Non-aqueous foams stabilized by crystalline particles: from design to applications

Liquid foams are complex colloidal systems based on gas bubbles dispersed in a liquid continuous phase [1].Two different categories of liquid foams exist: aqueous or non-aqueous. In contrary to aqueous foams, which have been extensively studied, non-aqueous foams represent a new promising emerging field [1]. Two types of non-aqueous foams are gaining interest: oil foams based on vegetable oil (oleofoams) and alcohol-based foams [2,3]. Oleofoams are a promising option to develop new food products combining both a reduced fat content and new appealing textures and sensorial properties. Oleofoams also possess other advantages of interest for cosmetic and pharmaceutical applications: long-term stability lasts for months even above room temperature, reduction in microbial spoilage as water is absent and so preservatives are not needed [4]. Therefore, oleofoams appear to be a perfect new product regarding the increasing trend to develop "clean label" products in various industries. Alcohol-based foams are gaining interest nowadays since the global pandemic due to COVID-19 and the frequent use of alcohol-based hand sanitizers as recommended by the World Health Organization.

The main difference between aqueous and non-aqueous foams comes from the relatively large difference in the surface tension of the solvents [1]. For non-aqueous systems, the low surface tension makes the adsorption of hydrocarbon-based surfactants energetically unfavourable. One way to produce and stabilize non-aqueous foams is to use surfactant crystalline particles, which can adsorb at the air-liquid surface [5]. In this talk, we will present how crystalline particles based on fatty acids and fatty alcohols can lead to the production and stabilization of both oleofoams and alcohol-based foams [2,6]. The formation and stabilization mechanisms of these two types of non-aqueous foams are the same and based on the adsorption of crystalline particles at the air-liquid surface, which reduce the bare surface area by their presence rather than lowering the surface tension [5]. The key parameter for crystals to adsorb at the air-non-aqueous liquid surface is to exhibit a suitable three-phase contact angle below 90°. These foams are ultrastable due to the dense layer of adsorbed crystals at bubble surfaces that considerably reduce both disproportionation and coalescence.

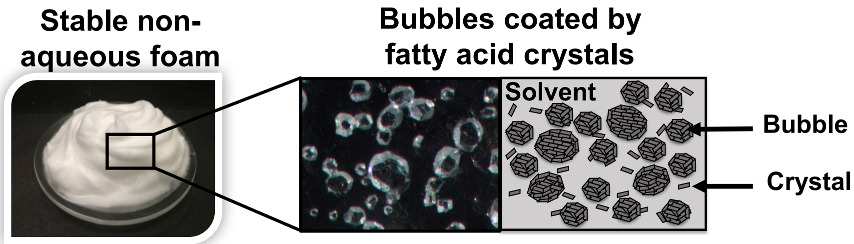

Illustration of non-aqueous foam stabilized by the presence of fatty acid crystals both in bulk and at the interface as observed by polarized light microscopy

1. Fameau A-L, Saint-Jalmes A. Adv Colloid Interface Sci. 2017;247:454–64.
2. Fameau A-L, Ma Y, Siebenbuerger M, Bharti B. J Colloid Interface Sci. 2021;600:882–6.
3. Fameau A-L, Saint-Jalmes A. Front Sustain Food Syst. 2020;4(110).
4. Callau M, Jenkins N, Sow-Kébé K, Levivier C, Fameau A-L. J Cosmet Sci. 2021;72(4):399–405.
5. Fameau A-L, Binks BP. Langmuir. 2021;37(15):4411–8.
6. Callau M, Sow-Kébé K, Jenkins N, Fameau A-L. Food Chem. 2020;333:127403.