Photoresponsive Self-Assemblies based on Fatty Acids

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Stimuli-responsive surfactants have been recently the focus of many studies [1]. pH-responsive surfactants have been widely studied because of their potential in applications where pH variations are necessary to control self-assembly, such as in enhanced oil recovery or demulsification processes. Fatty acids are a simple class of natural pH responsive surfactants [2]. Here, we present a photoresponsive surfactant system based on fatty acids in the presence of a photoacid generator (PAG) [3]. PAGs are commercially available molecules, relatively inexpensive and they get photolyzed by UV light.

We investigated photoresponsive systems based on fatty acids with different chain lengths in the presence of PAG [3-4]. Under UV irradiation, photolysis of the PAG in aqueous solution resulted in a decrease in pH, triggering a change in fatty acid assembly (Figure 1). Using a multi-scale approach before and after UV irradiation, we characterized the effect of this pH decrease. At the molecular scale, pH and infrared spectroscopy measurements were used to determine the fatty acid ionization state. At the microscopic scale, the self-assembled structure was characterized using small-angle neutron scattering and microscopy. We showed that the change of pH occurring during UV irradiation leads to the protonation of some fatty acids under deprotonated form ($-COO^-$) to produce carboxylic group (-COOH). When the two forms (protonated and deprotonated) coexist, hydrogen bonding formation occurs. This reduces the headgroup area, leading to change of packing parameter and in turn to a change of self-assembly from spherical micelles to vesicles or lamellar phases, depending on fatty acid chain length. We showed a potential application for this photoresponsive system by demonstrating how the UV-induce change in the self-assembled structure can tune the foaming properties [3-4].

This method provides a new simple approach to produce photoresponsive surfactant systems based on environment-friendly fatty acid dispersions. This approach should be generally applicable to other commercially available surfactants with a pH-sensitive headgroup, which is an asset for potential applications in various fields in which stimuli-responsive systems are needed.

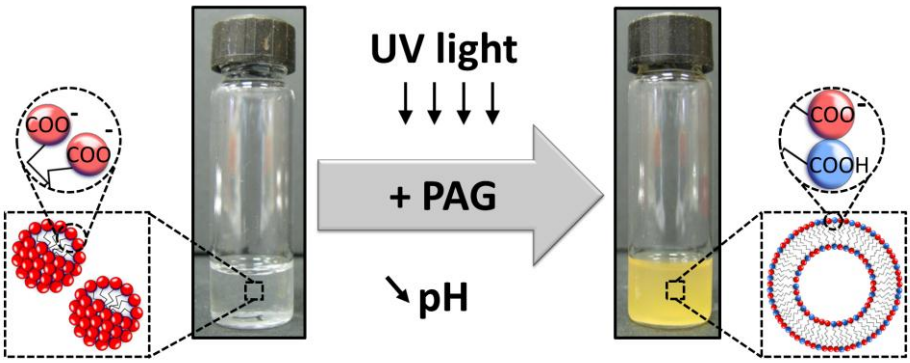

Figure 1: Before UV irradiation, spherical micelles of fatty acids are present in solution. Self-assembly transitions are triggered by UV irradiation due to a pH change induced by the presence of PAG.

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