NEW POLYMER STABILIZED LIQUID CRYSTALS FOR ELECTRICALLY CONTROLLED LIGHT POLARIZER

V.V. Presnyakov, L. Zohrabyan, A.-M. Albu*, T.V.Galstian

Center for Optics, Photonics and Lasers, Laval University, Québec, G1K 7P4

* *University Polytechnic of Bucharest, Department of Polymers, 149, calea Victoriei, Bucharest*

Objectives

➢ Polymer stabilized liquid crystals (PSLC) are attractive materials for various applications based on the effect of electrically controlled light scattering [1]. In such a system a small amount (about 3%) of monomer is dispersed in pre-oriented liquid crystal layer, which is then *in situ* polymerized. Cross-linking polymer networks are usually created to achieve the strong fixation of the initial liquid crystal orientation [1-3]. When the initial orientation is planar (see next page), the cell is highly transparent in the absence of an electric field and exhibit an anisoptropic light scattering under field application. So, a reverse-mode light polarizer can be produced. This polarizer does not absorb light.

➢ We are studying PSLC having flexible polymer chains. In our case the polymer network is involved into process of reorientation. A normal-mode polarizer, which scatter the light at V=0 and transparent in a high voltage state can be developed using this type of PSLC structure [4].

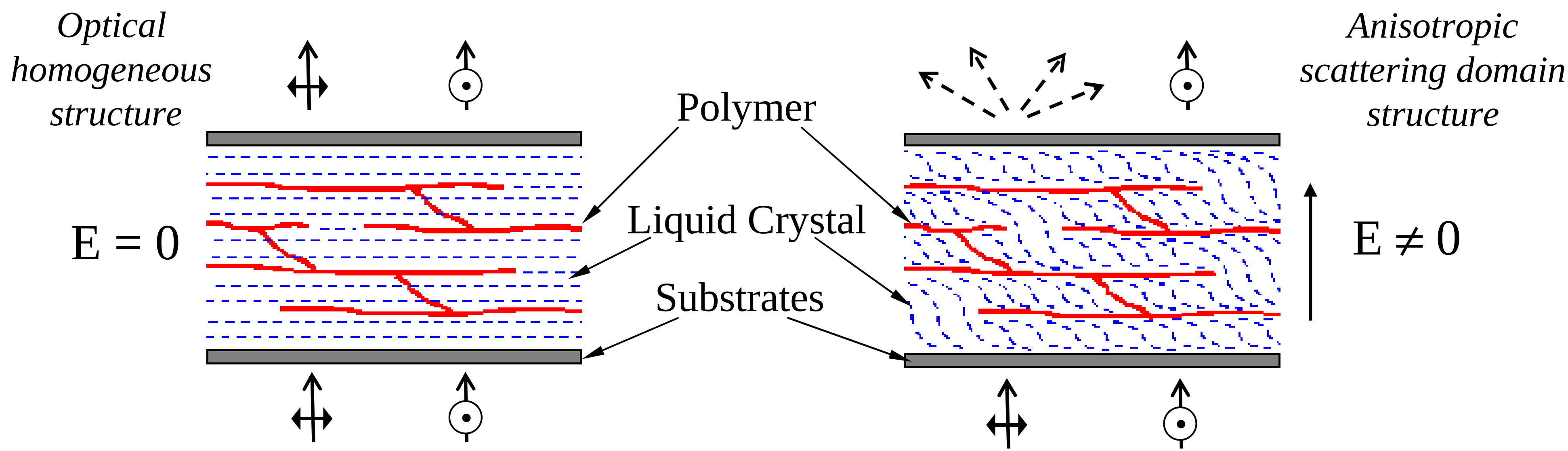
[1] G.P.Crawford, S.Zumer, *Liquid Crystals in Complex Geometries*, (Taylor&Francis, London, 1996).

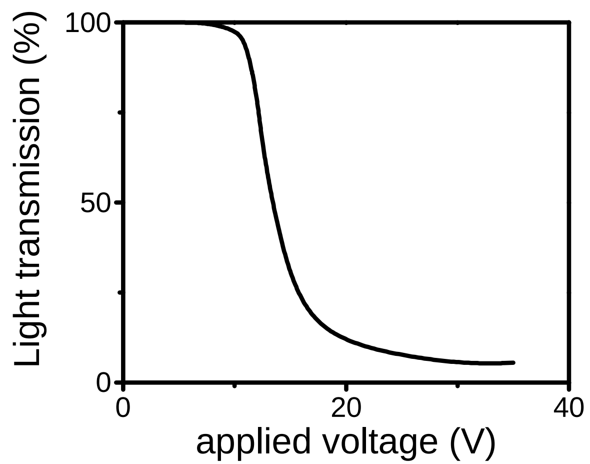
[2] R.A.M.Hikmet, *J. Appl. Phys.* **68**, p.4406, 1990.

