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Formation processes of topological defects in photo-responsive liquid crystals by studied by the command surface

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Topological defects in liquid crystals (LCs) have been paid attention because it could be related to the collective structure and motion, and related to biology and active matter; however, the basic understanding for them such as structure and alignment is lacking. We studied how the topological defects could change the molecular orientation/alignment from the observation of photo-induced orientation change of topological defects in LCs.[1] In this study, the formation processes of topological defects were studied from the observation of the photo-induced formation of them by using the command surface, where the molecular alignment was originally homeotropically aligned.

The LC alignment was initially controlled as the homeotropic alignment by adding azo-dyes interacting with a glass surface.[2] The photo-absorption of azo-dyes induced the homeotropic to the planar alignment, during which topological defects were formed. A sample was 4-Cyano-4'-heptylbiphenyl (7CB) doped with 4-(Phenylazo)phenol (PAP) and was put into a glass and a planar LC cell. The color microscopic images were converted into the molecular angle and the order parameter images by the pre-trained neural network function. An optical image sequence of the photo-response is shown in Fig.1(a). Under the UV light irradiation, the homeotropically aligned black image was changed into color images with a planar alignment. At the same time, topological defects appeared and they were connected with brushes. An example of the predicted local angles and order parameters around the topological defects at 140 ms after the light irradiation is shown in Fig.1(b) and (c). These predicted mappings show that the LC molecules were oriented in each brush regions and disordered especially in the connecting regions by two defects. This formation method of topological defects and the analyses could reveal the formation processes of topological defects consisted of these reorientation and disorder processes.

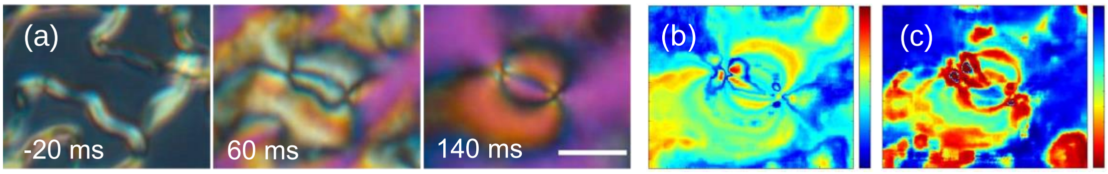

Fig. 1 (a) Optical images sequence (scale bar 10 μm). The predicted local (b) angles and (c) order parameters around the topological defects 140 ms after the light illumination.

1) Sakanoue, H.,et al., Acs Omega **2019**, 4 (9), 13936.
2) Ichimura, K., Chem. Rev. **2000**, 100 (5), 1847.