Induced smectic ordering and blue phase formation in mixtures of cyanobiphenyls and cholesterol esters

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Background & objectives

- Two non-trivial problems in liquid crystal ordering – formation of induced smectic mesophase in mixtures of nematics (due to alleged specific interactions between the molecules of different chemical classes) and formation of so-called “blue phases” in a more or less narrow range beliw the cholesteric to isotropic phase transition.
- An idea emerged to study a liquid crystal (LC) system potentially capable of exhibiting both these apparently unrelated phenomena, aiming to get a certain insight thererin.

Materials & methods

- Cholesteryl oleyl carbonate (COC) as a smectogenic chiral component with its own cholesteric mesophase.
- A cyanobiphenyl-based mixture E7 was used as nematic matrix – to broaden the mesophase temperature range as compared with [N.I. Lebovka, L.N. Lisetski, M.I. Nesterenko, V.D. Panikarskaya, N.A. Kasian, S.S.Minenko, M.S. Soskin. *Liquid Crystals*, 2013, v.40, 968-975, DOI: 10.1080/02678292.2013.786796].
- Differential sacanning calorimetry, optical microscopy, temperature-dependent optical transmission measurements with special analysis of selective reflection

Results & discussion

- It has been found that in mixtures of nematic E7 and smectogenic cholesteryl oleyl carbonate (COC) the SA-N* transition temperature is substantially (by ~20K) increased, as compared with pure COC, at E7 concentrations around ~40%.
- Within the same concentration range, the isotropic transition is preceded by formation of blue phase, with its maximum width of ~3.5 K clearly correlated to the increased thermal stability of the SA phase.
- Selective Bragg reflection of light (BRL) spectra were measured in all three temperature regions, including the unwinding of thecholesteric helix on cooling towards SA phase and characteristic selective BRL changes in the blue phase. In the latter case, the measured λmax values were dependent both on the helical twisting power in the cholesteric phase and on thelattice size and orientation in the blue phase.

