Optical Force Manipulation of Nematic Liquid Crystal Assembly

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1. Introduction

Liquid crystal (LC) shows interesting physical properties in between solid and liquid phases. Generally, LCs are categorized into thermotropic and lyotropic type. The first is temperature sensitive while the later is concentration dependant. At microscopic level, LCs molecules are represented by director. The director is average orientation of a group of LCs molecules at specific localized volume. Liquid Crystal Display (LCD) technology and others were made possible by manipulating LCs director in between of polarizers using electrical field [1]. It has been shown that line defect in LCs can be optically manipulated with and without particle probe [2][3]. In a meanwhile, plasmonic field in a nanogap structure suggested possible localized manipulation of molecules which offers LC assembly manipulation [4]. Therefore, we aim for the LC assembly manipulation by optical force on plasmonic nanostructure.

2. Methodology

Sample

4′-Pentyl-4-biphenylcarbonitrile or also known as 5CB is a nematic LC used in this study. It behaves in LC phase between 18 to 35°C making it suitable for room temperature applications.

Experiment

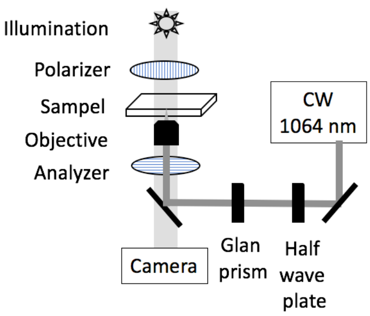

Figure 1 : Experimental setup

The experimental setup is depicted in the Figure 1. A linearly polarized infrared laser was focused by oil immersion 100x objective lens on the sample. The polarization state of the laser was adjusted using Glan prism and the half wave plate. The visibility of the sample was made possible through a pair of polarizer-analyzer.

Result

Our initial result without plasmonic-assisted manpulation are reported here. Figure 3. shows the disclination at the location spot indicated by red spot in Figure 2. A bending at disclination line was observed for laser power 250 mW (as measured at objective inlet). However, this bending is not permanent. It returned to original shape after the laser is switched off. The local assembly disturbance was also observed even in the homogenous area, but too weak. In the future work, we are preparing LC on nanostructure to establish a strong localized plasmonics field for assembly orientation control.

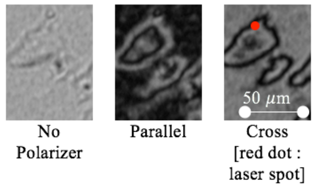

Figure 2 : Sample view under 10× objective between a pair of polarizer and analyzer.

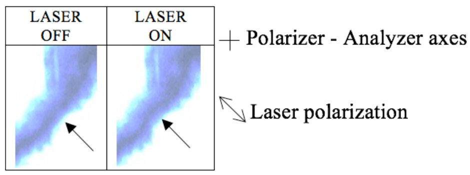

Figure 3 : Disclination disturbance (shown by the arrow)

3. Conclusion

We observed temporary disturbance in the nematic LC when laser was focused in a local area. It showed good possibility to control the LC assembly director orientation using optical mean only. This grants possible manipulation by enhanced plasmonics field.

References

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