Experimental report

31/08/2022

Proposal: 9-12-657 **Council:** 4/2021

Title: Effect of mixed solvent and temperature on the the phase behavior of hydroxypropyl cellulose in the presence of sodium dodecyl sulfate

Research area: Chemistry

This proposal is a new proposal

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Samples: glycerol/C3H8O3
Hydroxypropyl cellulose
Sodium dodecyl sulfate/C12H25NaO4S
Full deuterated sodium dodecyl sulfate/C12D25NaO4S

Instrument	Requested days	Allocated days	From	To
D11	3	1	01/10/2021	02/10/2021
D22	3	0		

Abstract:

Smart materials, such as responsive aqueous foams, have gained considerable attention due their properties. These foams, for which the stability is sensitive to external stimuli, are of interest for several applications where both formation and destabilization of foams is required. Although thermoresponsive foams from synthetic polymers have been studied, poor results were achieved due to their instability and to the loss of responsiveness with temperature if mixed with sodium dodecyl sulfate (SDS). Our purpose is to study hydroxypropyl cellulose (HPC) as a green polymer alternative in mixture with SDS and glycerol to gain stable thermoresponsive foams. The comprehension of the structure of the HPC/SDS complex mixtures at the liquid-air interface should be related to the bulk complex with respect to the temperature is not clearly defined yet. SANS measurements are essential to define its morphology. Such measurements are limited, at the moment, to the bulk solution in preparation of future measurements on foams with a proper cell.

(9-12-657) Effect of mixed solvent and temperature on the phase behavior of hydroxypropyl cellulose in the presence of sodium dodecyl sulfate

Hydroxypropyl cellulose (HPC), one of the most well-known cellulose derivatives, is a surface-active non-ionic polymer that is soluble in both water and organic solvents. One of the most interesting property of this polymer is its thermo-responsivity, in fact, HPC can change its solubility as a function of temperature. This feature allows the HPC to be considered for stimuli-responsive foams, where macroscopic properties need to be reversibly changed on demand also with the use of co-solvent such as glycerol which is an aqueous foam stabilizer. Thermo-responsivity from HPC is substantially associated with the lower critical solution temperature (LCST) of the polymer in aqueous solutions. The presence of cosolvent can drastically modify this temperature and the size and morphology of the aggregate above the LCST. Furthermore, this kind of polymer typically forms complexes with anionic surfactants. This process has been widely investigated; however, studies in presence of glycerol are completely absent in the literature. Also, the effect of temperature on the morphology of the complexes (both in the presence and absence of glycerol) is not yet investigated. The purpose of this research project is a description of the complexation process which occurs between HPC and SDS in terms of temperature gradient and surfactant concentration and in presence of glycerol. Preliminarily, we investigated the effect of sodium dodecyl sulfate (SDS), a widely used surfactant, on the transition temperature (LCST) of the hydroxypropyl cellulose (HPC) in aqueous solution and in mixed solvent water/glycerol 7/3 w/w by Fluorescence Spectroscopy and Dynamic Light Scattering (DLS) using a temperature gradient. From the Fluorescence data, the presence of SDS causes the shift of the LCST at a higher temperature compared to the one without the surfactant, on the other hand, the presence of glycerol causes a reduction of the LCST. From DLS for the system HPC-SDS, we observe a marked change in the size of scattering objects as the temperature is raised. From the SANS data, by increasing the SDS concentration the morphology changes from a rigid rod chain to a “pearl necklace” structure. It is also evident a substantial change in scattering profile between the measurements at 25 °C and 65 °C (shown in figure 1), is a sign of the formation of polymeric aggregates, even if the presence of glycerol causes a reduction in the aggregates dimension.

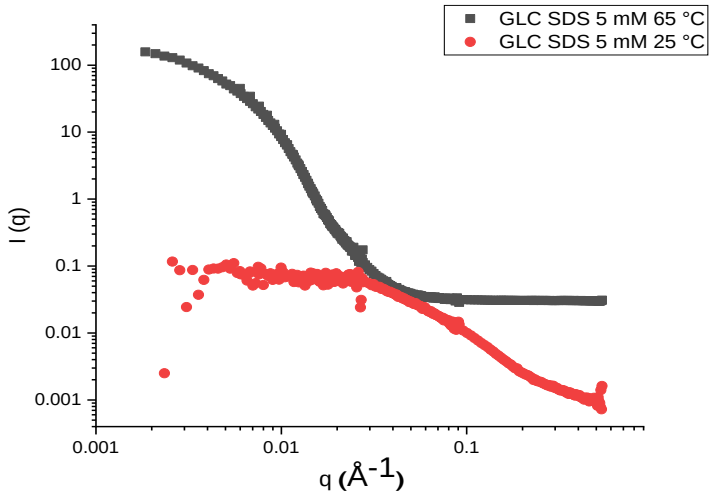

Figure 1. SANS profiles of glycerol/SDS 5 mM at 25 °C (red circles), and at 65 °C (black squares).

These SANS data will be fitted using SASView software to confirm the ellipsoid global structure and the local structure as a “pearl necklace” structure.