

## Fast polarization insensitive optical shutters using dual frequency liquid crystals

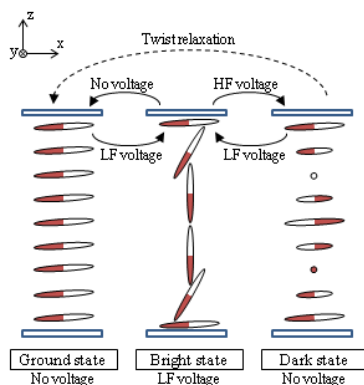
G. Mangelinckx,<sup>1</sup> J. Beeckman,<sup>1\*</sup> and K. Neyts,<sup>1</sup> O. Chojnowska,<sup>2</sup> R. Dabrowski,<sup>2</sup> J. Shin,<sup>3</sup> J.D.K. Kim<sup>3</sup>

<sup>1</sup> Department of Electronics & Information Systems, Ghent University, Ghent, Belgium

<sup>2</sup> Military University of Technology, Warsaw, Poland

<sup>3</sup> Samsung Advanced Institute of Technology, Yongin, Korea

Most of the existing displays and optical shutters based on liquid crystals work in combination with linear polarizers. This implies that often more than half of the light is lost due to optical loss in the polarizers and/or the fact that the incoming light is unpolarized. For a number of shutter and filter applications it is important to have a high transmission, while it is not necessary to have a very high contrast. When considering nematic liquid crystals for use in fast optical shutters or filters, a number of possibilities exist. Dual-frequency liquid crystals offer faster switching possibilities because they can be switched from one state to another with a low frequency voltage and switching back can be achieved with the aid of a high frequency voltage. One of the limiting factors for the switching speed of dual-frequency nematics is the appearance of backflow. As in vertically aligned nematic devices, a certain threshold voltage exists above which the switching speed increases drastically [1]. Above the backflow threshold, the liquid crystal ends up in a meta-stable twisted orientation as shown in the figure below.



Director profiles and switching behaviour in an anti-parallel planar dual-frequency liquid crystal cell

In this work we have implemented a fast optical shutter that works over the complete visible wavelength for unpolarized light. The device is a guest-host device in which dichroic absorbing dyes are mixed in low birefringence dual-frequency liquid crystal. The switching between the bright state (vertical alignment) and the dark state (twisted planar alignment) occurs both in less than one millisecond. The switching from the bright to the dark state occurs with the aid of a strong backflow effect. Simulations of the switching behaviour with a q-tensor model including flow agree well with the measured switching behaviour. Further simulations and measurements for other configurations reveal interesting switching modes with fast switching and/or multistable behaviour.

### References:

- [1] P.J.M. Vanbrabant *et al.*, Effect of material properties on reverse flow in nematic liquid crystal devices with homeotropic alignment, *Appl. Phys. Lett.* **95**, 151108 (2009)
- [2] G. Mangelinckx *et al.*, Fast polarization-insensitive optical shutter supported by backflow in dichroic dye-doped dual-frequency liquid crystal, *Liq. Cryst.* (submitted)

\* presenting author; E-mail: jeroen.beeckman@elis.ugent.be