Experimental report

08/01/2019

Proposal: 9-10-1546 **Council:** 4/2018

Title: Mixed H/F-Carbon surfactant monolayers for fire-fighting applications

Research area: Chemistry

This proposal is a new proposal

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Experimental team: Christopher HILL

Local contacts: Yuri GERELLI

Samples: Fluorocarbon Surfactants

Instrument	Requested days	Allocated days	From	To
FIGARO	3	2	24/09/2018	26/09/2018
D17	3	0		

Abstract:

The aim is to use Neutron Reflectivity (NR) to gain essential information on the adsorption properties of fluorocarbon/ hydrocarbon mixtures in commercial fire-fighting foam formulations. These practical surfactants (Figure 1) have already been studied individually by NR (at the ISIS facility), and a good understanding of their interfacial properties has been gained. Therefore, these results will be able to provide essential information on which surfactants are dominating the interfacial properties of the fire-fighting foam formulation. This is the second stage in a 3-year program, including NR, so that F-carbon surfactants can be replaced by more environmentally-responsive low-F or hydrocarbon analogues. Chris Hill is a 3rd year PhD student fully funded by fire-fighting technology company Angus Fire (French subsidiary company, Eau et Feu).

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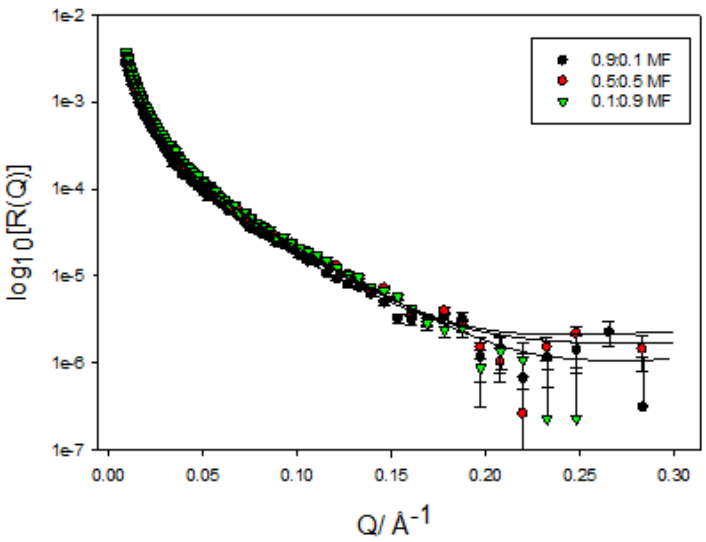
Instrument: FIGARO
Dates of experiment: 24/09/2018 to 26/09/2018

Fire-fighting foam formulations are complex, multicomponent systems that contain mixtures of fluorocarbon (FC) and hydrocarbon (HC) surfactants. By having a mixture of FC and HC surfactants, these formulations are found to exhibit superior properties spreading over an oil surface, because the air-water surface will be preferentially covered with the FC surfactant to depress the air/water surface tension effectively, whereas the HC surfactant will preferentially adsorb at the oil/water interface to depress the interfacial. Although this is well known in the field, there has not been any research to determine how the orientation/ composition of the surfactants at the air/water interface both individually and as mixtures in mimics of a real fire-fighting formulations.

The experiment was based on trying to characterise the monolayer of a fluorocarbon (FC)/ hydrocarbon (HC) mixed surfactant system using contrast variation neutron reflectivity. There were three FC surfactants (1 anionic, 1 non-ionic and 1 zwitterionic) which were all mixed with d-SDS at three different mole fractions (0.9:0.1, 0.5:0.5, 0.1:0.9). The measurements were carried out on all three mixed systems at these mole fractions, at multiple concentrations above and below their pre-defined respective mixed CMCs in ACMW, D2O and F-Contrast matched water. Initial results from the zwitterionic fluorocarbon surfactant/ d-SDS mixed system studied are shown below in ACMW:



1157: SDS MF	Fitted SLD/ (10^{-6} Å^{-2})	Fitted Thickness/ (Å)
0.9:0.1	1.98	20.50
0.5:0.5	2.00	26.20
0.1:0.9	2.50	23.40

Figure 1: Zwitterionic Capstone 1157 and d-SDS at different mole fractions above respective CACS. Black lines are fitted models to the data. The table shows the parameters used to fit the data.

The results shown are all at 2 x CAC at the 3 different studied mole fractions, to make sure that the surface is fully saturated. From the results, it can be seen that as the mole fraction of d-SDS increases, the SLD increases, suggesting that the composition of the interface is changing. The results suggest the formation of mixed monolayers containing both FC and HC surfactants, although the surface seems to be dominated by the FC surfactants. We are still carrying out analysis on the remainder of the data, which will make up a substantial chapter in my thesis and we hope to also write up this work for publication in 2019.