[3] Y.-H.Fan, H.Ren, S.-T. Wu, *Appl. Phys. Lett.* **82**, p.2945, 2003.

[4] V.V.Presnyakov, T.V.Galstian, *19th ILCC, Edinburgh, Abstracts* **P-755**, 2002; *Mol.Cryst.Liq.Cryst.* **413**, p.545, 2004.

Electrically induced light scattering from polymer stabilized liquid crystals



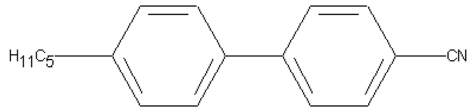


Typical transmission-voltage dependence of the light component polarized parallel to the initial nematic orientation

R.A.M.Hikmet, *J. Appl. Phys.* **68**, p.4406, 1990

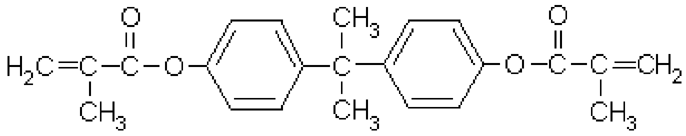
Materials and sample preparation

- Nematic liquid crystal mix E7 *(from Merck)*, based on CB :



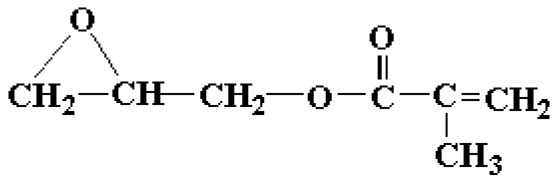
- Monomers

biphenol-A-dimethacrylate :

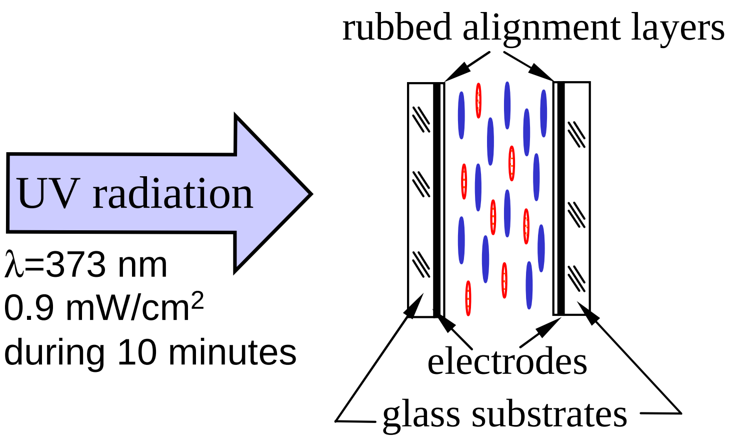


(from Aldrich)

glycidyl methacrylate :



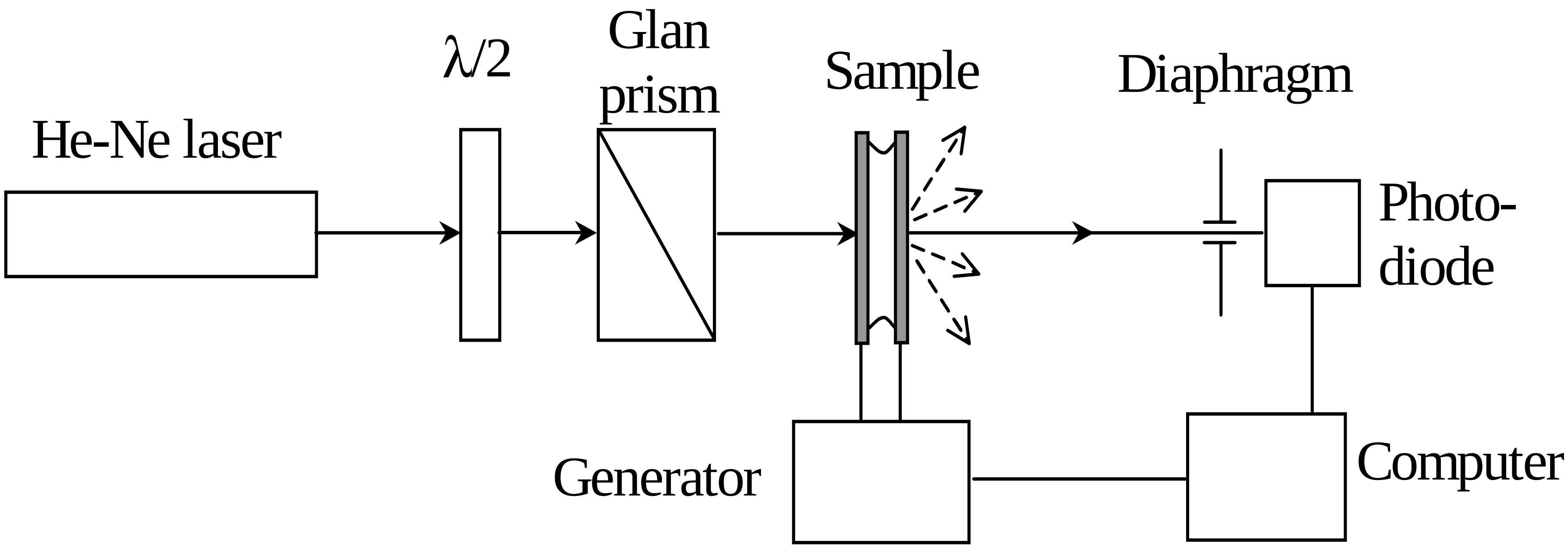
(from Sartomer)



