Modeling upscaled voltage-driven liquid crystal smart windows

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There is a trend towards larger liquid crystal devices as the displays become larger. But liquid crystals are also considered for smart window applications. Smart windows that switch between opaque and transparent state in response to external stimuli have a wide potential for application in energy efficient buildings [1]. The most common liquid crystal smart windows are controlled by means of applied voltage. The fabrication and the driving of small centimeter sized windows has been investigated extensively, but quite a number of issues arise when it comes to meter

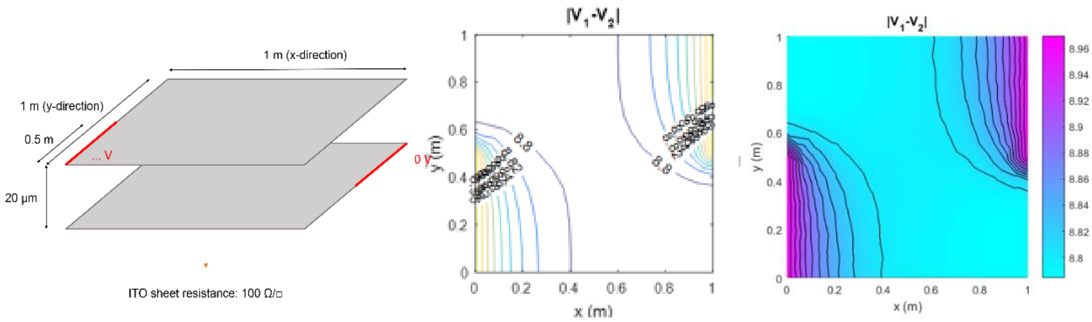

Figure 1 The geometry and contact formats of the LC smart window

sized windows. We developed a model to describe the non-uniform electric field distribution across large surface area liquid crystal devices. In this model, the voltage distribution is calculated using two coupled differential equations [2], taking into account the finite conductivity of the ITO and the capacitance of the liquid crystal layer. The optical transmission is calculated accordingly using the Jones Matrix formalism. The simulation model is able to predict any undesired non-uniform optical behavior, with different applied voltage signals (e.g. a sine or block wave).

The figure shows the geometry and voltage distribution for a smart window with a size of 1 m × 1 m. Then an experimental measurements on this window is conducted to compare with the simulation results. The results provide the prediction of the optical behavior of the liquid crystal smart windows and give reference for the choice of contact format.

[1] R. Baetens, B. P. Jelle, and A. Gustavsentitle, Properties, requirements and possibilities of smart windows for dynamic daylight and solar energy control in buildings: A state-of-the-art review, Solar Energy Materials and Solar Cells 94, 87 (2010).

[2] J. Beeckman, I. Nys, O.Willekens and K. Neyts, Optimization of liquid crystal devices based on weakly conductive layers for lensing and beam steering, Journal of Applied Physics 121 023103 (2017).