Electrically tunable and polarization independent liquid crystal lens

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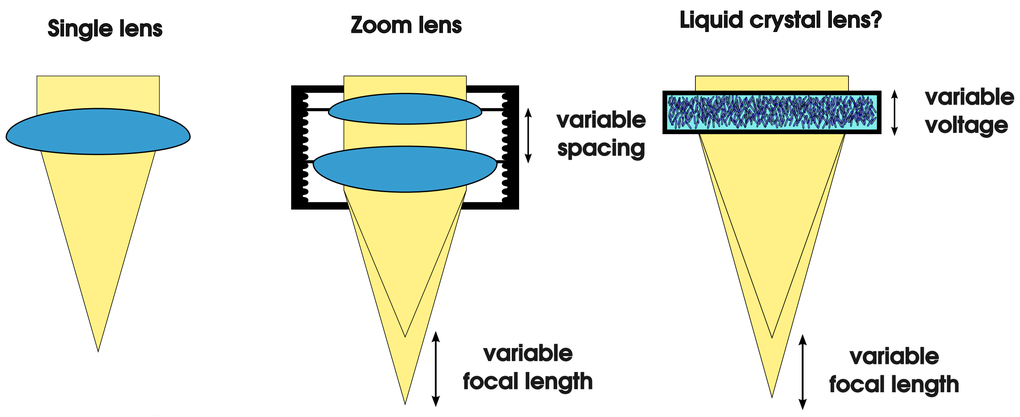
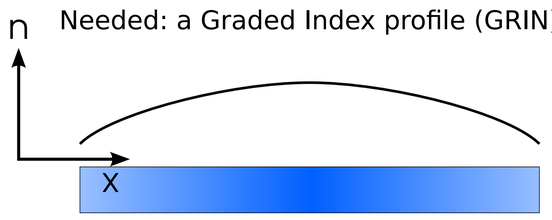
RESEARCH AIM

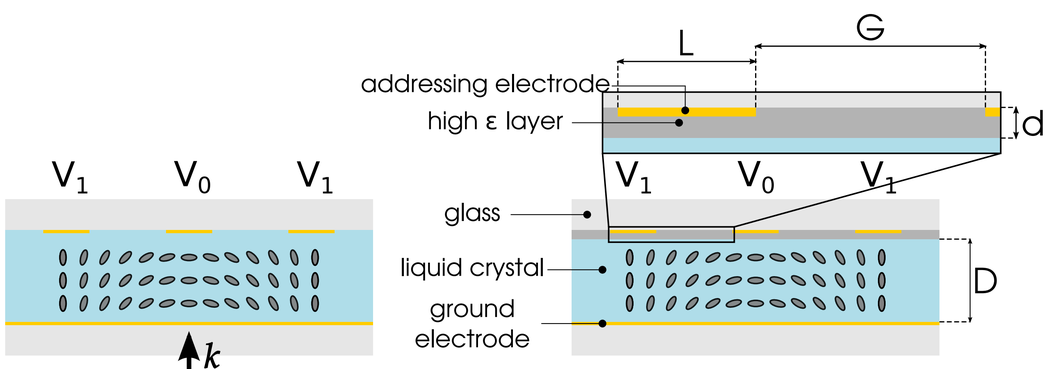


Can **liquid crystals** be used to make electro-optically **tunable lenses** for use in e.g. **solar concentrators** and **mobile device cameras**?



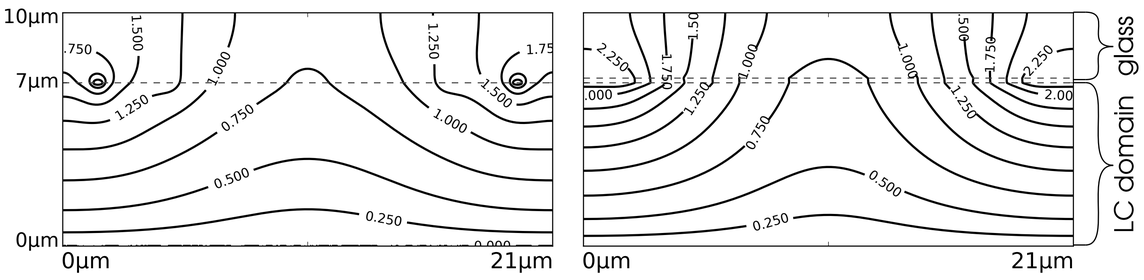
ORDINARY NEMATIC

Comparison of 2 cell addressing schemes



Remark: a device based on a nematic liquid crystal is polarization dependent!

