Complex periodic liquid crystal structures by holographic photo-alignment

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Photo-alignment is a novel method to define the anchoring direction for liquid crystal by illumination a photosensitive polymer with polarized UV light. Using two interfering UV laser beams with opposite circular polarization, a periodic alignment pattern is obtained (Figure 1 left). A liquid crystal cell in which the two substrates have periodic photo-alignment patterns with orthogonal periodicity, provides complex 3D director patterns without disclinations (Figure 1 middle). The period of these patterns is twice that of the photo-alignment and symmetry breaking leads to two equivalent states. The resulting 3D director pattern depends on the cell thickness and the periodicity of the photo-alignment.

The director pattern can be identified by performing numerical simulation with a Q-tensor finite element method. The simulation results can be verified by polarization optical microscopy (Figure 1 right) or by observing the diffraction properties of the structure. The director pattern can be deformed continuously by applying a potential difference between the two substrate electrodes [1]. At high voltages, the director is mainly homeotropic, except near the substrates. At low voltages, the director remains perpendicular along diagonal lines. The periodic structures have interesting diffraction properties with a small number of diffraction orders if the period of the UV illumination is small.

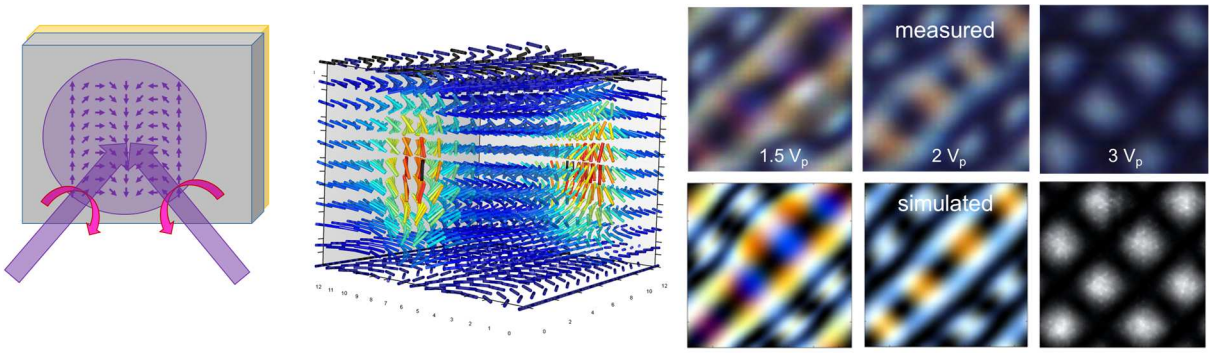

Figure 1: Left: Periodic photo-alignment by two circularly polarized UV laser beams. Middle: simulated 3D director distribution. Right: measured and simulated patterns in polarization optical microscopy.

References

[1] I. Nys, J. Beeckman, and K. Neyts, "Switchable 3D liquid crystal grating generated by periodic photo-alignment on both substrates," *Soft Matter,* vol. 11, no. 39, pp. 7802-7808, 2015.

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