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Towards self-powered dynamic glass based on nematic liquid crystals and organic photovoltaic thin films

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Dynamic glass, whose transmittance in the visible and NIR can be adjusted under the action of an external stimulus, allows us to monitor solar radiation in buildings and vehicles and to improve energy performance. The most advanced dynamic glass technologies currently available are based on electrochromic, photochromic or thermochromic materials. However, their large-scale use is still limited by high costs, high energy consumption, slow response times or lack of user control.

In this communication, we will present a new type of dynamic glazing that has the potential to overcome some of the bottlenecks of existing technologies. The devices, called photovoltaic spatial light modulator (or PSLM), combines a layer of a twisted nematic liquid crystals with an organic photovoltaic thin film and offers an unprecedented level of performance and control over light transmission. The overall structure of the device is similar to that of a standard liquid crystal valve, except for the organic layer, which is used for liquid crystal alignment and photon harvesting (Figure 1a). As with a standard light valve, the transmittance of the device under cross-polarizers is reduced by applying an external voltage whose amplitude exceeds the liquid crystal Freedericksz transition voltage V_{Fr}. We will show that for PSLMs, the V_{Fr} decreases in amplitude with increasing light intensity leading to a decrease in the device transmittance at a fixed voltage. By studying the impact of different organic interfacial layers on the optical response of the device, we will further demonstrate that the light-induced shift in V_{Fr} is due to a photoelectric field generated by the organic thin film under illumination. The electric field modifies the liquid crystal director and alters the transparency of the device. We will further show that it is possible to modulate the transmittance at zero bias by using a thin film based on a P3HT:ICBA tandem bulk heterojunction (Figure 1b). These results pave the way for a new self-powered dynamic glass technology, with sub-second response times and straightforward user-control.

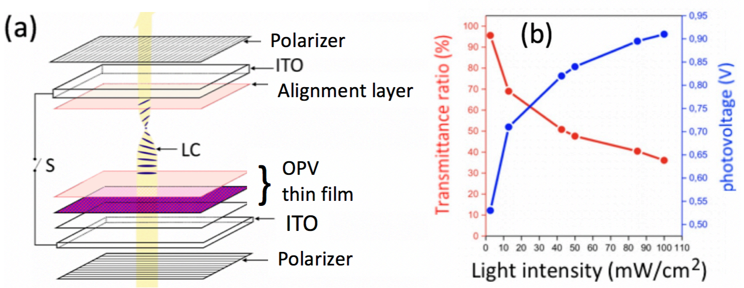

Figure 1: a) PSLM device structure. b) Ratio between transmittance before and immediately after closing the switch (S), and photovoltage versus light intensity.