Flatland: colloid stability in 2-D systems

PhD-fellow:	Cecilia Bernardini, M.Sc. cecilia.bernardini@wur.nl
Supervisors:	Prof. Dr. M.A. Cohen Stuart (Physical Chemistry and Colloid Science, WUR) Prof. Dr. F.A.M. Leermakers (Physical Chemistry and Colloid Science, WUR)
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Introduction

Langmuir monolayers have been subject of wide investigations: initially their study was confined to the determination of surface pressure/ molecular area curves of pure substances, which allowed the characterisation of their physical state and the calculation of thermodynamic parameters; then the development of new characterisation techniques, such as fluorescence and Brewster Angle microscopy, broadened this field of study, allowing the investigation of more complex systems and unravelling new phenomena, like, for instance, phase separation between different components of mixtures spread at the air/water interface.
This phenomenon parallels the behaviour of 3-D complex fluids (emulsions, foams, colloidal particle suspensions) which are not provided of suitable stabilising agents, and has raised the question whether mixed Langmuir monolayers can form 2-D colloids, and how such a 2-D colloidal system could be stabilized and controlled.

Aim of the project

The purpose of this project is a systematical investigation of 2-D colloidal systems, particularly aimed at determining the forces acting on them and their influence on their overall stability. 3-D colloids can achieve stabilisation using surfactant additives, which partition preferentially at the interface, reducing the surface tension and thereby decreasing the tendency towards phase separation: two-dimensional systems could respond analogously, if added with a compound which preferentially partitions at the phase boundary (the contact line) between the two different substances, a so called line-active agent or lineactant, which is able to decrease the line tension and improve the stability of the 2-D dispersionLine-active behaviour has been observed in cholesterol[1], when added to Langmuir monolayers formed by crystalline DPPC dispersed in fluid DPPC phase, and in a model system consisting of phase-separated fluorinated and hydrogenated fatty acids[2], added with tailor-made amphiphiles with hybrid tails, partly fluorinated and partly hydrogenated. Current investigation is aimed at identifying new model systems and their relatively suitable lineactants, and at finding quantitative techniques for measuring the line tension they display. Future developments concern how to prepare stable and controllable 2-D colloidal dispersions and their possible technological applications.

References

[1] R. M. Weis, H.M. McConnell, *J. Phys. Chem.* **89**, 4453-4459, (1985).
[2] D.K. Schwartz *et a.*, *PRL*, **100**, 037802 (4), (2008).