λ=373 nm
0.9 mW/cm^2
during 10 minutes

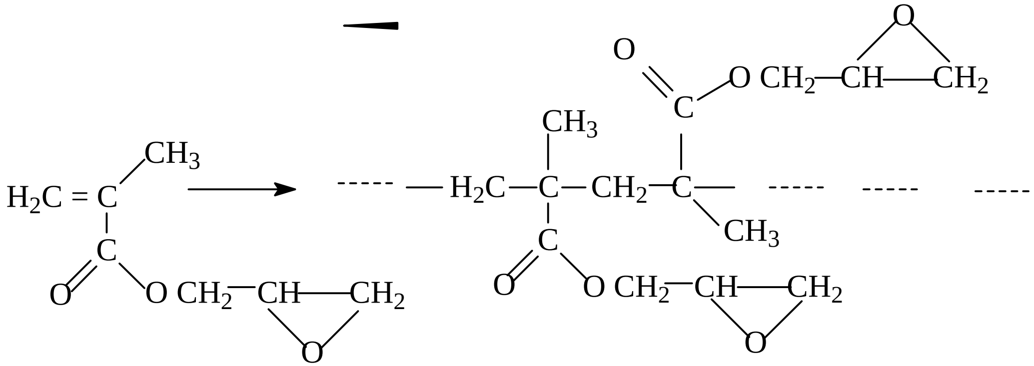
Planar liquid crystals cell

Experimental setup for electro-optical measurements

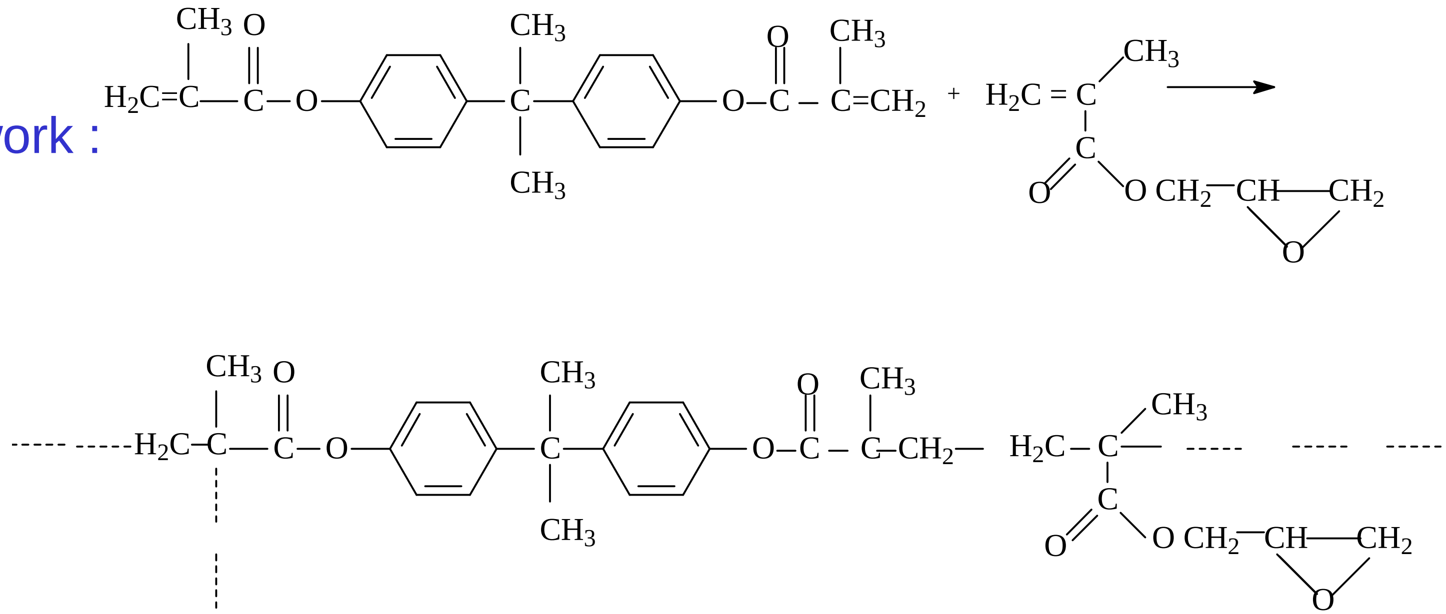


Reaction of polymerization

Flexible polymer chains :

