

Molecular orientation change of chiral nematic liquid crystal in phase transitions of heating and cooling process studied by microscopic FT-IR spectroscopy

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Chiral nematic liquid crystals (N*LCs) with helical molecular structure show the N* phase and blue phases (PBs). Study on molecular orientation of each phase consequent upon conformational changes by phase transition is important to reveal the mechanism of stability of BPs and developing of new devices as well. In this study, the polarized microscopic FT-IR spectroscopy has been applied for study on parallel and vertical molecular orientation change of N*LC by phase transitions.

The sample was prepared by mixing with NLCs (5CB:6CB:5OCB:7OCB = 3:2:4:1) and ISO6OBA₂ (7wt%). The mixture was sandwiched between two CaF₂ substrates coated PVA thin film which were rubbed 30 times to the direction of substrate long axis. The 14 μm-thickness polystyrene film was used for spacer in the N*LC cell. The infrared spectra measurements of N*LC molecules in the cell were carried out by polarized FT-IR spectrometer (Perkin Elmer, Spectrum One) equipped with microscope unit. The temperature was controlled in the range between 35.0 °C and 42.0 °C by the hot-stage (Mettler, FP82HT).

Microscopic observations of steadily cooled and heated the obtained N*LC mixture have resulted in the following phase sequence: BPIII at 39.8 °C, isotropic phase at 41.0 °C, on heating and BPIII at 40.8 °C, BPII at 40.0 °C, BPI at 39.8 °C, N* phase at 38.0 °C on cooling. Figure 1 shows the band intensity ratio of CN and CH₂ stretching modes (CN/CH₂) at non-polarized IR measurements on heating and cooling process. The CN/CH₂ ratio is decreased at phase transition from N* to BPIII on heating, while it is also decreased at phase transition from BPI to N* phases on cooling process. These results suggest that the LC molecular orientation in N* phase with respect to the substrate is changed to considerably perpendicular on cooling process. The maximum of CN band intensity in polarized IR spectra of the LC molecule of N* phase by cooling process is observed at 130 degree with respect to rubbing direction, indicating that the helical axis of N*LC on cooling process is incline with respect to the parallel direction whereas that had been vertical to substrate before heating.

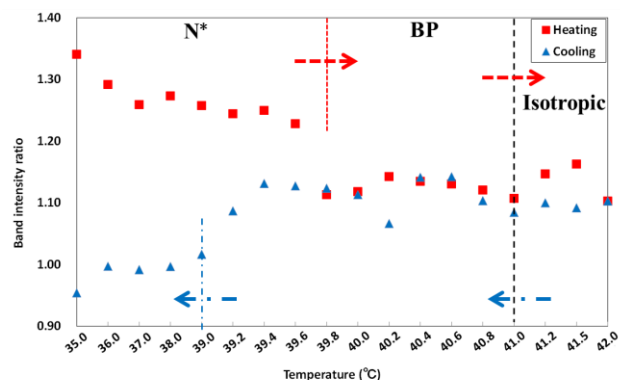


Fig 1. Band intensity ratio change of CN/CH₂ by heating and cooling.