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How to produce responsive aqueous foams based on green surfactants?

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Soft materials, such as foam and emulsion systems, which respond to external stimuli, are on the leading edge of materials research and have recently been of interest to many scientists, such as Isabelle Grillo. The macroscopic responsivity relies on the ability to react at microscopic or mesoscopic scales. Stimuli-responsive surfactants that can change their structure in response to a trigger such as pH, temperature or light have attracted great attention due to their versatile applications in various fields. A change in the molecular structure of the surfactant activated by stimuli can affect the self-assembled structure in water and the interfacial activity, which can in turn tune the properties at the macroscopic scale such as emulsion and foam stability. Responsive foams correspond to foams for which stability can be reversibly tuned between ultrahigh stability and immediate destabilization under stimuli [1].
Fatty acids are anionic surfactants of particular interest since they can be extracted from agricultural resources and are available in large amount in nature. These biomolecules can be qualified as green surfactant with both biodegrability and low toxicity. Fatty acid molecules can self-assemble under various shapes in aqueous solution [2]. These self-assembled structures can respond to stimuli such as pH and temperature due to changes occurring at the molecular level [2]. These specificities make them green surfactants of special interest to tune the foam stability.
Our approach to produce responsive foams from fatty acid self-assemblies is to use the links between the microscopic, mesoscopic and macroscopic scales. The prerequisite to produce these smart foams is a perfect understanding of the mechanisms leading to changes of self-assembled structures both in bulk and at the air/water interface under stimuli. These structural changes are determined by neutron scattering. 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 [3-4].We will illustrate how both SANS and neutron reflectivity are fundamental techniques to obtain the key information to produce thermoresponsive foams based on this system [5]. We will also discuss how these systems can be made to be photo- as well as magneto responsive [6-7]. Systems, such as those presented here, could find application in a wide range of industrial and environmental processes that require controlled, non-contact and on-demand defoaming.

References

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