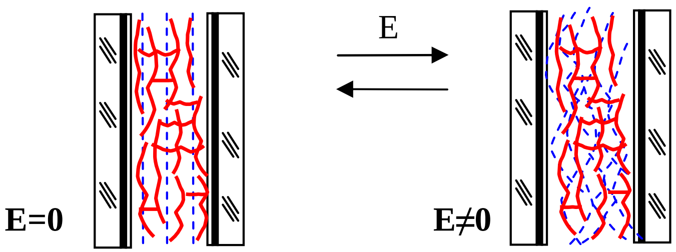


Cross linking
polymer network :



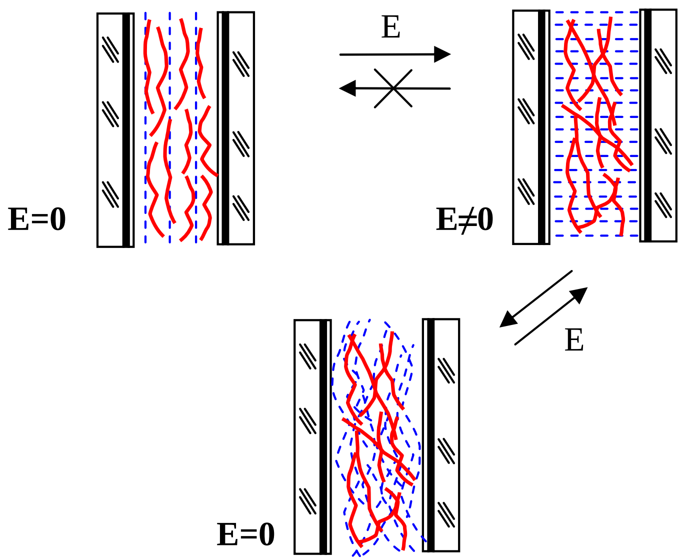
Electro-optics of cells with two different polymer networks

