

Designing responsive foams with an adjustable temperature threshold of destabilization

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ABSTRACT

Responsive aqueous foams refer to foams for which the macroscopic stability with time can be switched between a stable and an unstable state [1]. The optimization of many processes such as washing or material recovery processes require at the same time the formation of a stable foam, as well as the need to destabilize it in another step of the process. Our aim was to design thermoresponsive foams with a widely adjustable temperature threshold of destabilization.

We developed a green formulation: 12-hydroxystearic acid (12-HSA) mixed with counterions (alkanolamine) of different chain lengths, and at different molar ratio R between 12-HSA and the counterions [2-3]. First, by coupling microscopy techniques, SANS & X-ray scattering and DSC, we investigated the bulk structures, from the molecular to the mesoscopic scale. For all the counterions and depending on the temperature and R, either 12-HSA micron-size tubes or micelles were formed. We showed that tubes transitioned into micelles at a precise temperature. This temperature transition depended on both R and the alkyl chain length of the counter-ion and could be precisely tuned from 20°C to 75°C. We highlighted that the transition at the supramolecular scale came from the chain melting phenomenon at low R and the surface melting process of the hydrogen bonds at high R [2]. Second, at the macroscopic scale, we demonstrated that foams were ultrastable in the presence of tubes [3]. However, by increasing the temperature of the foam above the temperature transition, they rapidly collapsed when tubes transform into micelles. Remarkably, by changing the counterion and R, the foam can be precisely stabilized/destabilized at any given temperatures between 20°C and 75°C (Figure 1).

It is the first time that, by using the same surfactant, responsive foams are made with a threshold temperature varying over such a wide range of temperatures [3].

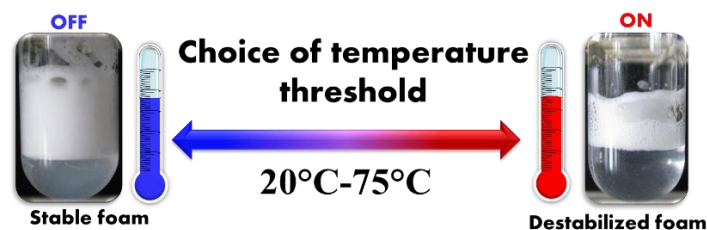


Figure 1: Illustration of the thermoresponsive foams between 20 to 75°C.

[1] S. Fujii, & Y. Nakamura. *Langmuir*, 2017, 30, 7365.

[2] A-L. Fameau, F. Cousin & A. Saint-Jalmes. *Langmuir*, 2017, 33, 12943.

[3] A-L. Fameau, F. Cousin, R. Derrien & A. Saint-Jalmes. *SoftMatter*, 2018, 14, 2578.