Electronic Supplementary Information for

Complex liquid crystal superstructures induced by periodic photo-alignment at top and bottom substrate

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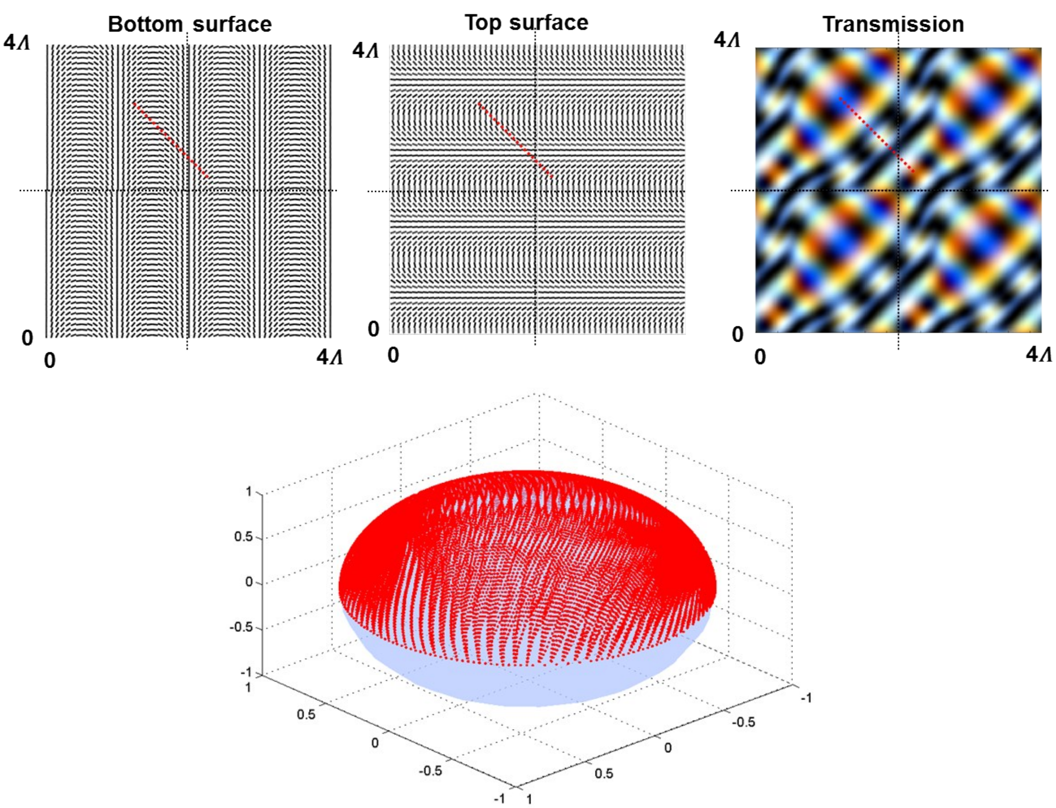

Figure S1 Top: alignment at the bottom and top surface and simulated transmission between crossed polarizers for 2 x 2 unit cells of the normal grating structure. A cross-section is taken between the corner points $(5/4\Lambda, 5/4\Lambda, 0)$, $(5/4\Lambda, 5/4\Lambda, d)$, $(9/4\Lambda, 1/4\Lambda, 0)$, $(9/4\Lambda, 1/4\Lambda, d)$ as indicated with the red dotted line. Bottom: graphic representation of the directors in this cross-section on the unit sphere. The alignment at the top and bottom substrate describes a half circle in the equatorial plane, the director in the bulk fills the half unit sphere.

In the normal grating structure, symmetry breaking is necessary to obtain a disclination-free structure. This leads to the formation of a unit cell with 2Λ * 2Λ dimension and a vertical region in the bulk of the cell. If the director is planar everywhere in the cell, a twist disclination (strength 1) should appear. By inducing a region with vertical alignment in the bulk, the twist disclination can be avoided. This is clarified by a graphic representation of the directors for a specific cross section on the unit sphere in figure S1. In the cross section with corner points ($5/4\Lambda$, $5/4\Lambda$, 0), ($5/4\Lambda$, $5/4\Lambda$, d), ($9/4\Lambda$, $1/4\Lambda$, 0), ($9/4\Lambda$, $1/4\Lambda$, d) the alignment at the top and bottom surface describes a half circle in the equatorial plane. A twist disclination is unavoidable if the director stays planar everywhere in the bulk, but the director configuration with vertical regions in the bulk results in an elegant solution that fills the half unit sphere without a discontinuity (figure S1).

