Experimental report

04/04/2016

Proposal: 9-10-1423 **Council:** 10/2014

Title: Effect of hydrotropes on film bending energy in w/o microemulsions

Research area: Chemistry

This proposal is a new proposal

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Samples: water-alkane-surfactant-hydrotrope

Instrument	Requested days	Allocated days	From	To
D22	1	0		
D11	1	0		
D33	1	1	15/05/2015	16/05/2015

Abstract:

Hydrotropes are small amphiphilic molecules with hydrophilic character. The compounds have numerous industrial uses as additives for enhancing solubilization of hydrophobic compounds, detergents, stabilizing emulsions etc. When used in combination with surfactants, hydrotropes give enhanced stabilization to systems of research interest, such as water-in-oil (w/o) and oil-in-water (o/w) microemulsions. Interestingly hydrotropes added to spherical droplet microemulsions can induce formation of anisotropic droplets (ellipsoid/cylindrical) - in both aqueous and oily phases. This shows that hydrotropes have a profound effect on properties of the interfacial films, forcing curvatures different from spherical. Such changes in film packing and aggregation shape enhance viscosity of the dispersions, suggesting potential applications such as enhanced oil recovery (EOR). However, origins of these properties of hydrotropes are not yet properly understood. Here, a method is proposed to investigate the effect of hydrotrope molecules as stabilizers in mixed films with a standard surfactant, in w/o microemulsions, by studying the surfactant film bending energies using SANS.

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Abstract

An oxygen-rich hydrocarbon (HC) amphiphile has been developed as an additive for supercritical CO_2 ($scCO_2$). The effects of this custom-designed amphiphile have been studied in water-in-CO_2 (w/c) microemulsions stabilised by analogous fluorocarbon (FC) surfactants, $nFG(EO)_2$, which are known to form spherical w/c microemulsion droplets. By applying contrast-variation small-angle neutron scattering (CV-SANS), evidence has been obtained for anisotropic structures in the mixed systems. The shape transition is attributed to the hydrocarbon additive, which modifies the curvature of the mixed surfactant films. This can be considered as a potential method to enhance physico-chemical properties of $scCO_2$ through elongation of w/c microemulsion droplets. More importantly, by studying self-assembly in these mixed systems, fundamental understanding can be developed on the packing of HC and FC amphiphiles at water/CO_2 interfaces. This provides guidelines for the design of fluorine-free CO_2 active surfactants, and therefore, practical industrial scale applications of $scCO_2$ could be achieved.

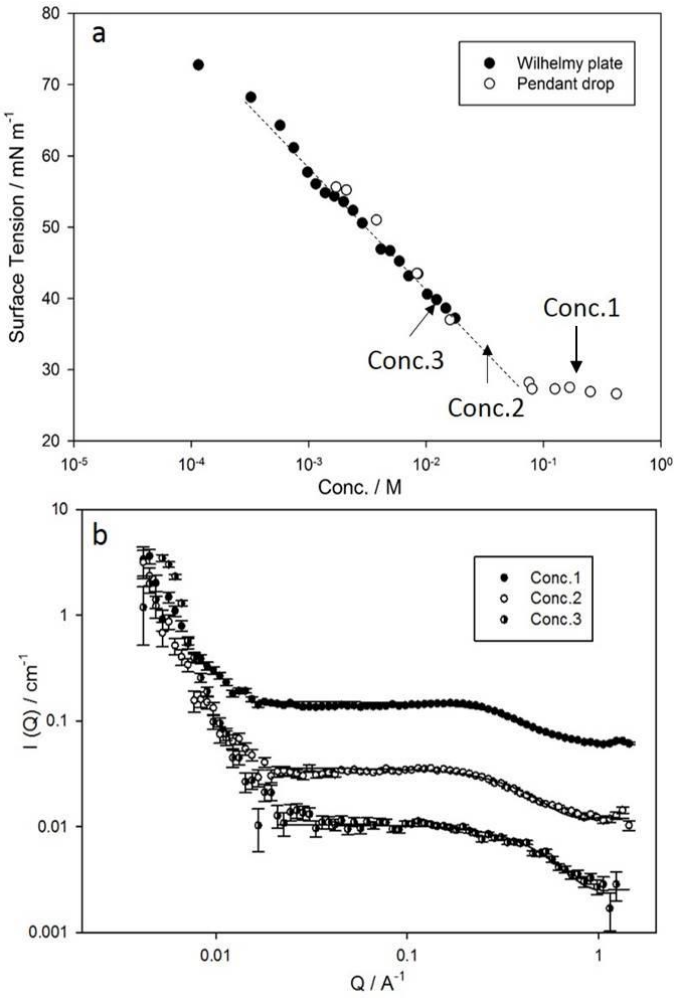

Figure S3a (upper) a plot of surface tension vs. the concentration of surfactant, the results were obtained by both plate tensiometery (black dots) and pendant drop shape analysis (white dots). Figure b (lower), SANS results for di-

IGSS in D_2O at concentration $C_{di\text{-}IGSS}$=0.192 M (Conc.1), $C_{di\text{-}IGSS}$=0.046 M (Conc.2) and $C_{di\text{-}IGSS}$=0.011 M (Conc.3).