The New Phenomenon of Discrete Formation of Drops of Nematic Liquid Crystals, Induced by Fractal-Arrayed Resonators

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An new phenomenon has been observed on the surface of the Aires' microprocessor: the formation of discrete drops of nematic liquid crystals in several levels of fracticality, the arrangement of which correlates with the low-frequency angular diffraction structure of the ferrousmagnetic resonator, as well as the liquid crystals' transitions from a mesophase into an isotropic liquid at room temperature.

Introduction

For the past century, thin layers of nematic liquid crystals (NLCs) of various chemical structures have been the subject of universal physical research. They have led to the observation of a number of polymesomorphic and phase transitions, as well as the discovery and description of a large number of optical and electro-optical effects that find their main application in modern flat informational displays [1]. On the other hand, for the last decade a new application for NLCs has been developed for studying the state of surfaces of various materials [2]. It turns out that thin layers of NLCs, which have been applied in the form of a free film with a thickness of 1μm, can be used as an unusual recording media. They have made it possible to observe, with high spatial resolution, local distributions of weak electric, magnetic, heat, and other fields on a surface being studied through a polarizing microscope, and decorate and record defects in the microtopology or structural non-uniformities. Moreover, the effect of local reorientation of the NLCs was used.

In the same period, prototypes of Aires microprocessors with a low-frequency angular diffraction structure were designed and produced at the ″Aires″ New Medical Technologies Foundation's research center. It was observed that in the vicinity of the microprocessor, upon applying coatings to substrates made of various materials (glass, silicon), the coatings' properties changed significantly [3]. In particular, the fracticality of the structure of these coatings was revealed, consisting of the formation of alternating discrete areas of various textures. Thin layers of NLCs were used to more deeply study the effect of the Aires microprocessor on the surface properties of materials and coatings, and to partially visualize the detected effects.

This work describes a new class of phenomena in NLCs induces by the Aires microprocessor.

Experimental conditions

The subjects of research were thin layers of NLCs superimposed on the surface of a microprocessor. The well-studied compounds MBBA and 4CP, which contain a mesophase interval at room temperature, were used as NLCs.
The microprocessor is a thin wafer that has an artificially-superimposed, geometrically-synthesized, lined hologram with a line width of approximately 0.6 µm on one side (the working side) [4].
A thin layer (with a thickness of 1 µm) of thermotropic liquid crystal was manually painted on the non-working side of the microprocessor using a soft brush. In the experiments, in order to avoid providing an initial orientation to the NLCs' molecules, the layer was superimposed in an isotropic state. To do this, a mixture of NLCs was used with a volatile solvent (alcohol or acetone), which moved the NLCs into an isotropic state. After being applied to the surface, the solvent evaporated, but the NLCs' orientation was based solely on the conditions interacting with the surface. The resulting structures were observed through a polarizing microscope and recorded using photographic and computerized techniques

Experiment results

Several new phenomenon were observed in thin layers of NLCs in the vicinity of the Aires microprocessor:

1. Non-uniformity in the wetting of the microprocessor's surface by a thin layer of NLCs was detected. If under normal circumstances, NLCs would form a solid layer on the carefully cleaned surface, then on the carefully cleaned surface of the microprocessor there was, with high reproducibility, a spatially discrete structure of individual drops (Fig. 1). Upon observing through a polarizing microscope the process of applying the layer of NLCs, drops were seen to form instantaneously, without the transitional processes of wetting each of the material's NLCs. It seemed as if the formation of a sold layer of NLCs had been blocked. The emerging picture of a two-dimensional distribution of drops is associated with the special structured nature of the properties of space in the vicinity of the microprocessor. The effect was also observed when applying the NLCs to the working surface.

2. The two-dimensional distribution and sizes of the drops exhibited a certain regularity, which correlates in a specific way to the geometry of the microprocessor's lines. A large distribution of drop sizes was observed at several fractal levels (Fig. 1). In a number of instances, regularity in the position of small drops relative to large drops was observed (Fig. 1). The picture is made with repeated application and removal of the layer of NLCs.

