Characteristics of polyglycerol esters at air-water interfaces

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Polyglycerol esters (PGE), which are commonly used in various food products, have been shown to be very powerful foaming agents. To better understand how air bubbles are stabilized by this particular surface active agent the mechanical properties of the interface have been studied by interfacial rheology in shear and dilatational mode [1, 2]. It is important to consider both dilatational and shear rheology in order to be able to describe the foaming behavior as well as the foam stability [3]. Using the pendant drop technique at low concentrations and ambient temperature, equilibrium could not be reached even after 4 hours of adsorption time [2]. Therefore all the measurements are performed in a non-equilibrium state, which has to be taken into account in the interpretation of the results.

Because polyglycerol esters show such a remarkable foaming behavior, they are thought to stabilize the interface by a unique mechanism. Since the nature of this surfactant’s structure at the interface is still largely unknown, the main goal of the current project is to gain a better understanding of the stabilization mechanism. One hypothesis, discussed in [2], was based on the fact that the bubble stability was increased at higher adsorption times, which led to the conclusion that multiple layers of surfactant are adsorbed at the interface. This hypothesis was supported also by cryo-scanning electron micrographs that showed thick layers of surfactant [2]. Another hypothesis, which was discussed in [4] for the case of sodium stearoyl lactylate (SSL), would be that at longer adsorption times the surfactants either reorient, form surface clusters, or since PGE like SSL also is a mixture of different molecules, the surfactant molecules that adsorbed at the interface first, are over the course of time replaced by the most surface active molecules in the mixture.

The stability of the foams can be influenced by varying several parameters, such as the pH of the foaming solutions. In addition it is known that these parameters also influence the lamellar structures, in this case the multi-lamellar vesicles, in the bulk solutions [5]. The influence of these parameters, and the thereby changed structures, on the mechanical properties of the interfaces are therefore of major interest. Often only the adsorption behavior of surface active agents is studied, even though the desorption behavior is important to understand the degree of reversibility of the adsorption of a surfactant molecule [6]. By exchanging the bulk fluid (surfactant solution) during an experiment, the behavior of a surfactant covered interface can be studied under changing conditions.