Cross linking polymer network



➢ reversible switching between optical homogeneous and multi-domain structures

Flexible polymer chains

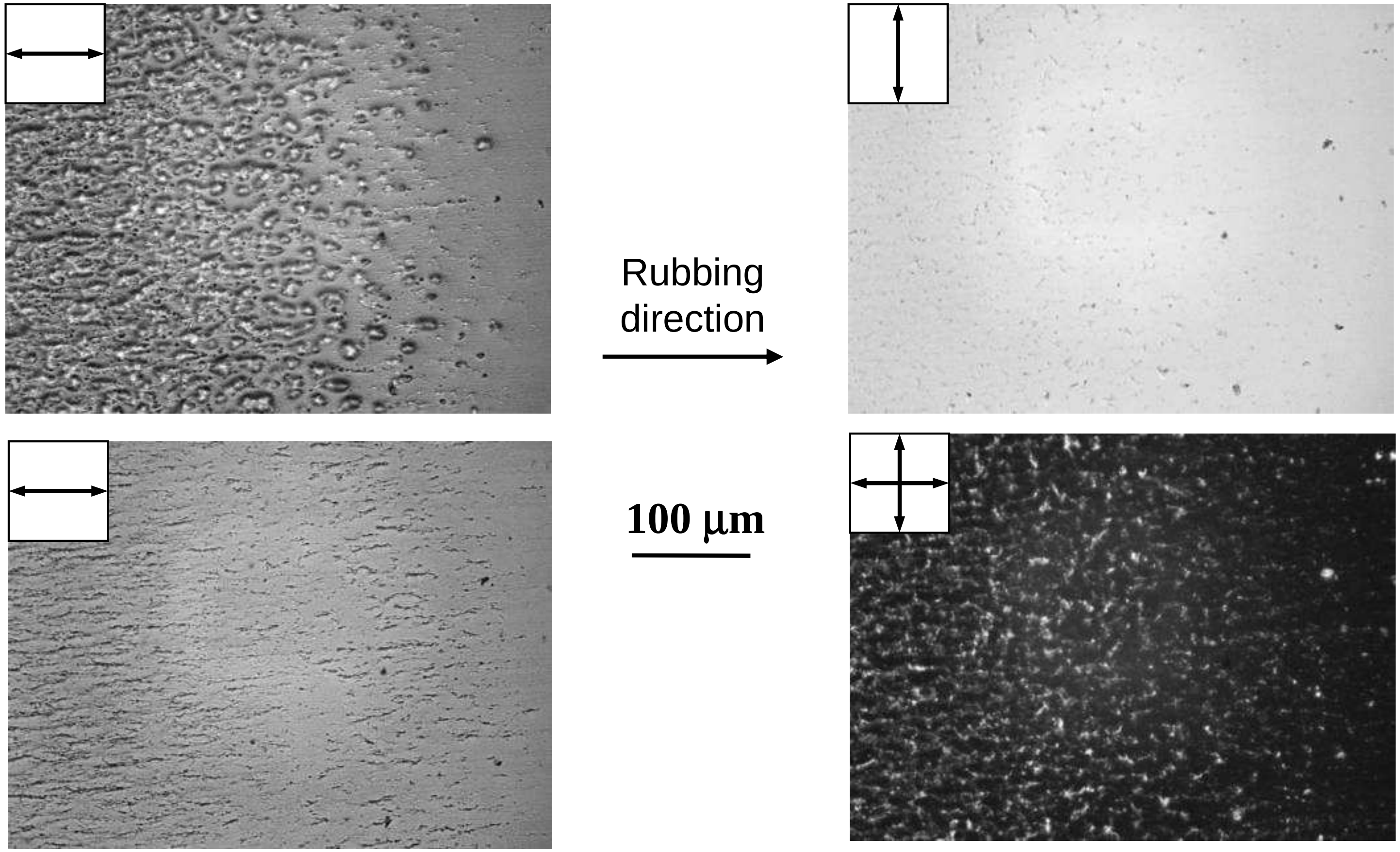


➢ the network prevents the nematic relaxation;
➢ the sample relaxes into multi-domain structure, and can be reversible switched into homeotropic state

Residual scattering in the cell with flexible polymer network

U=0

U=20V



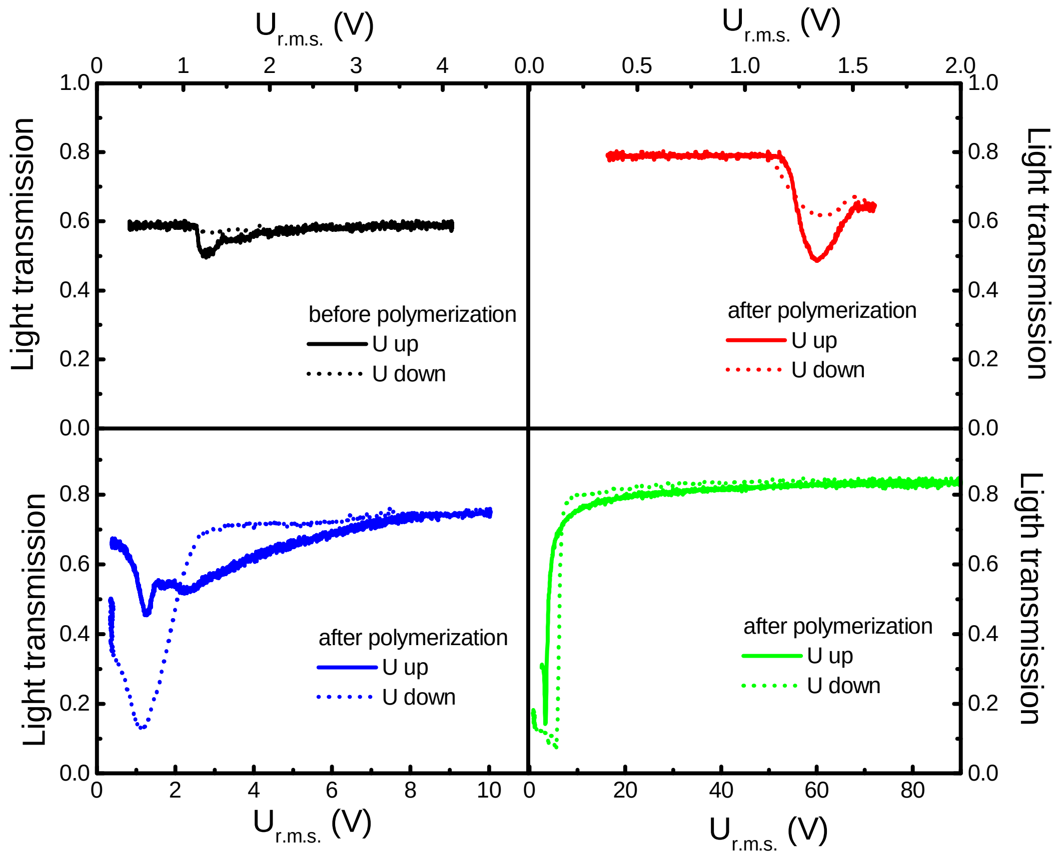
U=0

U=0

Arrows show the orientation of the polarizers

Electro-optical response in the cell with flexible polymer network

Transformation of electro-optical response by varying the maximal value of applied voltage



Light polarization is parallel to the direction of initial nematic orientation; cell thickness is 9 μm

