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RECONFIGURABLE DEVICES THAT EXTEND OUR SENSES

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Overview

Liquid crystals (LC) are reconfigurable materials that have traditionally been used in flat panel display devices. Nematic LCs have rod-like molecules, which respond to electric and magnetic fields in fascinating and interesting ways. Therefore, researchers are constantly investigating ways of exploiting the elastic and rod-like properties of LCs in other applications including healthcare and telecommunications [1]. In our case, we aim to showcase how LCs can be used to improve and extend our senses. This is achieved via reconfigurable wearable devices that respond to low voltages from micro structured electrodes [2]. Examples of our devices include a tuneable antenna and a lens that can be worn on the wrist or the human eye. In particular, we demonstrate innovative electrode structures to manipulate the thick LC cell with relatively low voltage to achieve high resolution and quick response times.

This technology could be applied in different scenarios, for example, displays, wearable applications and photo-communication

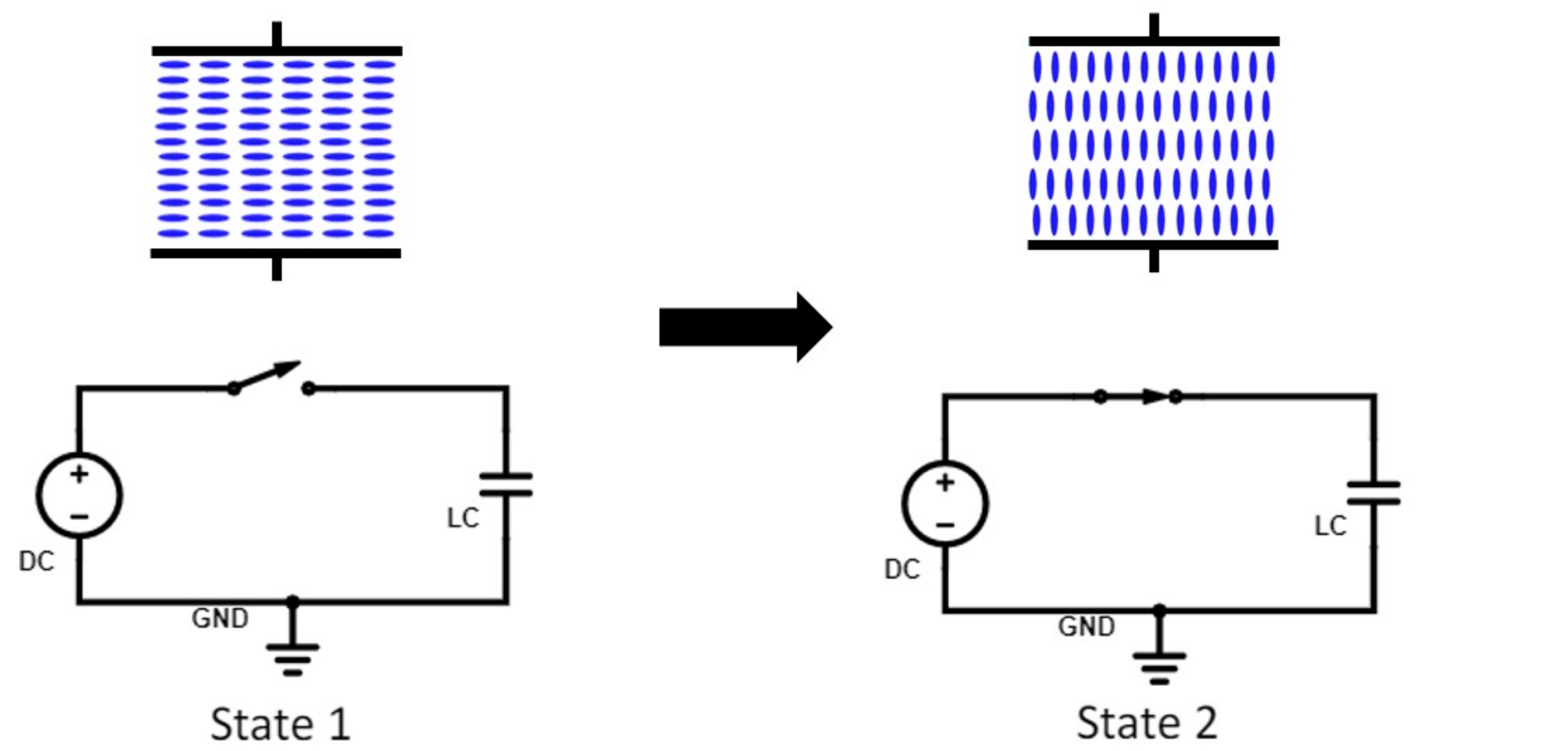

Fig. 1. This figure demonstrated how NLCs react to electric field variation.

