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X-ray studies of structural ordering in metastable Langmuir monolayer.

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Monomolecular films formed on the surface of a liquid by self-organization of amphiphilic molecules are commonly called Langmuir monolayers. The arachidic acid Langmuir monolayers formed on a solution of cerium nitrate were studied in this work. We have identified unusual mode of the structural ordering of such monolayers. The results are based on the analysis of data obtained using the grazing-incidence X-ray diffraction method. The atypical features of the diffraction maps are revealed: the rounding of the Bragg rods, which lie exactly on the circle in reciprocal space. This is atypical for a two-dimensional polycrystalline structure: the classical map for a two-dimensional monolayer generally shows three vertical peaks. The measurements were carried out at the ‘’Langmuir” station of the Kurchatov synchrotron radiation source.

For the analysis of 2D diffraction maps, the model of the grazing-incidence X-ray diffraction has been developed to describe the lateral ordering in Langmuir monolayers.
At high surface pressure (compression beyond the collapse point $\pi \sim 55$ mN/m), the reorganization of the monolayer structure is observed: a pseudo-herringbone structure is formed in the monolayer and the system becomes corrugated. This is a new type of structural ordering. For the first time, the numerical simulation of two-dimensional diffraction maps reproducing atypical features observed in experimental diffractograms has been carried out and their quantitative description has been performed.

To develop the theoretical model, the conditions of the grazing-incidence X-ray diffraction, the distorted-wave Born approximation (DWBA) and the kinematic theory of scattering on Langmuir monolayers were used. The details of the diffraction model to describe these corrugated Langmuir monolayers and the results of the numerical analysis of the diffraction data are presented in this paper.

Primary author: MUFTAKHOVA, Lia (National Research Centre ”Kurchatov Institute”)

Co-authors: Mr NIKOLAEV, Konstantin (National Research Centre ”Kurchatov Institute”, Moscow Institute of Physics and Technology); Mr ROGACHEV, Alexander (National Research Centre ”Kurchatov Institute”); Mrs NOVIKOVA, Natalia (National Research Centre ”Kurchatov Institute”); Mr YAKUNIN, Sergey (National Research Centre ”Kurchatov Institute”)

Presenter: MUFTAKHOVA, Lia (National Research Centre ”Kurchatov Institute”)

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