L. M. Blinov. *Physical properties and applications of Langmuir films.* Langmuir films or Langmuir-Blodgett films are stacks of monomolecular layers of surface-active materials transferred from a water surface to a solid substrate. These films are quasi-two-dimensional partially ordered structures and have a unique set of electrical, magnetic, optical and other properties.[1–3]

Langmuir-Blodgett films have the following very important special properties:

a) they are composed of individual monolayers whose thickness is determined by the size of the organic molecule and its orientation with an accuracy down to fractions of an angstrom;

b) the films have a sharply expressed anisotropy of the ordering of the molecules, and their properties differ strongly for the longitudinal and tranverse directions with respect to the normal to the film;

c) the molecular composition of the different monolayers can be varied as desired by the experimenter and in this manner complicated molecular ensembles can be produced in which each molecule has its own functional purpose.

1. Optical properties. The specific details of the packing of organic molecules in a monolayer leads to a number of interesting optical effects. Thus, for example, exciton excitations can be transmitted to considerable distances along molecular aggregates of dyes, where they are then captured by interceptor molecules purposefully introduced into the monolayers. Phenomena of this kind simulate processes in biological structures (photosynthesis) and can be used for sensitizing surfaces of photographic materials. By modifying the index of refraction of individual monolayers by introducing into them atoms of heavy metals it is possible to produce artificially different profiles of the coefficients of refraction of multilayer structure as a whole, and this is of great interest for integrated optics.

2. Polar structures and superlattices. In the process of transferring monolayers from the surface of the water to a solid substrate it is sometimes possible to preserve the same orientation of their macroscopic dipole moments and to ob-

tain a polar multimolecular structure. Such structures possess the entire set of properties characteristic of solid polar crystals: pyro- and piezoeffect, electro-optic effect, generation of the second optical harmonic. By alternating monolayers of different molecules it is possbile to produce superlattices which have different repetition periods of its structural elements (commensurate or incommensurate). Superlattices have very unusual diffraction properties in x-ray and optical regions of the spectrum.

3. Electrical properties. In the system of alternating monolayers of donor and acceptor molecules a transfer of charge arises from donor to acceptor. The doping of this system by molecular iodine removes the Peierls proscription concerning conductivity, and a stack of conducting layers arises each being of several angstrom thickness. Such structures are very promising for the study of mechanisms of superconductivity of organic metals.

A single monomolecular layer can withstand an electric field up to 10^7 V/cm and even higher. This is associated with the fact that at a thickness of the order of 10–20 Å even in such a strong field the carrier of the charge does not acquire an energy greater than 1–2 eV, and this is insufficient to produce defects of the structure. Therefore there exists a possibility of studying the Stark effect and the tunnel effect under conditions of rigorously prescribed molecular orientation with the corresponding shape of the potential relief.

4. Other properties and applications. Since the molecular orientation in Langmuir-Blodgett films is strictly prescribed a possibility appears of carrying out directed or, as it is sometimes said, vector chemical and photochemical reactions. The possibility of polymerizing such planes which stabilizes their structure and improves their mechanical properties seems to be of great importance. There exists also the possibility of an effective recording of information by optical methods or by an electron beam (electron lithography). Of great interest are the applications of Langmuir films in combination with traditional transistor elements where the films play the role of calibrated dielectric interlayers or active layers which produce sensitivity to external effects (sensors).

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