

CPP 2: Focus: Amphiphilic Systems II

Time: Monday 14:00–17:00

Location: ZEU 222

Invited Talk CPP 2.1 Mon 14:00 ZEU 222
Structure transformations in surfactant bilayer systems —
 ●OLSSON ULF — Div. of Physical Chemistry Lund University Box 124
 SE-221 00 Lund, Sweden

Surfactants and lipid bilayers in solution may form closed shells as in vesicles, planar films as in lamellar phases or multiply connected or branched films as in the sponge phases. Structural transformations between these different topologies involves the fusion or fission of bilayer films. Bilayer fusion and fission are also important biological events, like in endocytosis and exocytosis, and it is of some interest to study these processes in more simple surfactant model systems. Using non-ionic surfactants, where structural transformations are conveniently triggered by small temperature changes, we have studied kinetics in a sponge phase and the kinetics of a lamellar-sponge phase transition. In another study we have focused on vesicle stability. Since Ostwald ripening like processes in these systems are very slow and may be anti-coarsening, vesicle dispersions may have a very long shelf-life if vesicle fusion is a rare event. Vesicle stability depends on the surfactant monolayer spontaneous curvature.

Topical Talk CPP 2.2 Mon 14:30 ZEU 222
Structural Transitions in Self-aggregating Systems Studied by Means of the Stopped-flow Technique — ●MICHAEL GRADZIELSKI — Stranski-Laboratorium, Institut für Chemie, Technische Universität Berlin, Germany

Typically self-aggregating structures are highly dynamic species where characteristic times for structural reorganizations may range from μ s to weeks. Such structural changes can be triggered by mixing with other surfactants, polymers, or solubilisates. In our experiments rapid mixing was done by the stopped-flow technique and followed with turbidity, conductivity, and fluorescence detection or by coupling it to high-flux SANS/SAXS instruments which allows to obtain detailed structural information with a time-resolution of 5-50 ms. Using this method a variety of different structural transitions has been investigated, e. g. the formation of unilamellar vesicles by admixing oppositely charged surfactant or a cosurfactant, solubilisation processes in microemulsions, or the formation of interpolyelectrolyte complexes (IPECs) by admixing oppositely charged polyelectrolytes with charged block copolymer micelles. These processes were followed in structural detail and especially with respect to intermediate, non-equilibrium structures involved. These dynamic processes can be described by invoking simple elementary steps and analysing growth processes for instance in terms of Ostwald ripening or coalescence processes. In particular, in our experiments we are interested in how such intermediate structures differ from the final states and allow for a control of the structures formed.

CPP 2.3 Mon 15:00 ZEU 222
Dissolution of amphiphiles: a time- and space-resolved study — ●HELEN E HERMES and STEFAN U EGELHAAF — Physik der weichen Materie, Heinrich-Heine-Universität Düsseldorf, D-40225 Düsseldorf

Amphiphiles in solution can self-assemble into a variety of structures. Due to their molecular architecture, lipids and non-ionic surfactants tend to form lamellae over a wide range of sample conditions. Upon contact with water these stacks of bilayers swell due to the influx of the water. During this non-equilibrium dissolution process fascinating interface instabilities, so-called myelins, may be observed. To date, information about how such interfacial instabilities form and grow has been obtained using optical techniques. Recently, it has become possible to quantitatively determine the evolution of the microscopic concentration profiles using neutron imaging. Due to latest technical improvements in this method, time- and space-resolved water profiles can now be determined in-situ. In this presentation, an overview of current understanding of the dissolution of amphiphiles and the formation of non-equilibrium structures will be given. Particular emphasis will be placed on the new quantitative data obtained using neutron imaging and the knowledge gained by a comparison with computer simulations of the processes occurring during amphiphile dissolution.

CPP 2.4 Mon 15:15 ZEU 222
Dynamics of Morphological Transitions in Self-Aggregating Systems Studied by Stopped-Flow Experiments —

●ANINA BARTH¹, MICHAEL GRADZIELSKI¹, ISABELLE GRILLO², and THEYENCHERI NARAYANAN³ — ¹Stranski-Laboratorium für Physikalische und Theoretische Chemie, Institut für Chemie, Technische Universität Berlin, D-10587 Berlin, Germany — ²Institut Max von Laue-Paul Langevin (ILL), F-38042 Grenoble Cedex 9, France — ³European Synchrotron Radiation Facility (ESRF), BP 220 F-38043 Grenoble Cedex

The question of the dynamic behaviour of amphiphilic systems has been investigated. One way to study rapid kinetics is the stopped-flow method in which two volumes of solutions are rapidly mixed and the properties of the mixed solution followed as a function of time, for instance by fluorescence spectroscopy, turbidity, conductivity measurements and small-angle x-ray or neutron scattering. A topic of broad interest is the interaction of surfactants in aqueous solution with hydrophobic material. Although there has been a deep interest in the dynamics of micellar solutions some years ago, less is known about the more complex process of solubilisation. For that purpose quaternary systems of surfactant, cosurfactant, oil, and water were employed and by a systematic variation of their molecular architecture a comprehensive understanding of the solubilisation dynamics is to be achieved. Stopped-Flow fluorescence measurements were done in order to study the formation process of and exchange dynamic between microemulsion droplets.

