

# Experimental report

24/08/2017

**Proposal:** 9-10-1499

**Council:** 10/2016

**Title:** Aggregation for surfactants used in fire fighting

**Research area:** Chemistry

**This proposal is a new proposal**

**Main proposer:** Julian EASTOE

**Experimental team:** Christopher HILL

Adam CZAJKA

Gavin HAZELL

**Local contacts:** Isabelle GRILLO

**Samples:** water fluorocarbon surfactants

Instrument	Requested days	Allocated days	From	To
D11	0	0		
D33	2	1	26/02/2017	27/02/2017
D22	0	1		

## Abstract:

The aim is to probe micellar structures of three common industrial fluorotelomer surfactants used in fire-fighting foam formulations (Figure 1) using contrast variation SANS. These surfactants will be studied individually, and as mixed systems, using typical compositions found in fire-fighting foam formulations. The data will allow to (1) identify the adopted micelle structures for each surfactant and (2) understand how/if aggregation is affected by mixing so as to provide new understanding on the colloidal properties of these practical surfactants. This is the first stage in a new 3-year program, including SANS, so that F-carbon surfactants can be replaced by more environmentally-responsive low-F or hydrocarbon analogues. Chris Hill is a 1st year PhD student fully funded by fire-fighting technology company Angus Fire.

9-10-1499

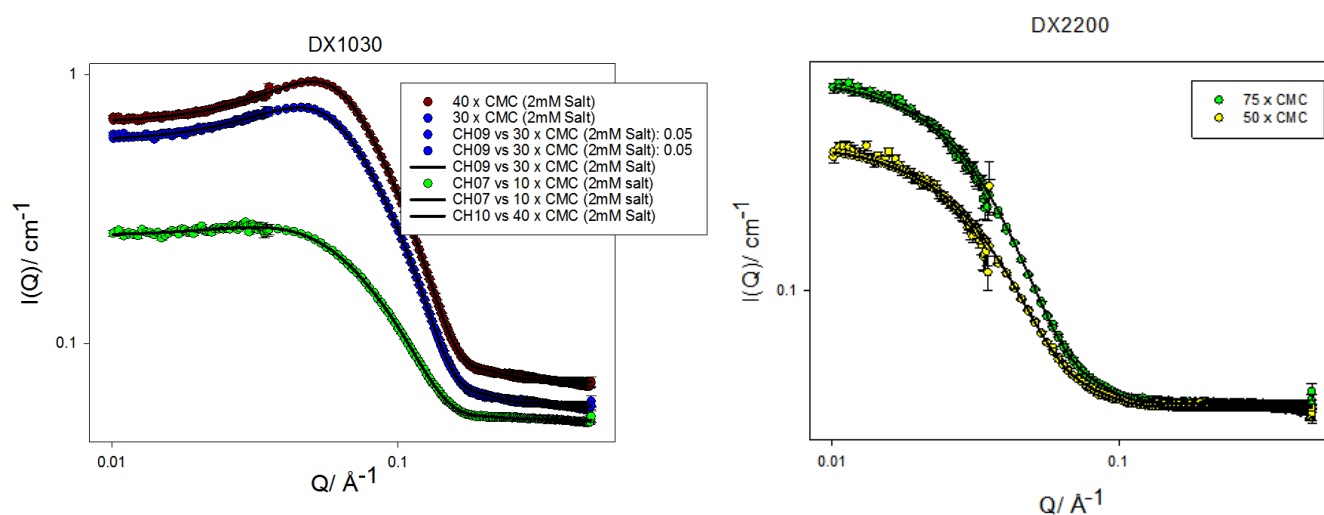
**Title:** Aggregation for surfactants used in fire-fighting

**Instrument:** D33

**Dates of experiment:** 26/02/2017 to 27/02/2017

Fire-fighting foam formulations are complex, multicomponent systems, often containing mixtures of fluorinated and hydrogenated surfactants. It is of interest to determine how these surfactants self-assemble individually and in mixtures in mimics of a real fire-fighting formulations. By having a good understanding of how these surfactants self-assemble individually, any changes to the scattering profiles when studying mixed systems should be obvious. Therefore, this experiment was carried out to gain a sound understanding of how these surfactants self-assemble individually.

Small-angle neutron scattering (SANS) experiments were carried out on three common fluorinated fire-fighting surfactants (1 anionic, 1 non-ionic and 1 zwitterionic), figure 1 shows the scattering profiles for both the anionic and the non-ionic surfactants. 2 mM of NaCl was added to the anionic surfactant to attempt to remove the structure factor, however a higher concentration was determined to be necessary for complete charge screening. Guinier and porod approximations have been used to determine the radius of these two aggregating species. From guinier  $R = 23 \pm 2 \text{ \AA}$  for anionic DX1030 and  $R = 41.5 \pm 1.5 \text{ \AA}$  for non-ionic DX2200 (Porod approximations gave very similar values). Model fits have been attempted and good fits were achieved, providing radii similar to values observed from initial guinier and porod approximations. These results are only preliminary at the moment, and complete analysis is currently being carried out. With regards to the zwitterionic surfactant, the scattering profile was found to scatter to much lower values of  $q$  (rod like scattering profile) and we are having trouble modelling the data, hence why it has been omitted from the report. Once complete analysis has been carried out, we will begin to start writing a manuscript and the results will be featured within it.



**Figure 1.** SANS of anionic DX1030 and Non-ionic DX2200. The solid lines represent attempts to fit the data to a spherical form factor for DX1030 (with an added structure factor for the higher concentration samples) and ellipsoidal form factor for DX2200.