

# Morphing surfaces formed in liquid crystal network under the electric field

Danqing Liu<sup>1,2\*</sup>, Dirk J. Broer<sup>1,2</sup>

<sup>1</sup>Laboratory of Functional Organic Materials & Devices (SFD), Department of Chemical Engineering & Chemistry, Eindhoven University of Technology, Den Dolech 2, 5612 AZ Eindhoven (NL)

<sup>2</sup>Institute for Complex Molecular Systems (ICMS), Eindhoven University of Technology, Den Dolech 2, 5612 AZ Eindhoven (NL)

We propose an original approach to create oscillating surface topographies in thin liquid crystal polymer network coatings by an electric field. By applying an alternating electric field from a pre-patterned interdigitated electrodes underneath of the thin liquid crystal coating, the coating surface deforms, and pre-designed local corrugations appear. In this way, glass-like surfaces can be brought into deformation as if they were liquids.

The activation principle is based on the creation of dynamic molecular voids by decreasing the order of crystal polymer networks (LCNs) and bringing the LCN into oscillation. [1] Here, we use an AC electric field to exert an oscillatory stress on the LCN polymer main chains. The mesogenic rods are thereby continuously deviating from their initial orientation and packing. This dynamic motion in polymer network leads to the formation of free volume. In order to boost the volume generation the AC field frequencies are tuned to match the natural network frequencies. This initiates resonance-enhanced oscillatory dynamics which largely amplify the deformation effects. The deformation of the coating surface is shown in Figure 1 which demonstrates that the coating deforms in between the electrodes.

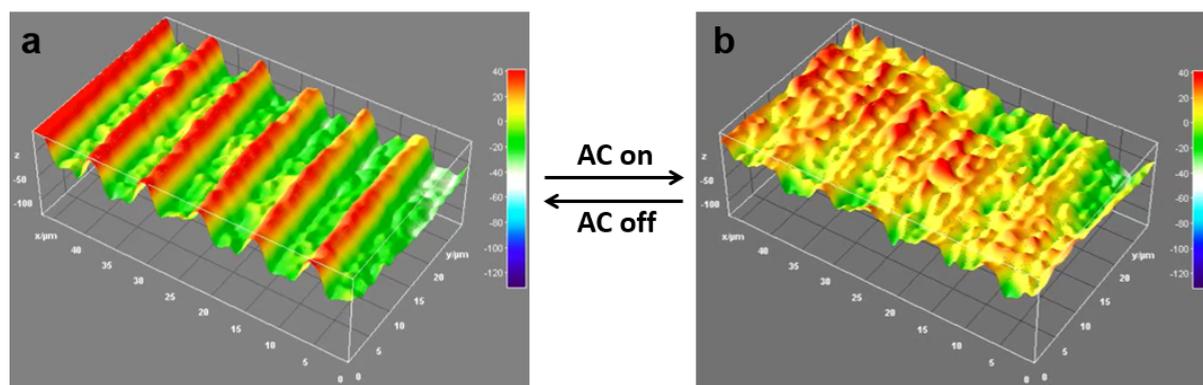


Figure 1. Surface deformations under an electric field. (a) 3D images of a coating on an electrode array in its initial state, and (b) when the electric field is on.

The response time of formation and relaxation of surface topographies in our LCN coating are on the order of 10 seconds. This is much slower than the rise and decay times of the electric field. This suggests that the deformation dynamics are dominated by viscoelastic deformation of the polymer network, rather than by dielectric properties. Related observations in azobenzene-modified LCNs support this conclusion. [2]

## References

- [1] D. Liu, N. B. Tito, and D. J. Broer, *Nat. Commun.* **8**, 1526 (2017).
- [2] D. Liu and D. J. Broer, *Nat. Commun.* **6**, 8334 (2015).

\*Corresponding author e-mail: d.liu1@tue.nl.