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ANISOTROPIC SCATTERING IN A STRETCHED NEMATIC LIQUID CRYSTAL

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Abstract.
We report on the effect of a strong anisotropy in light scattering appearing in a mechanically stretched nematic liquid crystal. An explanation is given considering liquid crystal director alignment along the axis of mechanical deformation. It is shown that the forces applied to the liquid crystal orient the anisotropic molecules along the direction of the stretching of the substation in the cell, similar to the effect of a polymer film stretching
Keywords: liquid crystal, anisotropic scattering, light polarization, capillary flow

The aim of this study was an inspection of mechanical stretching of a liquid crystal (LC).

The LC cell was manufactured from two glass plates without coatings, i.e. with clean glass surfaces of the walls. The spacing between the walls amounted 100 micrometers. The cell was filled with 5-CB (4-Cyano-4'-pentylbiphenyl) liquid crystal. When the whole volume was filled, we checked the transparency in crossed polarizers and detected the presence of an optical anisotropy axis along the direction of capillary motion. This effect is caused by the capillary flow alignment i.e. with the preferred orientation of molecules along the flow direction. The scattering was strong enough to decrease the directly transmitted beam more than 50% and did not depend noticeably on the input polarization.

Then we used mechanical stretching of the loosely ordered LC along the cell. The method consisted in the fact that part of the LC was "sucked" from the cell by applying filter paper to the open bottom part of the cell. In the cell, a directional movement of the LC was formed, which was caused by the action of these capillary forces. Oppositely, it was inhibited by the resistance of the material and the Laplace pressure, formed due to the meniscus in the empty part of the cell. The counteraction of these forces effectively stretched the LC and caused the orientation of the molecules along the movement, which as a result significantly reduced the deviation of the director. Schematically, the method of mechanical stretching of the LC in the cell is shown in Fig. 1.

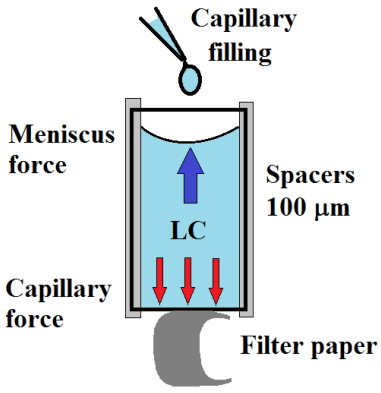

Fig. 1. Schematic explanation on the stretching forces acting on a liquid crystal within a cell. On the top, the empty part of the cell is separated with the liquid crystal by a meniscus which is shown at the plane of the cell, the bottom part is in a contact with filter paper

The resulting effect demonstrated strong anisotropic scattering shown in Fig. 2. The scattering was minimal when the light polarization was perpendicular to the axis of anisotropy but was much stringer for parallel orientation.

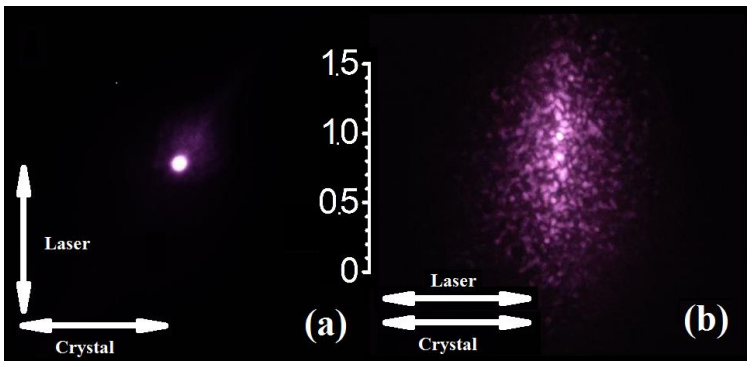

Fig. 2. Transmission of a laser beam through a cell, far-field view: (a) income light polarization is orthogonal to the anisotropy axis and (b) parallel to the axis

Conclusion. The experimental studies carried out in the work showed the possibility of mechanical influence on the weakly ordered LC in the cell. The forces applied to the liquid crystal orient the anisotropic molecules along the direction of the stretching of the substation in the cell, similar to the effect of a polymer film stretching.

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Анізотропне розсіяння у розтягнутому нематичному рідкому кристалі

Анотація.

Ми повідомляємо про вплив сильної анізотропії на розсіювання світла, що виникає у механічно розтягнутому нематичному рідкому кристалі. Дано пояснення з урахуванням орієнтації директора рідкого кристала вздовж осі механічної деформації. Показано, що сили, прикладені до матеріалу, орієнтують анізотропні молекули вздовж напрямку розтягування речовини в комірці, подібно до ефекту розтягування полімерної плівки.

Ключові слова: рідкий кристал, анізотропне розсіювання, поляризація світла, капілярний потік.

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