Methodology

Previous LC devices relied on top-bottom electrode structures to switch the cell in LCD applications. In future applications of LCs, cells could be ten or even hundred times thicker than previous designs to achieve greater phase retardation. Additionally, low voltages are required for reconfiguring this device (or surface) in wearable and portable applications. Therefore, we are investigating novel micro and nano-electrode structure to manipulate thick LC cells with relatively low driving voltages and faster response times. Experimentally verified Landau de Gennes macroscopic simulations will be used in my work. Fringing electric fields will switch these LCs, as shown in figure 2 when the electrode voltage is set to ± 5 V.

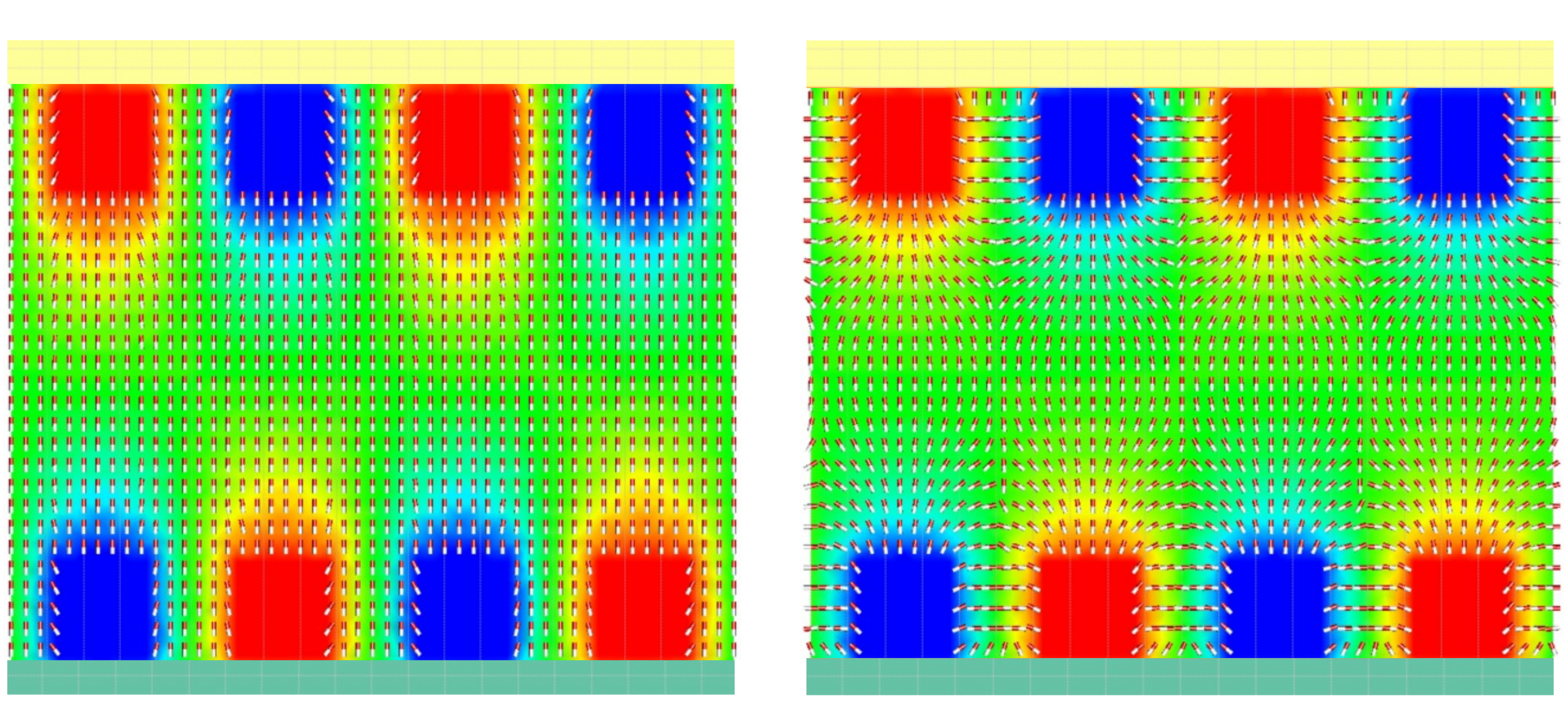

Fig. 2 Novel electrode structure for driving NLCs. (a) No voltage is applied to the electrodes (b) ± 5V is applied to the electrodes .

Result

LCs could be used in smart contact lenses to “tune” the antenna, as demonstrated in Fig. 3. Antennae can therefore support larger bandwidths and more compact dimensions, thereby extending and enhancing user experience.

