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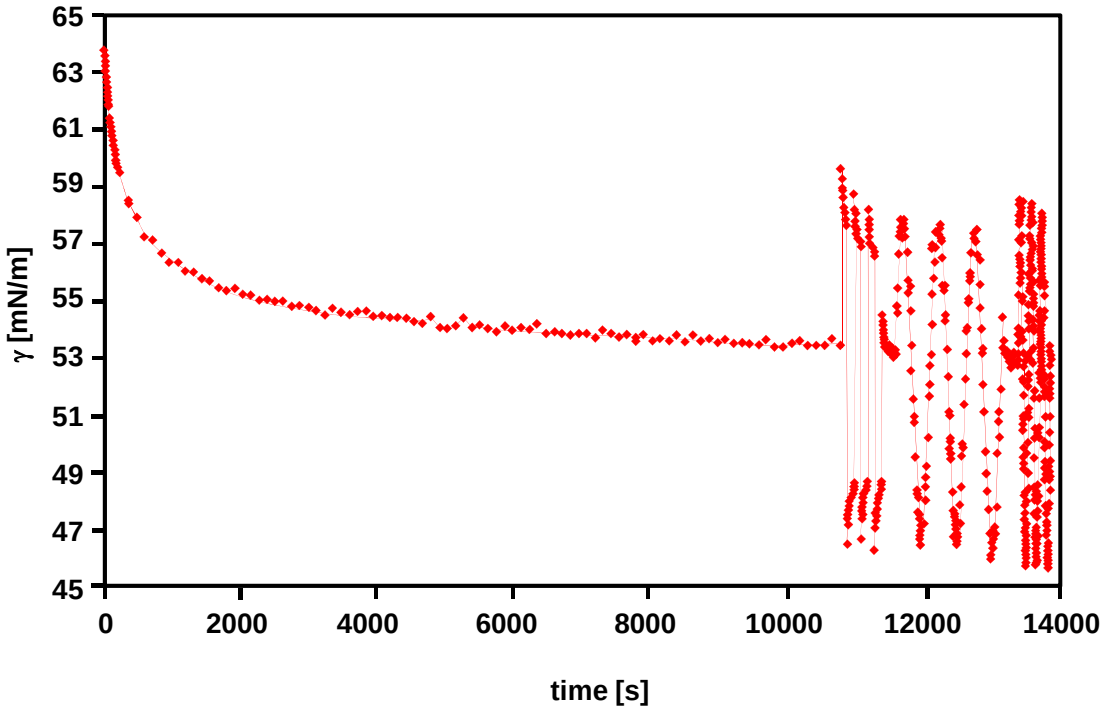
Dilational Elasticity and Viscosity from Oscillating Drops and Bubbles Using the Tensiometer PAT-1

Using the PAT-1 instrument, the dynamic dilational rheology of interfacial layers can be studied. During the experiments a drop or bubble is formed and kept constant. When the adsorption equilibrium has been reached relaxation experiments are started, in form of transient or harmonic perturbations. Note, these experiments can be performed at a water-air or water-oil interface (see for example
G. Loglio, P. Pandolfini, L. Liggieri, A. V. Makievski and F. Ravera, Determination of Interfacial Properties by the Pendant Drop Tensiometry: Optimisation of Experimental and Calculation Procedures, , in "Bubble and Drop Interfaces", Vol. 2, Progress in Colloid and Interface Science, R. Miller and L. Liggieri (Eds.), Brill Publ., Leiden, 2011, pp. 8-48.)
A typical experimental result has the following form, here obtained for an aqueous β-lactoglobulin solution (at 2×10^{-6} mol/l in buffer at pH 7).



The software used to display the results graphically is MS EXCEL, as the data from PAT-1 can be easily imported into an EXCEL worksheet. After about 11.000 seconds an almost constant surface tension value is reached, i.e. the adsorption equilibrium is established.
The following graphics show the zoomed part of the experiment, the change of surface area of the drop during the relaxation experiment, and then the resulting surface tension changes caused by the expansion and compression, respectively.