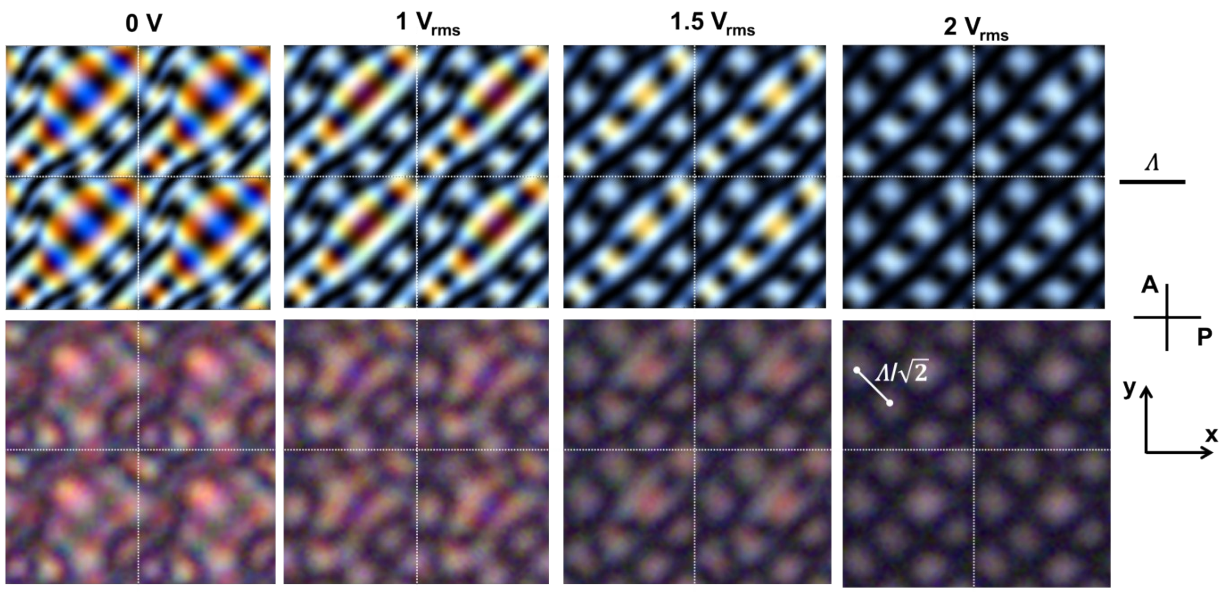

Figure S2 Comparison between the simulated transmission patterns (top) and the experimental measurements (bottom) for region A with the normal grating structure. Two by two unit cells are shown and the applied voltages are 0 V, 1 V_{rms}, 1.5 V_{rms} and 2 V_{rms} from left to right.

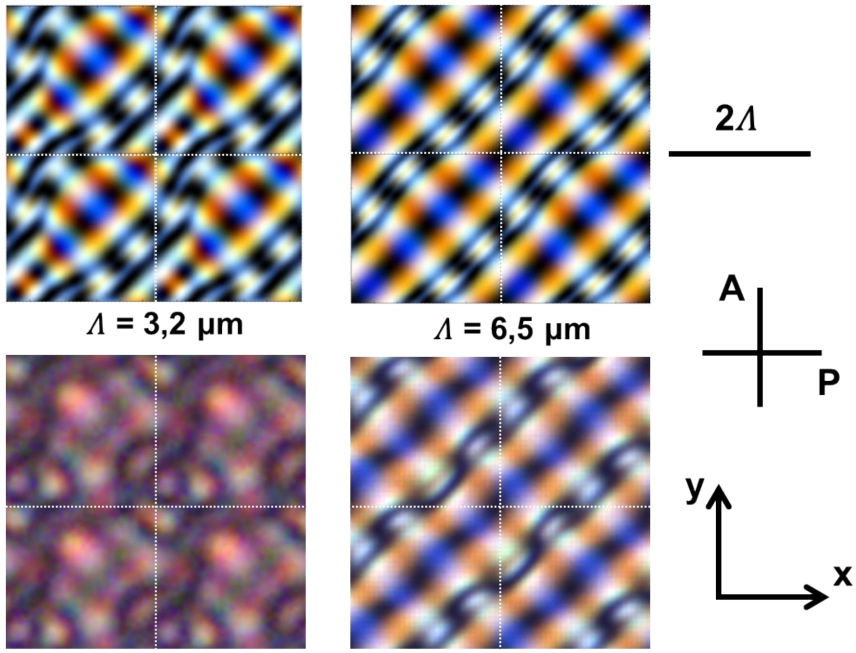

Figure S3 Comparison between the simulated transmission patterns (top) and the experimental measurements (bottom) for region A with the normal grating structure in two cells with different Λ/d ratio. The cell thickness in both cases was the same (d = 3 µm) but the alignment period was Λ = 3.2 µm in the left figure (as discussed in this paper) and Λ = 6.5 µm in the right figure (as discussed in our previous paper [1]). The asymmetry in the unit cell clearly increases for decreasing Λ/d ratio.

