Polarized Microscope FT-IR Imaging Spectroscopy of Molecular Orientation of the Disclination in Nematic Liquid Crystal

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While nematic liquid crystals (LCs) sometime form thread-like topological defects called disclinations, the mechanisms and molecular orientation studies are not enough. In this paper the polarized microscope FT-IR and imaging spectroscopy were performed to reveal the molecular orientation of disclination in nematic LC cell.

The 4-Cyano-4'-pentylbiphenyl (5CB) and CaF_2 plates were used for nematic LC and substrates of the sandwich cell, respectively. The FT-IR spectra were measured by FTS-7000 spectrometer and UMA600 microscope unit equipped with an imaging FPA (64×64 pixels) detector. The spatial resolution of the pixels in the map is 5.5 micro-meters.

Figure 1 shows the infrared imaging map of the disclination at polarization angle of 0°. The map are expressed the molecular direction calculated by band intensity ratio of CN/CH. This ratio is very large in dotted circle, indicating that the 5CB molecules are well oriented to the 0° direction in this region. The in-plane orientation and order parameter for each region has been determined by the comparison of band intensity for parallel and perpendicular vibration modes with respect to the molecular axis. Being carried out these analyses for every 10 degrees of polarization angles, the molecular orientations around disclination have been determined as illustrated by arrows in Figure 2. This result suggests that the defect is characterized to wedge disclination of strength -2π. On the other hand, the vertical molecular orientation around the disclination is calculated by CN/CH band intensity ratio of non-polarized spectra. The obtained results show that the orientational structure of 5CB molecules are determined homeotropic on the disclination point, while they are inclined with respect to the distance from the disclination point.

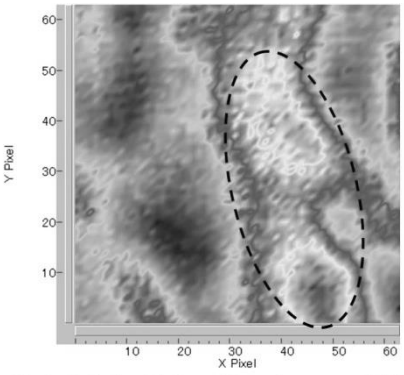

Fig 1. Polarized infrared imaging map of 5CB (polarization angle : 0°)

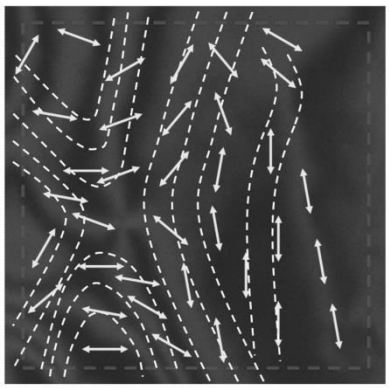
Fig 2. In-plane orientation in the disclination

According to this study, the imaging IR spectroscopy is powerful technique for characterization of three dimensional orientations of the LC molecules in disclinations.