How interfacial rheology can help to formulate a green surfactant.

Surfactants shape our daily life and play a key role in many processes such as cleaning, oil recovery and even food industry. However, the use of surfactants leads to a massive contamination of water and soils as large amounts are discarded into the environment each day. Researchers worldwide are on the search for environmentally friendly surfactants "green surfactants" that can replace the currently used systems and lead to a better ecological footprint. Amongst the most promising candidates are amino-acid based surfactants which can be synthesized from natural products (amino acids and lipids). There are many different amino acids and lipids available that can be combined to achieve different properties. Due to the broad variety of naturally abundant amino acids and lipids it is possible to generate surfactants with different properties. In order to reach a high efficiency, amino-acid based surfactants are compounded with other systems such as sodium lauryl glycine generating complex mixtures that need to be well understood to allow optimizing the formulation rationally. Interfacial rheological experiments by oscillating pendant drops provide an excellent tool to evaluate the absorption of the surfactant at the interface leading to better understanding of the molecular arrangement and the structure of the interfacial absorption films.

Pendant Drop Oscillation Experiment: Viscoelastic Modulus E*

The viscoelastic modulus E* indicates how fast surface active molecules can respond to a change in interface area. For the measurement, a pendant drop is suspended from a cannula surrounded by air (or an outer liquid phase) and its volume is periodically changed. With the volume also the interface area is changed which leads to an alteration of the interfacial tension over time. The speed of the interface tension change is depending on how fast the surface active molecules can reassemble to cover the newly formed interface. A characteristic value for the speed of this surfactant rearangement is the viscoelastic modulus E*.

B. Xu and his team from Beijing Technology and Business University successfully used sodium lauroyl glycinate (C12-Gly-Na) as a representative amino acid-based surfactant and compounded it with different surfactants such as sodium dodecyl sulfate (SDS; anionic), dodecyl trimethyl ammonium bromide (C12TAB; cationic) and Triton X-100 (non-ionic) in order to study the effects on the interfacial behaviour. From interfacial rheological measurements they deducted that mixed systems have a higher interfacial activity compared to pure C12-Gly-Na. Amongst the tested mixtures C12-Gly-Na/C12TAB led to the lowest CMC and the highest dilatation modulus and the experiments indicate the formation of a viscoelastic film at the interface. In addition, the dilatational modulus generally shows a maximum when the concentration of surfactant is increased. However, for amino acid-based surfactants there are two maxima (due to the hydrogen bonding of the amino groups). In presence of C12TAB the second maximum disappears since the strong electrostatic interactions dominate. This gives valuable information on the interfacial behaviour of amino acid surfactants which is urgently needed to pave a way for applying amino acid-based surfactant on a larger scale in cosmetics, food and daily chemical industry.

The dependency of the interfacial properties from time, disturbance frequency and concentration was studied in this work using our contact angle measurement device OCA 25 in combination with an oscillation syringe module ESr-O (Figure 1). This combination is an all in one solution to measure static and dynamic contact angles, surface free energy, surface and interfacial tensions as well as interfacial rheological properties.

Figure 1: ESr-O a versatile syringe module with precisely controllable back and forth piston speed for oscillation and dosing.

If you want to know more about the content of the article, you can directly view the literature information below.

[1] **Interfacial Dilational Rheology of Sodium Lauryl Glycine and Mixtures with Conventional Surfactants**; Z. Chen, · P. Zhang, · Y. Sun, · C. Wang, · B. Xu; *Journal of surfactants and detergents* **2019**, 22, 1477-1485**;** https://doi.org/10.1002/jsde.12312

Contact DPI for more information on the measurement of interfacial rheology.