Electro-optical simulation[1]

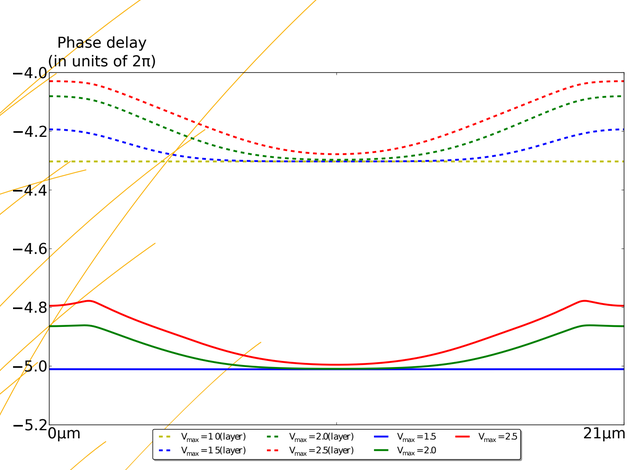


The isopotential lines within the LC vary less consistently when the liquid crystal is addressed directly. When a material with high dielectric constant is introduced, it acts as an interpolator between the electrodes, thereby reducing fringe field effects. The liquid crystal (E7 in the simulations) will reorient more gradually, which is desirable for a lens where the required phase profile is parabolic.

Using the simple **Jones matrix formalism** we simulate the optical phase profile.

A smooth parabolic phase profile is obtained. By tuning the applied voltages, the **focal length changes**.

Additionally, the threshold voltage for the device with the layer has decreased.