3. Edge effects were observed, consisting of an increase in the size of drops upon approaching the edge of the layer of NLCs (Fig. 2).

4. The effect of a local transition of parts of a drop of NLCs into an isotropic state was observed. In separate cases, the same drop can contain several small areas with different phases (Fig. 2), which maintain their state under observation for a long period of time. When observing phase transitions in NLCs under ordinary conditions, small areas are never observed. Only one long boundary that divides the areas of differing phase is visible.

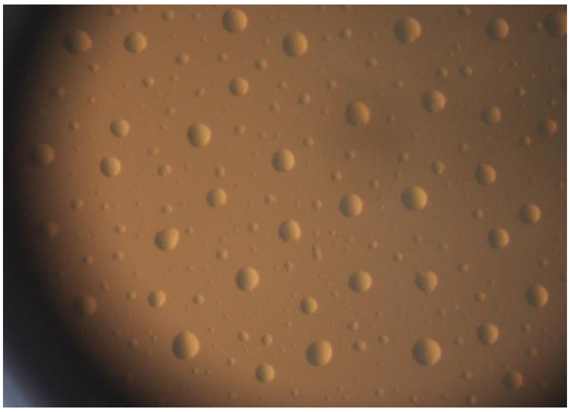

Fig. 1

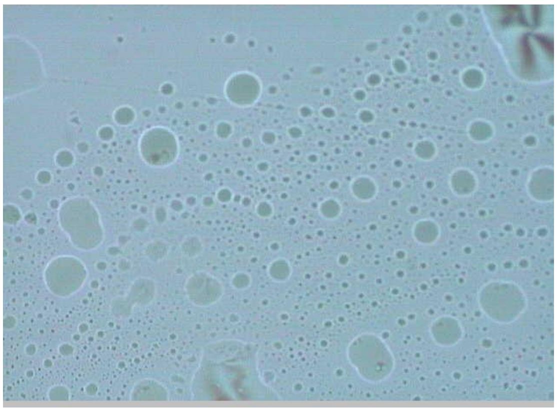

Fig. 2

Discussion of the results of the experiment

These phenomenon are due to the Aires microprocessor's influence on the layer of NLCs. This can be presumably be explained by the formation of a certain field or the microprocessor's structuring influence on the, presumably electromagnetic, existing field structure. The field being formed induces either the direct discrete formation of drops with a different fractal scale, or perhaps, the modification of the properties of the body or surface of the substrate on which the layer of NLCs has been applied (there is a fractally-arrayed topology on the back side of the substrate). It is also possible that both factors are in effect at the same time. Further research, including with regard to the substrate material, should provide an answer to this question. Also of interest is evaluating the behavior of NLCs on substrates with a different spectrum of absorption and transmission of electromagnetic radiation.
In the authors' view, the most important result obtained is the formation, on the microprocessor's surface, of somewhat regularly alternating areas covered by drops and areas not wet with NLCs. In the conceptualizations of modern surface physics, the boundary of these areas on the surface may be viewed as the boundary of specific phase transitions in the NLCs [3, 4]. An unexpected result was the appearance of the observed differences, due to the field created by the microprocessor's geometry.
At the same time, a local nematic-isotropic phase transition is observed in the drops of NLCs. Our experiments make it possible to determine the quantitative energy characteristics of the radiation causing the phase transition. This makes possible a

metrological description and the construction of a physical model of the process. We note that the observed local phase transition in areas of small spatial frequency is not characteristic of the normal conditions of its flow in NLCs, and may be additional evidence of the fracticality of this phenomenon.
The objectivity of these results is confirmed by independent research on the microprocessor's influence on the properties of thin copper membranes [4, 5], which have a similar structural regularity at the same spatial frequency.
The next step in further research will be to establish the strict correlation between the geometry of the Aires microprocessor and the fracticality of the layer of NLCs.
In conclusion, we note that these results open new opportunities in the study of the structural properties of space, which are a subject of hot discussion in modern physics.

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