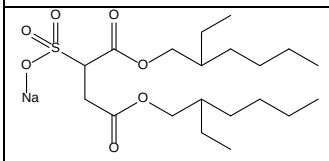
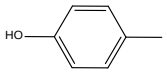
Na(AOT)	p-methyl phenol
	

Figure 1: Structures of surfactant and phenol used.

Scattering profiles at high T have been fit to a core-shell spherical models using fitting program SASview after applying the Guinier approximation and determining R_g for the species. When temperature is decreased, it is evident that there is a significant elongation of the micellar structure, indicative of the formation of the organogel. Elongation in these systems is key to the development of viscosifiers for supercritical CO_2 ($scCO_2$), many CO_2-philic surfactants are based on the structure of Na(AOT). As studying and classifying surfactant assemblies in $scCO_2$ is incredibly experimentally challenging (samples need to be formed in-situ at high pressure (100-500bar) in a specially designed sample environment) we have devoted a significant amount of time to developing methodology and theory which allowed less beam-time intensive environments (surfactant/D_2O/oil) to act as proxies for water-in-carbon dioxide microemulsion systems. This promising area of research can now be further explored through investigation of partially fluorinated surfactants CO_2-philic surfactants that are analogous to Na(AOT) and substituted phenols that could be transferred to $scCO_2$. A manuscript for publication of this work is currently being prepared.

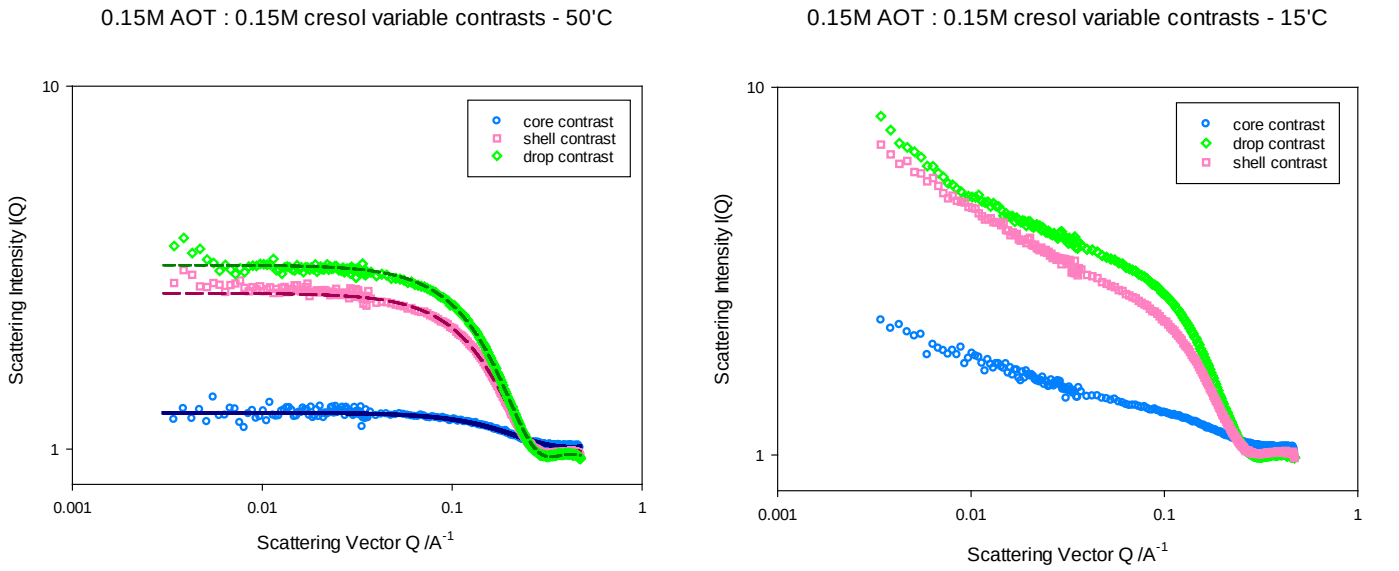


Figure 2: SANS profiles of Na(AOT) based organogels at high and low temperatures.