Effect of EO-groups and counterions on the surface dilatational rheology of dodecyl sulfate adsorption layers

Nikola Alexandrov,¹,* Krastanka G. Marinova,¹ Christine Bilke-Krause,² Krassimir D. Danov¹

¹ Department of Chemicalal Engineering, Faculty of Chemistry, Sofia University, 1 James Bourchier Ave., 1164 Sofia, Bulgaria
² Krüss GmbH, Borsteler Chaussee 85-99a, D-22453 Hamburg, Germany, *e-mail: na@lcpe.uni-sofia.bg

In order to compare the surface dilatational rheological properties of the low molecular ionic surfactants sodium dodecyl sulfate (SDS) and sodium dodecyl laureth-3 sulfate (SLES) we performed measurements using two experimental techniques: oscillating and expanding drop methods. The rheological behavior of the adsorption layers for both surfactants in the presence of a given amount of sodium ions was found to be the same in the frame of experimental error, which shows that the EO-groups has negligible effect. Our measurements by the oscillating drop method manifest that the viscous modulus $E''$ is very low (much smaller than the storage modulus $E'$) and does not vary considerably with the oscillating frequency up to 1 Hz.

Parameters determined from the oscillating and expanding drop measurements are compared with the predicted Gibbs elasticity and diffusion relaxation time from the thermodynamic adsorption isotherm describing the values of equilibrium surface tension of SDS. Experimental error of rheological measurements is especially analyzed and the reliability of the obtained parameters is estimated.

For SLES adsorption layers we compared the role of different counterions ($\text{Na}^+$, $\text{Ca}^{2+}$ and $\text{Al}^{3+}$) on the values of surface moduli. The storage modulus increases significantly with the increase of the counterion valency.

Results obtained by the expanding drop method are fully consistent with those from the oscillating measurements and confirm that the dilatational behavior of the SLES and SDS adsorption layers is predominantly elastic with a small surface dilatational viscosity for frequencies lower than 1 Hz. Kelvin-Voight rheological model describes the data from both types of experiments. The observed larger values of the surface dilatational elasticity of SLES in presence of $\text{Ca}^{2+}$ and $\text{Al}^{3+}$ counterions might be related to possible surface aggregation similarly to that described by Alargova et al.[1,2].