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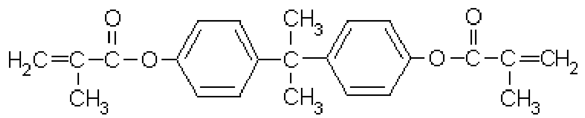
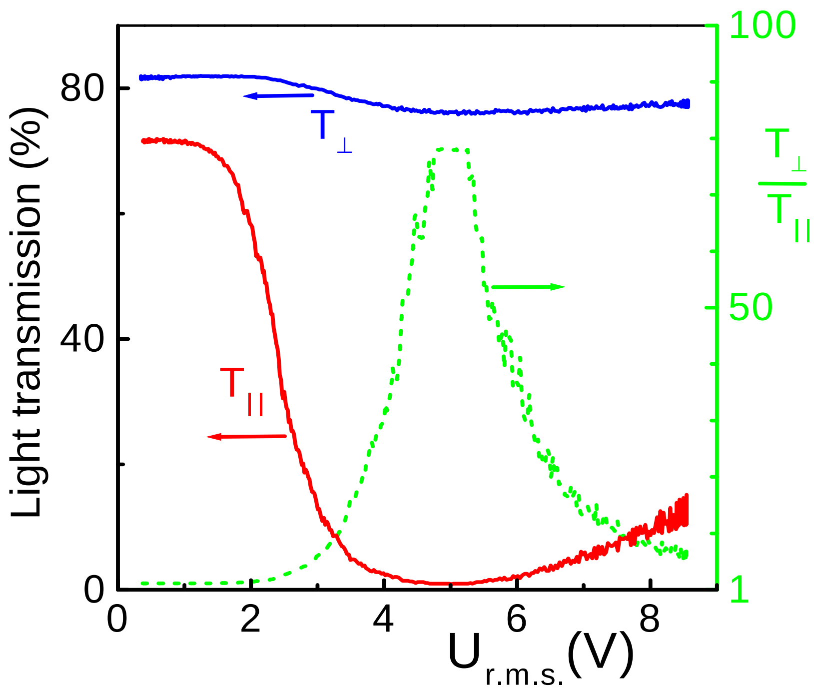
Transmittance-voltage dependences for the cells with two different polymer networks

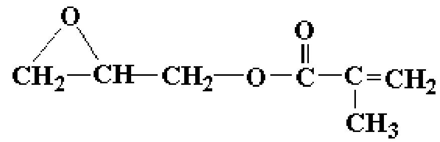
Cross-linking polymer network from monomer