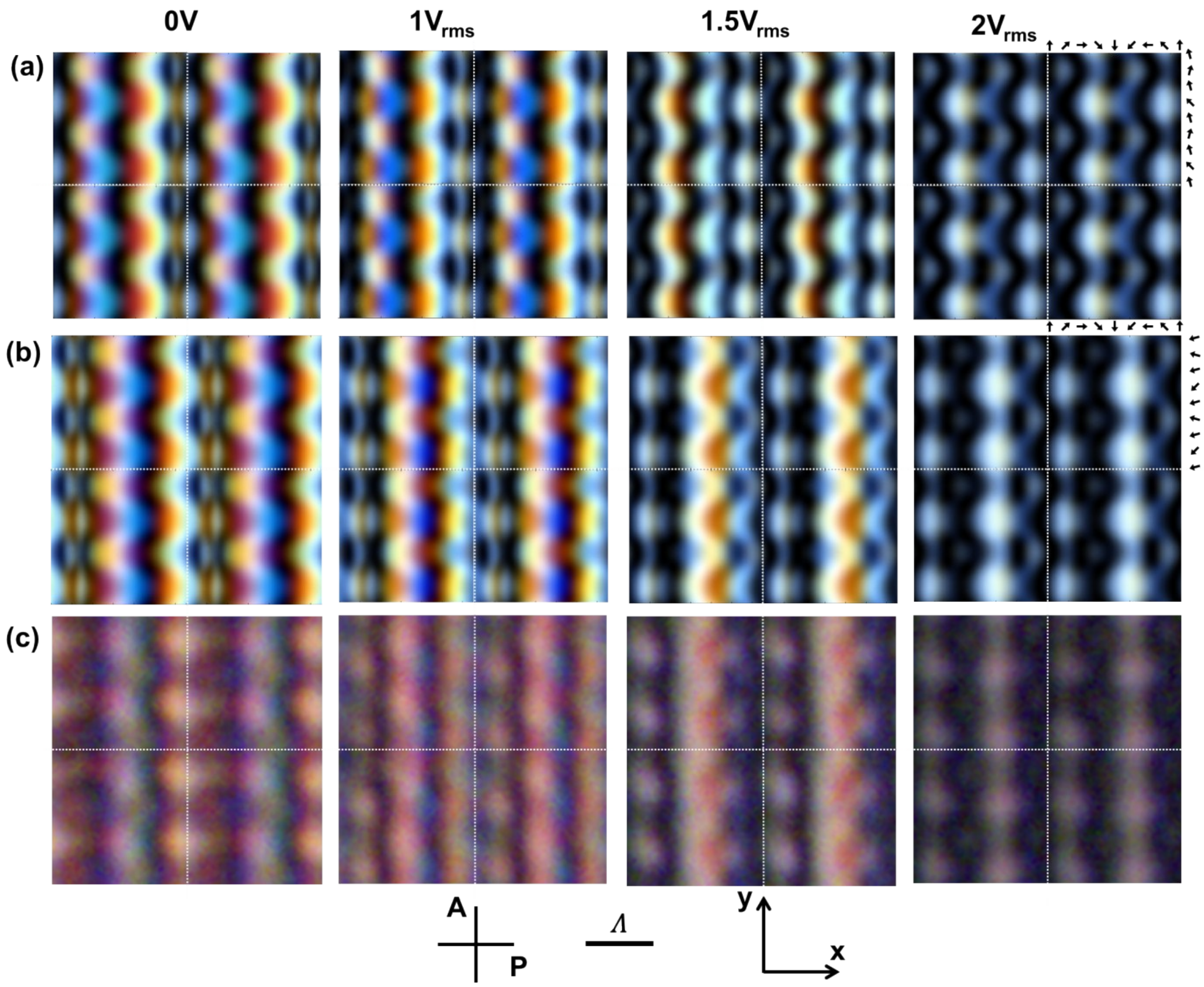

Figure S4 Comparison between the simulated transmission patterns (a, b) and the experimental measurements (c) for region B with stripes along the y-axis. Two by two unit cells are shown and the applied voltages are 0 V, 1 V_{rms}, 1.5 V_{rms} and 2 V_{rms} from left to right. The alignment at the bottom substrate is still following the ideal rotation while the alignment at the top substrate is defined by $\phi(y) = \frac{7\pi}{12} + \frac{\pi}{6}\sin(\frac{2\pi y}{\Lambda})$ in (a) and $\phi(y) = \frac{\pi}{12} + \frac{\pi}{6}\sin(\frac{2\pi y}{\Lambda})$ in (b). A good agreement between the experimental results (c) and the simulations with $\phi(y) = \frac{\pi}{12} + \frac{\pi}{6}\sin(\frac{2\pi y}{\Lambda})$ (b) is obtained.