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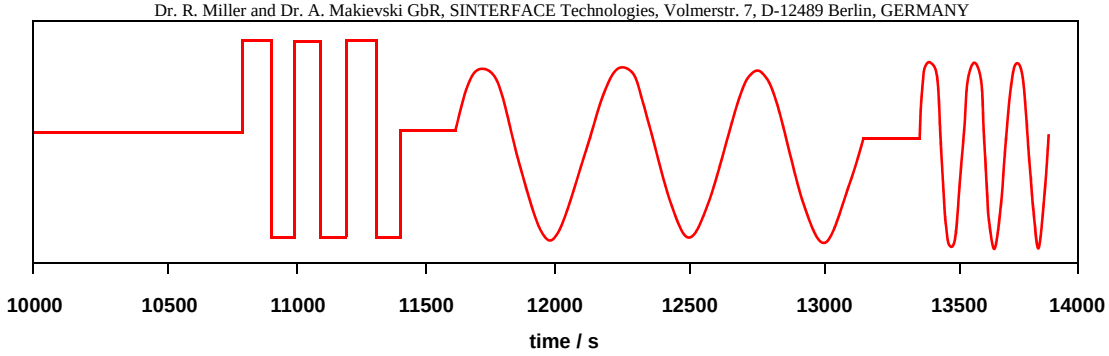
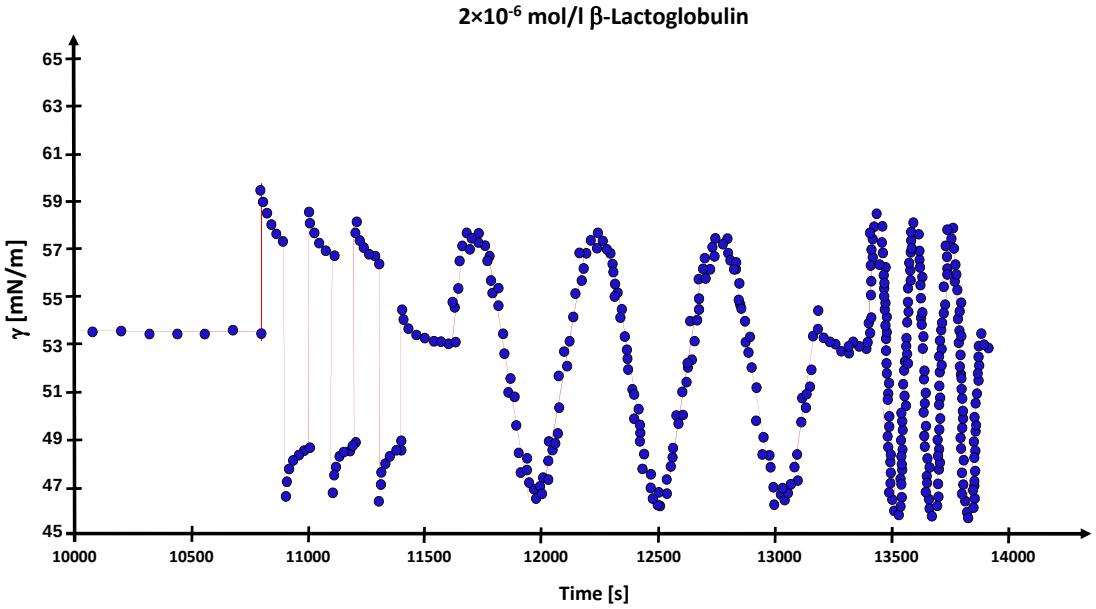


Time line of drop surface area changes



Zoom of the surface tension changes during the given surface area perturbations

Using a theoretical model, the relaxation mechanism of the studied protein (or surfactant) can be analysed. Algorithms and procedures for such an analysis have been described in a book chapter recently published (V.I. Kovalchuk, E.V. Aksenenko, R. Miller and V.B. Fainerman, Surface Dilational Rheology of Mixed Adsorption Layers of Proteins and Surfactant at Liquid Interfaces, in “Interfacial Rheology”, Vol. 1, Progress in Colloid and Interface Science, R. Miller and L. Liggieri (Eds.), Brill Publ., Leiden, 2009, p. 332-371, ISBN 978 90 04 175860).

Note, with the ODBA-1, available as additional tool for PAT-1, oscillations can be performed at frequencies up to 100 Hz, hence, it complements the frequency range of the standard PAT-1 by about three orders of magnitude. This methodology has been applied by us even in

microgravity missions on board the US space shuttles and is on its way to the International Space Station ISS for further experiments (see also V.I. Kovalchuk, F. Ravera, L. Liggieri, G. Loglio, P. Pandolfini, A.V. Makievski, S. Vincent-Bonnieu, J. Krägel, A. Javadi and R. Miller, Capillary pressure studies under low gravity conditions, Adv. Colloid Interface Sci., 161 (2010) 102–114).

Our service:

- measurement of dynamic surface or interfacial tensions over a respective adsorption time until equilibrium has been reached
- performance of square pulse and sinusoidal perturbations in a frequency range between 1 Hz and 0.01 Hz
- data analysis and graphical representation
- Fourier analysis of the oscillation experiments
- compare with standard surfactants
- reference to literature data
- literature analysis to the subject