Mechanism of formation of well ordered multilayers at air/water interface

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Thin films and interface phenomena are of interest because of possible applications in various fields e.g. for surface preparation, molecular electronics and optoelectronics and sensing, to mention only a few [1]. Fluorinated amphiphiles offer also a wide variety of biomedical applications as, for example, the surfactants for producing the medium with air microbubbles used as a contrast for sonography of living tissues (like lungs). Recently, the bolaamphiphiles became a subject of very intensive studies [2]. These molecules contain a hydrophobic, rod-like core with two polar groups on both ends and two side-chains, which are partially fluorinated. Synthetic bolaamphiphiles mimic the unusual structure of monolayer membranes found in archeabacteria.

Investigated compounds belong to a group of x- and t-shaped bolaamphiphiles, exhibit perfect reversibility and reproducibility of Langmuir isotherms due to formation of well defined, ordered lamellar structures [3]. Compression of Langmuir films of studied compounds leads to formation of stable, well ordered multilayered structures. The 3-, 5- and 7- layer films were transferred on solid substrate in single step procedure [4]. The formation of multilayer stacks follow a mechanism in which the molecules permeate across the film to form new layers inside the stacks but not on its top. The strong tendency for self aggregation of investigated compounds in drop casting experiments on water and silicon gave the additional proof for such mechanism. Only the 3-layer films were obtained even if excess of molecules was deposited. The excess molecules formed disordered aggregates on top of the 3-layer film and not additional ordered layers. Compression was needed for molecules to jostle on each other and permeate to form the 5- layer or thicker films.

The π(A) isotherms were recorded with simultaneous surface potential measurements and Brewster angle microscopy (BAM) observations. Films were transferred at a proper surface pressure onto a silicon substrate. X-ray reflectivity measurements were performed to verified formation of well-ordered 3D structures.

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References