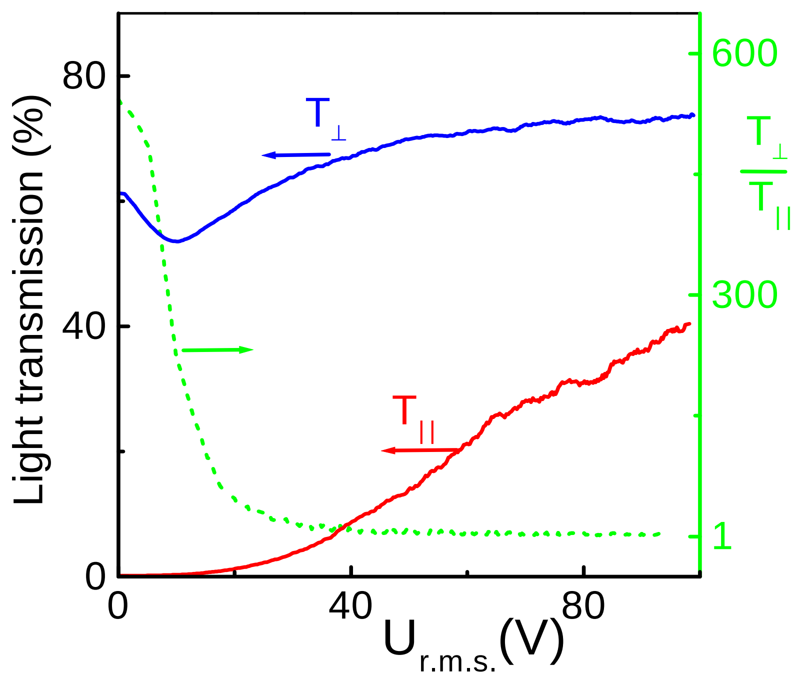




Reverse-mode PSLC; cell thickness is 5 μm

Flexible chains polymer network from monomer

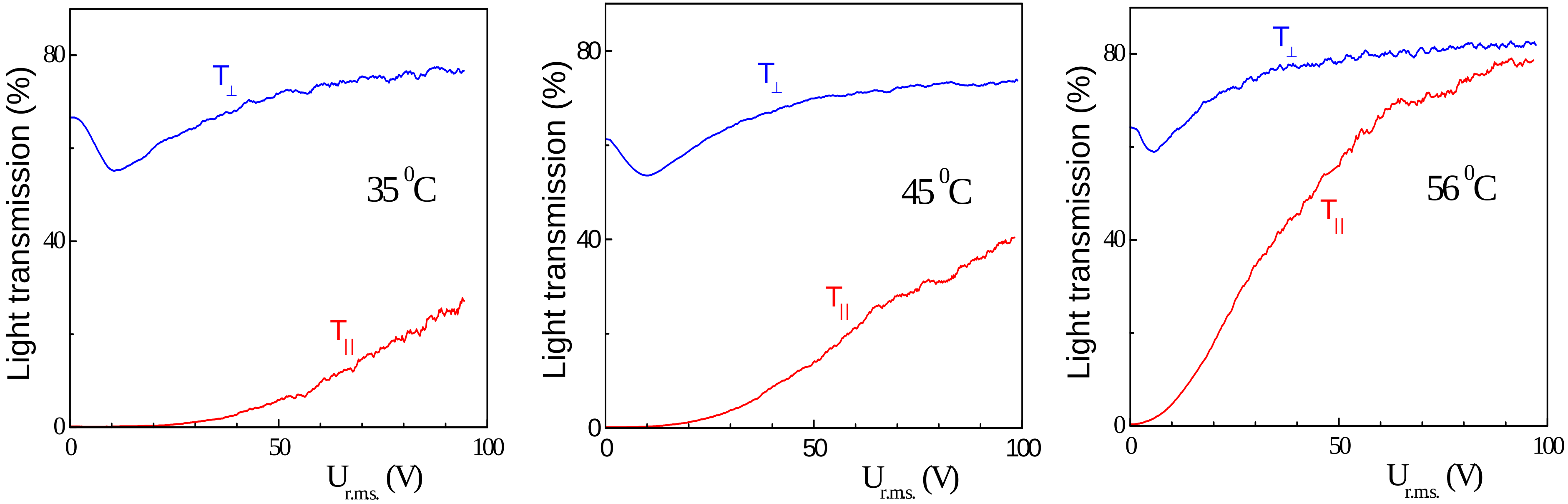




Normal-mode PSLC; cell thickness is 9 μm

Normal-mode scattering polarizer

Transmission voltage dependences at different temperatures



Light polarization :

$T_\perp$ – perpendicular to the direction of initial molecular orientation

$T_{||}$ – parallel to the direction of initial molecular orientation

cell thickness is 9 μm

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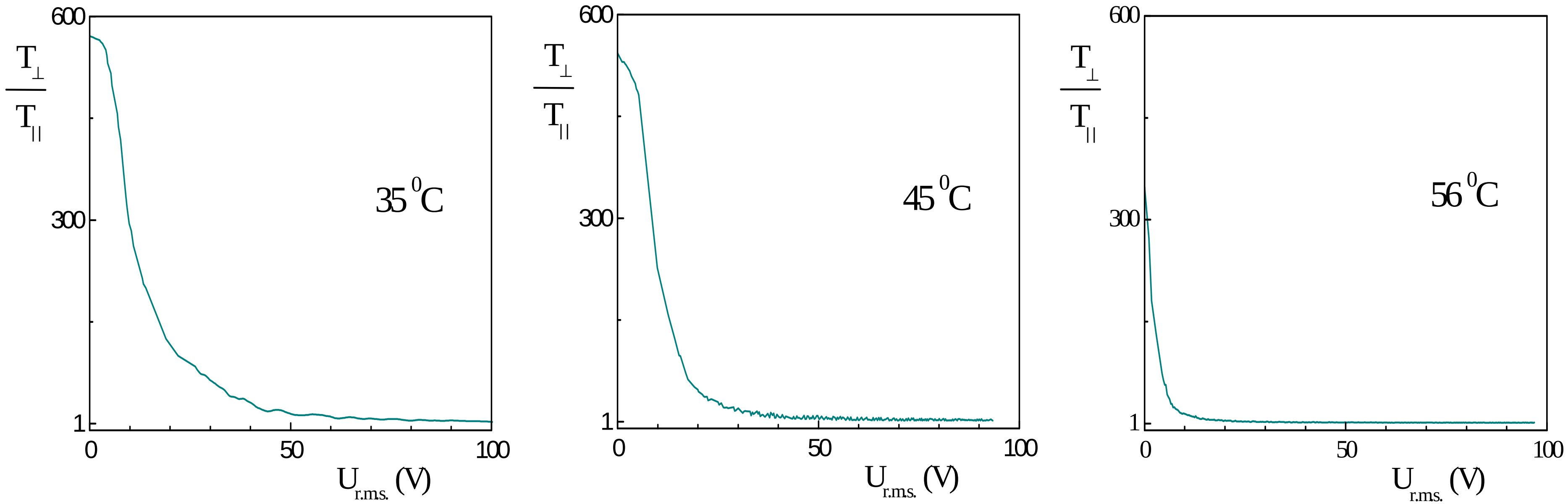
Normal-mode scattering polarizer

