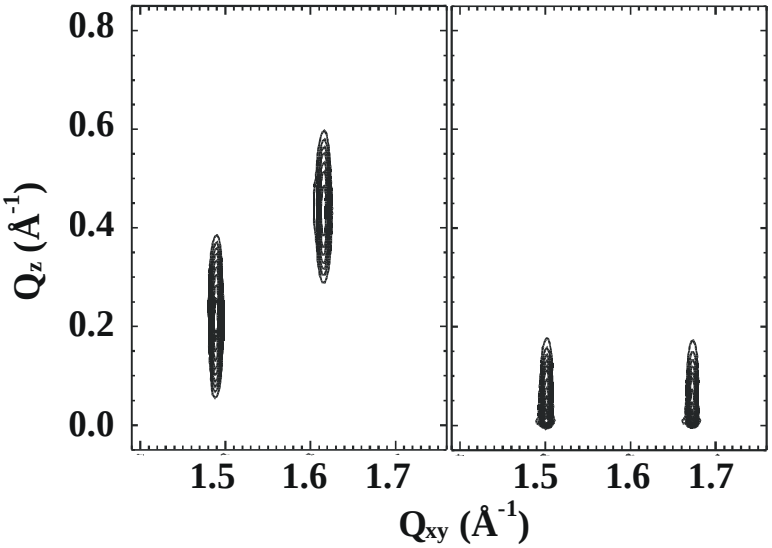
Langmuir monolayers with fluorinated groups in the hydrophilic head

G. Brezesinski, H. Möhwald, J.G. Petrov[1], T.R. Jensen[2] and K. Kjaer[2]

Max Planck Institute of Colloids and Interfaces, Am Muehlenberg 1, 14476 Golm/Potsdam, Germany
Institute of Biophysics, Bulgarian Academy of Sciences, 1 Acad. G. Bonchev Street, 1113 Sofia, Bulgaria
[2]Condensed Matter Physics and Chemistry Department, Risø National Laboratory, 4000 Roskilde, Denmark

Solutions of fluorinated surfactants and Langmuir monolayers of fluorinated amphiphilic compounds posses unique properties that make them widely used for fundamental studies and practical applications. Such substances strongly decrease the surface energy of liquids and solids, diminish surface friction, and render the surface potential of various interfaces negative when adsorbed or spread on them [1] The effect of fluorination of *the hydrophilic head* on the behavior of Langmuir monolayers was investigated using the non-ionic amphiphiles trifluoroethyl behenate (TFEB) and ethyl behenate (EB) (see sketch). TFEB forms less stable films than the non-fluorinated EB [2]. Both compounds exhibit compression-expansion hysteresis. At high surface pressure, TFEB molecules occupy a larger area than EB. The different number and location of phase transitions reported in the literature and the ambiguous identification of the monolayer phases based only on surface pressure-area isotherms requires a direct identification of the film structures.

Therefore, the molecular structure of TFEB and EB monolayers at the air-water interface was investigated by Grazing Incidence X-ray Diffraction (GIXD) (Fig. 1).



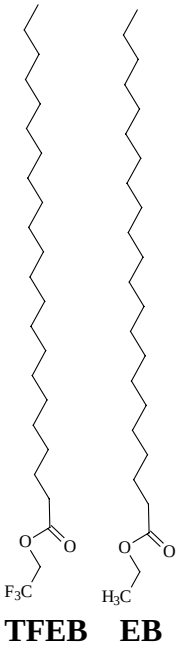


Fig. 1: Contour plots of the corrected X-ray intensities of TFEB (left) and EB (right).

The results obtained show that TFEB forms islands of upright oriented molecules packed in a centered rectangular lattice even at zero surface pressure. Compression of the monolayer only expels the voids between the islands. EB is packed in a centered rectangular lattice and tilted towards next-nearest neighbors (NNN). At high pressures, both monolayers have the same structure and lattice parameters. The cross-sectional area is very small (0.19 nm^2). At low surface pressure, the structural difference seems to result from different hydrophilicity of the head groups due to substitution of the CH_3 by a CF_3 group. As registered by BAM, differences in residual voids in TFEB and EB monolayers offer a qualitative explanation for the compression-expansion hysteresis .

References

[1] *Fluorinated Surfactants: Synthesis, Properties, Applications*, Edt. E. Kiss, Marcel Decker, New York, 1994

[2] J.G. Petrov and H. Möhwald, J. Phys. Chem. 100, 18458 (1996); J.G. Petrov, E. Polymeropoulos, and H. Möhwald, Langmuir, submitted (2000)