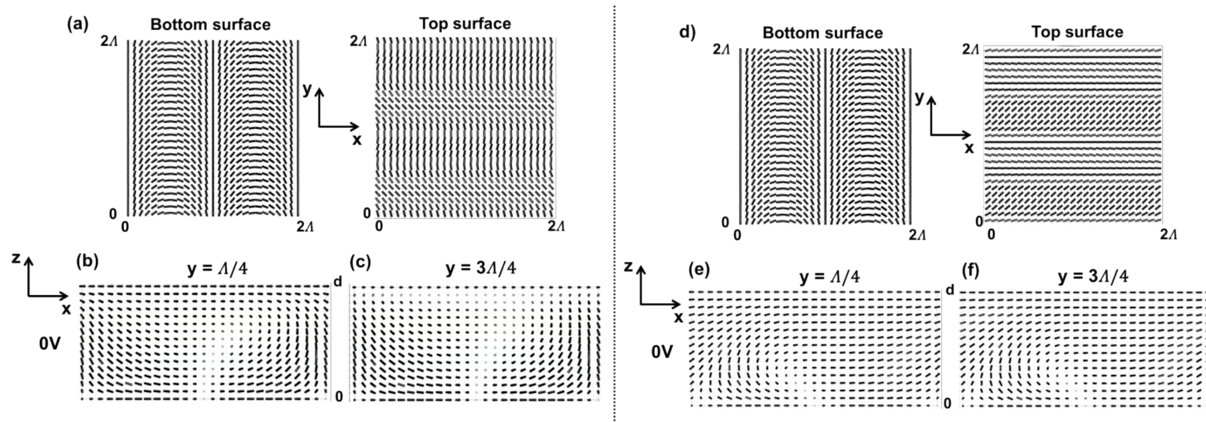

Figure S5 Comparison between the simulated director configuration for two different cross sections y = Λ/4 (b, e) and y = 3Λ/4 (c, f) for the ideally rotating alignment at the bottom substrate and $\phi(y) = \frac{7\pi}{12} + \frac{\pi}{6}\sin(\frac{2\pi y}{\Lambda})$ (a, b, c) and $\phi(y) = \frac{\pi}{12} + \frac{\pi}{6}\sin(\frac{2\pi y}{\Lambda})$ (d, e, f) at the top substrate.

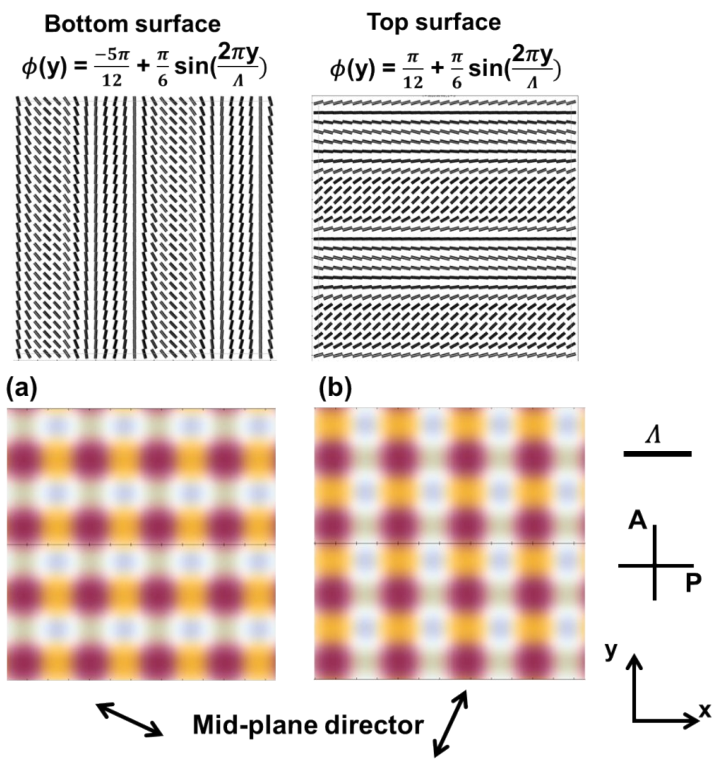

Figure S6 Simulated transmission between crossed polarizers for a cell with $\phi(y) = \frac{\pi}{12} + \frac{\pi}{6}\sin(\frac{2\pi y}{\Lambda})$, $\phi(x) = -\frac{5\pi}{12} + \frac{\pi}{6}\sin(\frac{2\pi x}{\Lambda})$. The twist handedness in (a) and (b) is opposite, illustrated by the schematic representation of the mid-plane director (bottom).

References

1 I. Nys, J. Beeckman, K. Neyts, *Soft Matter* **2015**, *11*, 7802.