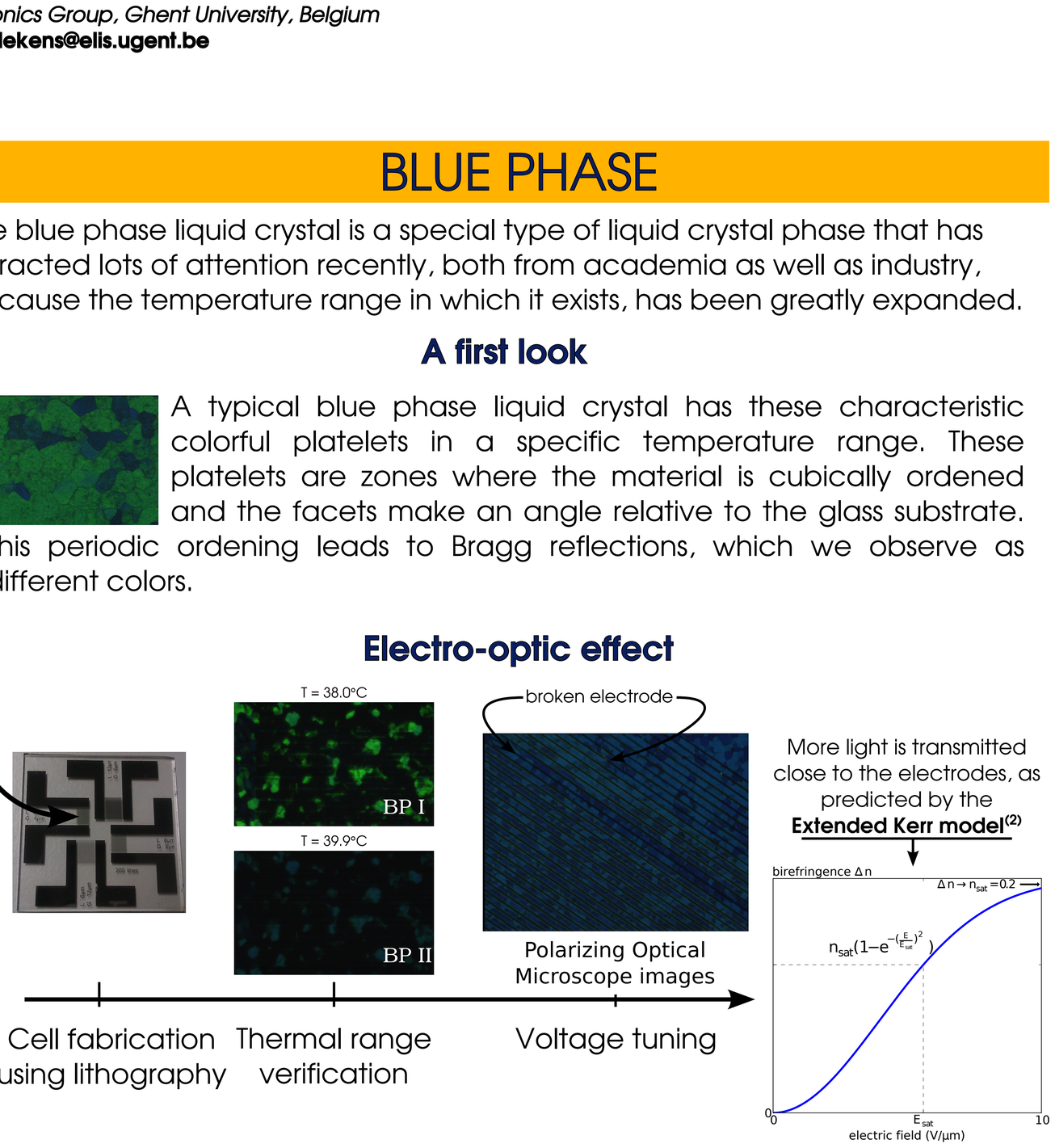
BLUE PHASE

The blue phase liquid crystal is a special type of liquid crystal phase that has attracted lots of attention recently, both from academia as well as industry, because the temperature range in which it exists, has been greatly expanded.

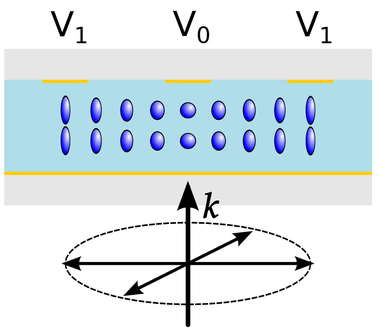
A first look

A typical blue phase liquid crystal has these characteristic colorful platelets in a specific temperature range. These platelets are zones where the material is cubically ordened and the facets make an angle relative to the glass substrate. This periodic ordening leads to Bragg reflections, which we observe as different colors.

Electro-optic effect



Polarization independence

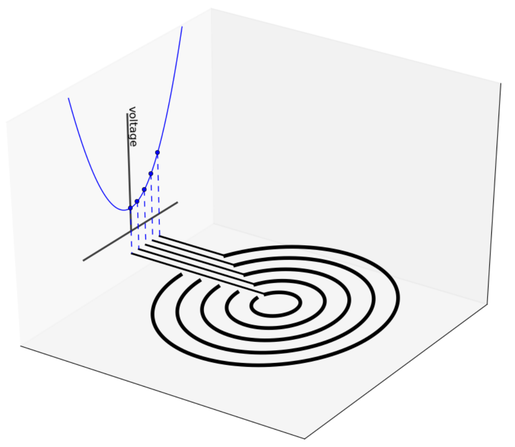


Due to its cubic unit cell, the blue phase is inherently isotropic. Its Kerr-like electro-optic behaviour allows us to create a GRIN cell that is polarization independent as well.

OUTLOOK

To create small, tunable camera lenses or solar concentrators, the blue phase liquid crystal will be injected between 2 glass plates. One of these is patterned with concentric electrodes to create a GRIN profile. By changing the voltages, the focal length can be altered.

Simulations will show what the optimal addressing voltages should be. However, the current electro-optical models describing the behaviour of the blue phase liquid crystal need to be refined. A series of experiments is planned.



Proposed lens electrode addressing geometry

REFERENCES

(1) R. James, *Modelling of High Resolution Liquid Crystal Devices*. (2006) doi: 10.1093/jmp/jhs077.

(2) J. Yan, *Extended Kerr effect in a polymer-stabilized blue-phase liquid crystal composite*. (2010) doi: 10.1063/1.3318288

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