Adsorption and Lubrication of Alanine-based Anionic Surfactant with Cationic Polyelectrolyte at Solid/Aqueous Solution Interfaces

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Anionic surfactants and cationic polyelectrolytes form complexes through electrostatic interactions in water. These complexes change their phase state due to charge balancing and are typically formulated in shampoos [1, 2]. In recent years, amino-acid-based surfactants are of increasing interest due to aspects of their environmental and human-friendly nature [3].

In this study, we characterized adsorption of surfactant-polymer complexes on a solid surface. We employed sodium dodecanoyl β-methylalanine (C12MeAlaNa) as an amino-acid-based anionic surfactant and a quaternary ammonium-type cationic polyelectrolyte (CP). The solid surface used in this study was negatively charged hydrophilic silica. The adsorption and desorption behaviors on the solid surface were evaluated using a quartz crystal microbalance with dissipation monitoring (QCM-D) technique and atomic force microscopy (AFM). Furthermore, lubrication of the adsorbed complexes was assessed using a ball-on-plate type automatic friction analyzer.

QCM-D measurements demonstrated that premixing aqueous solutions of C12MeAlaNa and CP resulted in decreased frequency ($\Delta F_3/3$) and increased energy dissipation (ΔD_3), suggesting the formation of a relatively thick and viscosity-dominant adsorption film. This adsorption is driven by positive charges of CP as anchoring sites, even though negative charges originating from C12MeAlaNa predominate in the mixtures. Subsequent rinsing with pure water resulted in increases in both $\Delta F_3/3$ and ΔD_3. This reflects increased viscosity of the adsorption film remaining on the solid surface.

Regarding lubrication properties, the adsorption of these complexes significantly reduced kinetic friction coefficients compared to a pristine silica surface. The excellent lubricity was maintained even after rinsing with pure water, due to the adsorption film remaining on the surface.

References:

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