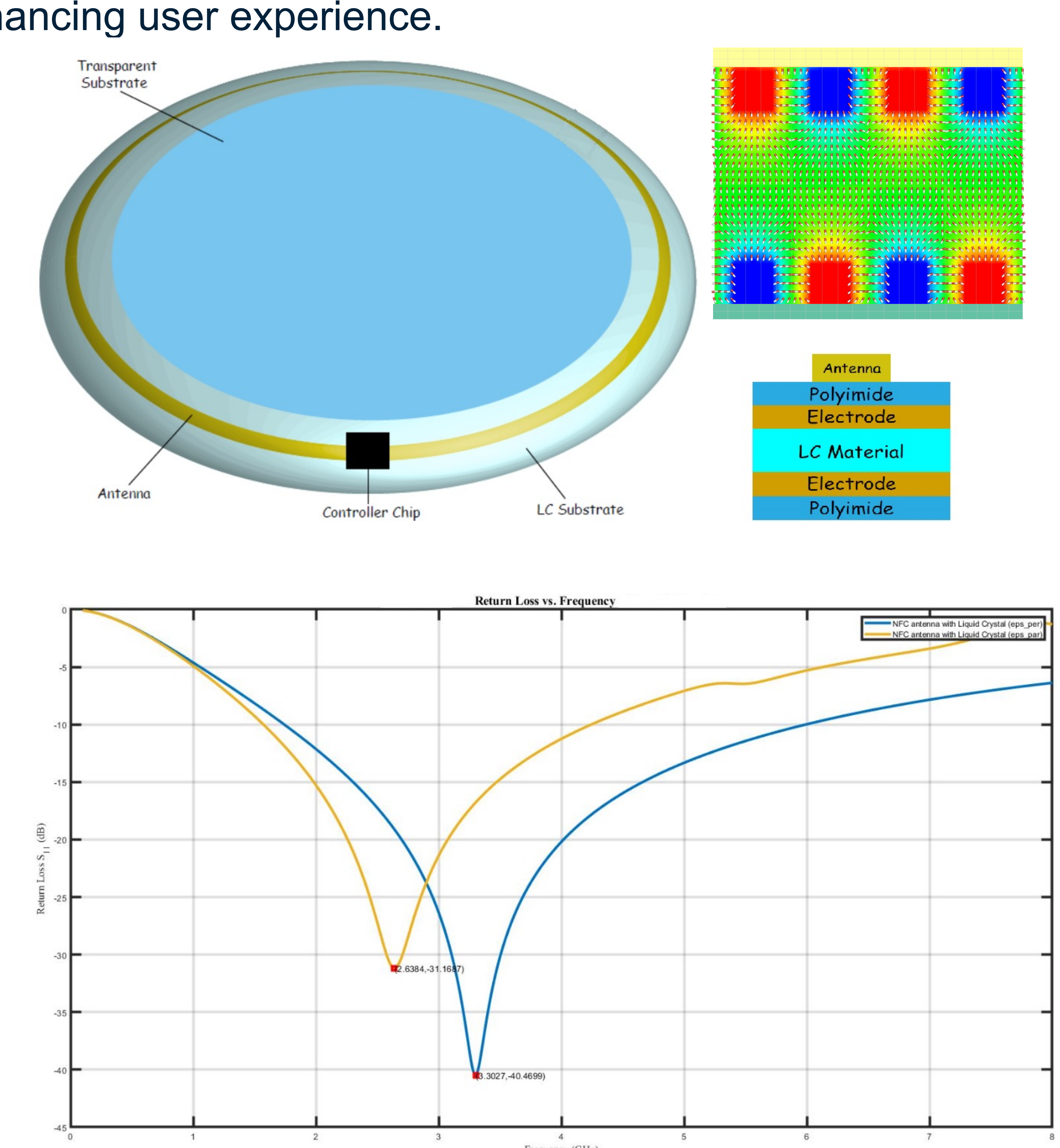

Fig. 3. Reconfigurable antenna with liquid crystals.

Conclusion and Future Work

LCs are nanomaterials that could be used in wearable applications. In this poster, we proposed a novel electrode structure to manipulate a thick liquid crystal cell and demonstrated how this could be used in a smart contact lens for tuning the antenna’s frequency. In future work, we will focus on fabricating the reconfigurable antenna and validating our simulation work.

References

[1] Ghannam, R. , Xia, Y., Shen, D., Fernandez, F. A., Heidari, H. and Roy, V. A.L. (2021) Reconfigurable surfaces using fringing electric fields from nanostructured electrodes in nematic liquid crystals. Advanced Theory and Simulations, 4(7), 2100058.

[2] James, R., Willman, E., Ghannam, R., Beeckman, J., & Fernández, F. A. (2021). Hydrodynamics of fringing-field induced defects in nematic liquid crystals. *Journal of Applied Physics*, *130*(13), 134701.

[3] Wilkinson, T. D., Henderson, C., Gil Leyva, D., Ghannam, R., & Crossland, W. A. (2006). Non-display applications and the next generation of liquid crystal over silicon technology. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *364*(1847), 2721-2732.