Effect of alkyl-based surfactant acidity and hydration on the multivalent-metal ion-surfactant interactions

R.F.P. Pereira¹ *, Maria J. Tapia², A.J.M. Valente¹, H.D. Burrows¹

¹ Dept. of Chemistry, University of Coimbra, 3004-535 Coimbra, Portugal
² Dept. of Chemistry, University of Burgos, Plaza Misael Bañuelos s/n, Burgos 09001, Spain
* e-mail: rpereira@qui.uc.pt

The study of multivalent cations and anionic surfactant interactions, in aqueous solutions is of both fundamental and practical importance, since they can lead to dramatic effects on the mixed solution phase behaviour. [1] The factors responsible for the formation of aggregates by amphiphilic molecules in aqueous solutions are well established and there is a vast literature of experimental data which supports theoretical predictions. Although these systems have been widely studied and a number of reviews have been reported, there is not much information about the formation and structure of the resulting aggregates, which complicates the development of models of such systems in solution.

Colloidal systems involving multivalent metal ions have applications in detergency, wastewater treatment, gel formation and development of thickeners and dispersants, catalysis, analytical chemistry, froth flotation for metal ion recovery, and contrast agents for magnetic resonance imaging. These systems have also considerable potential in materials science, including templated synthesis of mesoporous materials, preparation of nanoparticles, and formation of metal-organic frameworks (MOFs). [1,2]

In this work we will discuss the effect of two different surfactants (sodium dodecyl sulfate and sodium dodecanoate) on multivalent ion-surfactant interactions. These surfactants are salts of strong and weak acids, respectively, such that the role of surfactant solution acidity on the interaction play will be studied and rationalised.

Divalent cations, Ca²⁺ and Pb²⁺, and trivalent cations Al³⁺ and Cr³⁺, are used in the study. All of these ions are of great interest due to their industrial, environmental and biological importance. Special focus will be given to aluminium and chromium, which have been chosen to encompass an important property of hydrated trivalent metal ions. These ions have the same general physical properties, but they differ in their tendency to lose water in their primary hydration sphere, where the exchange of water in the primary hydration sphere of Cr(III) is at least six orders of magnitude slower than with Al(III). [3] Thus, an assessment of hydration on possible interactions can be discussed.

Interactions metal-surfactant are followed using different techniques, including electrical conductivity, potentiometry (pH and ion selective electrode), optical transmittance, NMR and inductively coupled plasma-atomic emission spectroscopy.

With the present study, we intend to contribute to a deeper understanding of the structure of solutions which will be valuable for both practical and fundamental applications.