Polarizing efficiency at different temperature as function of applied voltage



cell thickness is 9 μm

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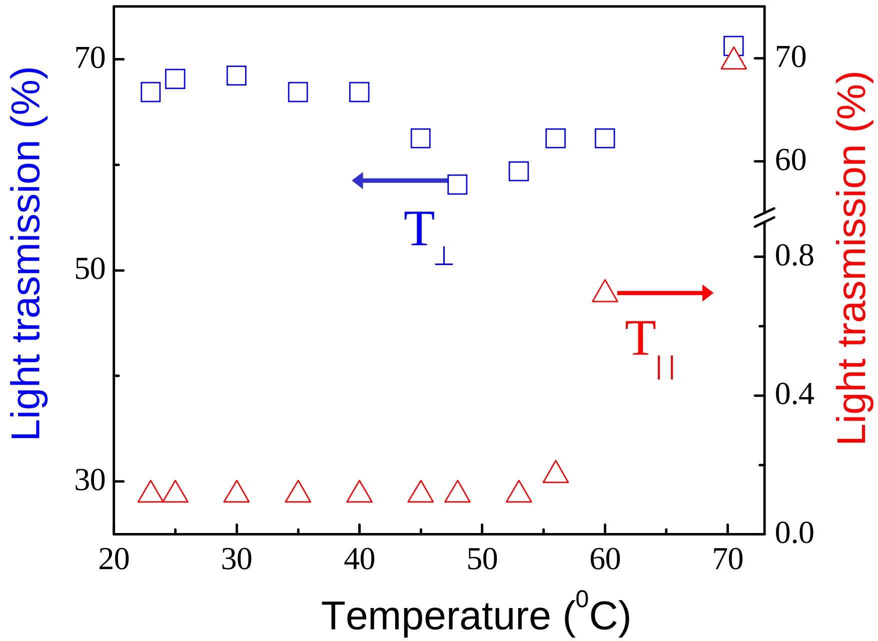
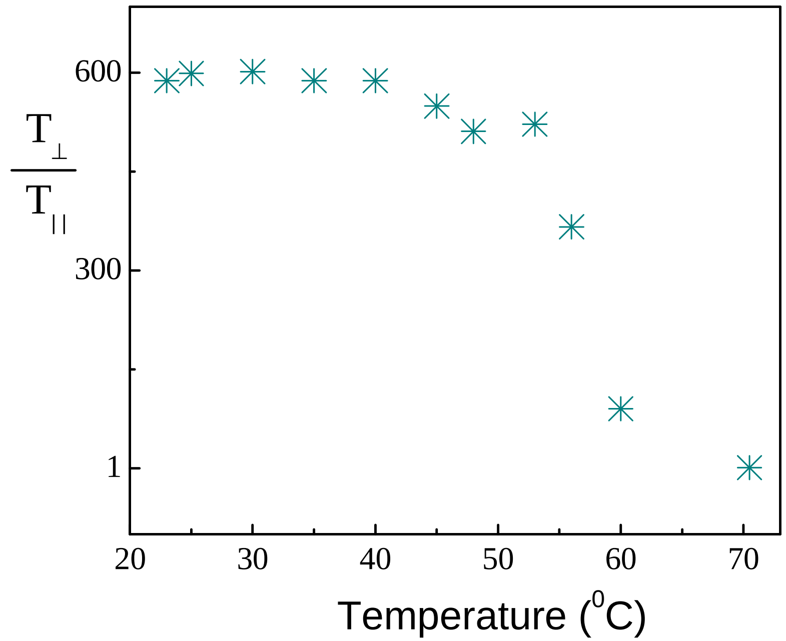
Normal-mode scattering polarizer

Light transmissions and polarizing efficiency as a function of temperature





Light polarization :

□ – perpendicular to the direction of initial molecular orientation

Δ – parallel to the direction of initial molecular orientation

cell thickness is 9 μm

Conclusion

- depending on the monomer structure two distinct PSLC have been obtained
- the first one revealed classical electro optic behavior: it was reversible between light transparent state at zero voltage and anisotropic scattering state at maximum voltage
- in contrary, the second one exhibited the anisotropic scattering in the field off state, while upon applied voltage it became practically transparent for all polarizations of the incident light
- dynamics of the polymer networks formation and their morphology were studied

Applications

- normal mode scattering polarizer with electrically controlled efficiency of polarization is demonstrated
- the ratio of the intensity of polarized component in the passed through the PSLC radiation achieves the 600 and can be varied by electric field
- such polarizer is capable of working in a wide spectral range (visible and near infrared) practically without absorption of light (with high power lasers!)
- fabrication of such polarizer does not require an additional procedure of mechanical orientation of the material