15 min. break

Invited Talk CPP 2.5 Mon 15:45 ZEU 222
Molecular Reorganization during Membrane Adhesion and Fusion — ●REINHARD LIPOWSKY — Max Planck Institute of Colloids and Interfaces, Potsdam/Golm, Germany

The molecules within biomimetic and biological membranes are rather mobile and can reorganize themselves in various ways. During membrane adhesion, this reorganization leads to the formation of domain patterns induced by the topography of the underlying substrate [1] or by the clustering of adhesion molecules [2,3]. During membrane fusion, the molecules of the adjacent membranes are reorganized to form a fusion pore (or neck). One particularly simple way to induce fusion is provided via membrane tension. [4,5,6] One fusion pathway consists of interbilayer flips and nucleation of a hemifused membrane segment with two tension-dependent energy barriers. [5] Another pathway involves hemifusion via the rupture of one membrane. [6]

[1] B. Rozycki, T. Weigl, and R. Lipowsky, Phys. Rev. Lett. 100, 098103 (2008) [2] T. Weigl and R. Lipowsky, Biophys. J. 87, 3665 (2004) [3] M. Asfaw, B. Rozycki, R. Lipowsky, and T. Weigl, Europhys. Lett. 76, 703 (2006) [4] J. Shillcock and R. Lipowsky, Nature Materials 4, 225 (2005) [5] A. Grafmueller, J. Shillcock, and R. Lipowsky, Phys. Rev. Lett. 98, 218101 (2007) [6] L. Gao, R. Lipowsky, and J. Shillcock, Soft Matter 4, 1208 (2008)

CPP 2.6 Mon 16:15 ZEU 222
Pressure Jump Relaxation Investigations of Lipid Bilayers Using FTIR Spectroscopy — ●MARTIN SCHIEWEK and ALFRED BLUME — Martin-Luther-Universität Halle-Wittenberg, Institut für Chemie, Mühlpforte 1, 06108 Halle(Saale)

The relaxation kinetics of aqueous lipid dispersions after a pressure jump (p-jump) were investigated using time-resolved FTIR spectroscopy with a time resolution of ca. 10 ms. The methylene stretching vibrational bands and the carbonyl band were analyzed to detect changes in conformational order of the hydrocarbon chains and to follow the degree of hydration of the head group, respectively. The kinetics of the transition was found to consist of multiple processes with relaxation constants from seconds down to milliseconds. Faster processes are also present, but could not be resolved by our instrument.

This is the first investigation showing directly the time resolved change in chain order in lipid bilayers induced by a pressure jump using IR spectroscopy. The results obtained with this IR detection method support previous results obtained with light scattering and fluorescence techniques that the change in chain order after a perturbation is a multi-step process with the initial molecular events occurring with time constants shorter than milliseconds.

CPP 2.7 Mon 16:30 ZEU 222
Pressure-jump time-resolved NMR experiments on Phospho-

lipides up to 250 bar and 3 ms jump time — ●GÜNTER HEMPEL¹, MARINA KRUMOVA², UWE HEUERT³, MARTIN SCHIEWEK⁴, and ALFRED BLUME⁴ — ¹Martin-Luther-Universität Halle, Institut für Physik, D-06099 Halle, Germany — ²Universität Konstanz, Fachbereich Chemie, D-78457 Konstanz, Germany — ³Fachhochschule Merseburg, D-06217 Merseburg, Germany — ⁴Martin-Luther-Universität Halle, Institut für Chemie, D-06099 Halle, Germany

Pressure is an important thermodynamic and kinetic variable in the investigation of soft condensed matter and biomolecular systems. It is recognized that conformational properties, aggregation and crystallization processes etc. are widely affected by the pressure.

Design and performance of a pressure-jump instrument for time-resolved NMR experiments are described. A special feature is the need of using non-ferromagnetic materials for all parts placed in or near the magnet. Fast pressure release at a time resolution of 3 ms is achieved opening a fastly acting valve driven by piezo stack. The pressure-jump cell is placed in an especially constructed NMR probe, which can be used in standard spectrometers.

We investigated a pressure-driven order/disorder phase transition of a chain-deuterated dimyristoyl-phosphatidyl*choline (DMPC)-water

dispersion. First changes from ordered towards disorder-phase spectra could be detected after some 100 ms; the transformation process finished after about 30 s.

CPP 2.8 Mon 16:45 ZEU 222

Structural changes in aqueous lecithin and bile salt mixtures: dependence on ionic strength — ●DILEK MADENCI and STEFAN U. EGELHAAF — Physik der weichen Materie, Heinrich-Heine Universität, Düsseldorf, Germany

Mixtures of lecithin and bile salt form mixed micelles and vesicles in aqueous solution. Their properties have been well-studied under physiological conditions (150 mM electrolyte, pH 7-8), while other conditions are still hardly explored. Upon increasing ionic strength the formed structures and the transitional pathways (micelles, coexistence of micelles and vesicles, and vesicles), change the generated structures completely from those observed under physiological conditions. We quantitatively determined these structures formed in a broad range of electrolyte concentrations with various scattering techniques, x-ray, light and neutron scattering and calorimetry.