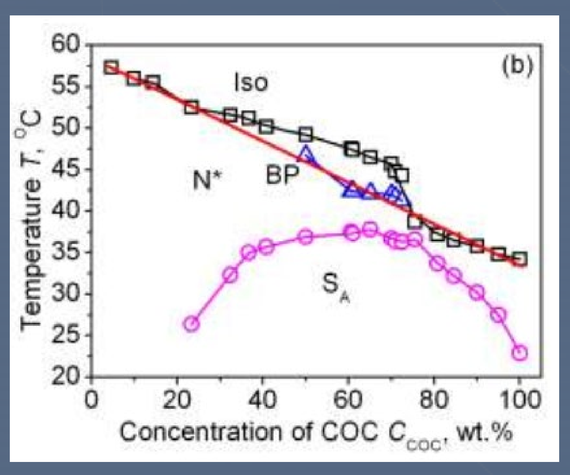


Fig. 1. *Phase diagram of E7 + COC on cooling*

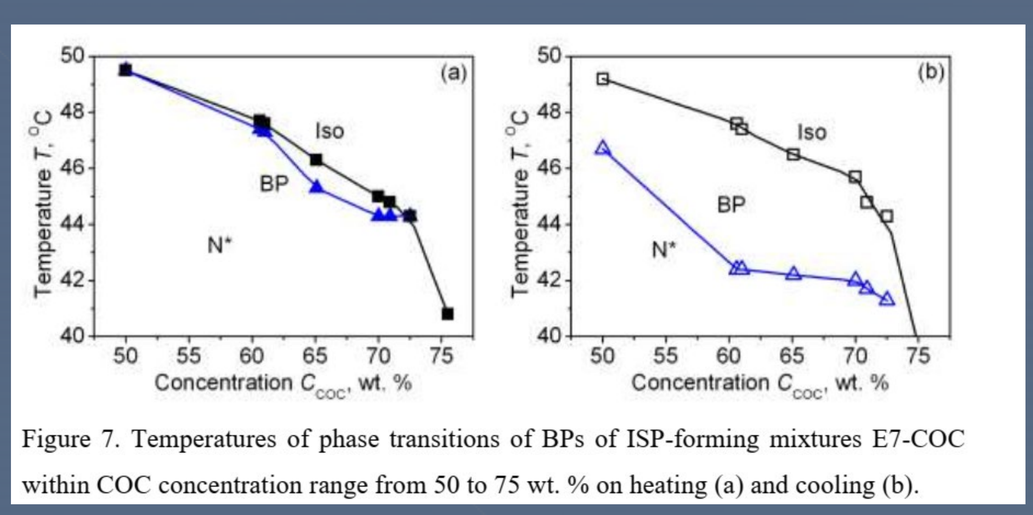


Figure 7. Temperatures of phase transitions of BPs of ISP-forming mixtures E7-COC within COC concentration range from 50 to 75 wt. % on heating (a) and cooling (b).

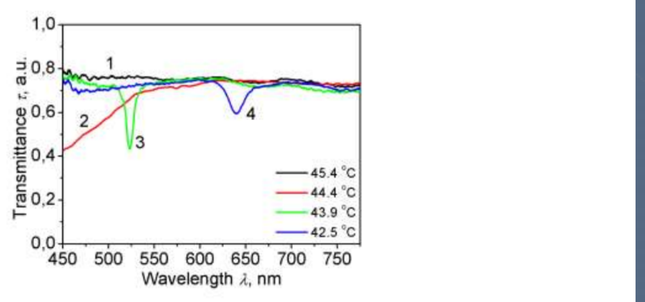
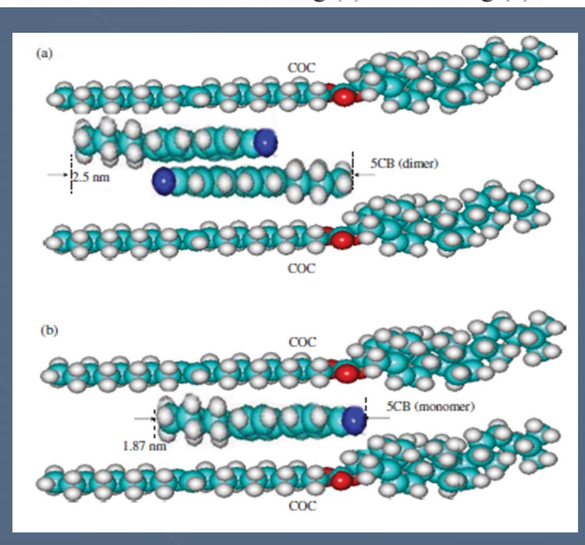


Figure 8. Transmission spectra of the BPs of IPS mixture containing 72.5 wt. % of COC and 27.5 wt. % of E7 at different temperatures during cooling: 1) – Iso at 45.4 °C (black spectrum); 2) – BPIII (*i.e.* fog phase) at 44.4 °C (red spectrum); 3) – BPII at 43.9 °C (green spectrum); 4) – BPI at 42.5 °C (blue spectrum). Thickness of LC cell was 26.1 μm.



To explain the formation of induced smectics in COC+5CB: dimers vs monomers

Conclusions

Conclusions

Our idea was to study peculiar features of phase transitions in liquid crystal systems based on nematics and cholesterol esters as a peculiar type of chiral dopants. In particular, we used both conventional nematic mixtures like E7 and an N_{tb}-forming mixture comprising CB7CB, CB6OCB and 5CB, as well as smectogenic cholesteryl oleyl carbonate (COC) and cholesteryl nonanoate (CN).

The E7-COC systems in the concentration range of ~ 25 - 80 wt. % COC showed a pronounced increase in the S_A – N^* transition temperature. This effect, which can be considered as a sort of induced smectic phase (ISP) formation, was noticeably stronger than that observed earlier with 5CB, but it nearly vanished with CN, which supported the molecular packing mechanism of ISP formation. As an accompanying effect, it was found that such ISP mixtures showed a certain deviation from linearity of the concentration dependence of temperature Iso and the appearance of the BPs, the concentration range of which clearly correlated with the ISP formation.

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