Inkjet-printing chiral nematic free-standing caps for colorful solar cells

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Photovoltaics are one of the leading solutions for the transition from carbon emitting fossil fuels to renewable energies [1] and solar panels are becoming increasingly visible due to their integration in various surfaces beyond roofs such as facades, balconies or blinds. Their traditionally dark blue or black color will have a growing visual impact on the population which could in turn resist their implementation [2]. There is a need for customizing solutions that will allow to camouflage or use the solar panels for artistic purposes, without compromising their power conversion efficiency (PCE). This means that the coloring method should transmit a maximum of the incident light to the panel's solar cells, while allowing versatility in color palette and patterning to achieve a full aesthetic potential. However, traditional coloring methods still present a trade-off between retained PCE, color range and process complexity [3]. Here, we take advantage of the self-organized helical modulation of chiral nematic liquid crystals to produce structural color in a narrow and controlled reflection band, where only 50% of the incident light is reflected while the rest is fully transmitted through. We used inkjet printing as a fast and precise method to deposit "pixel-like" caps with diameters ranging from 40 to 130 microns on glass substrates coated with an alignment layer. Analyzing arrays of over eighty caps, we investigate the effect of the alignment layer on their optical properties and demonstrate that caps with similar saturation and brightness to thin films can be achieved in retro-reflection. Finally, by adding the deposited CLC caps on top of a solar cell, we link their optical properties to the PCE loss for the cell underneath, and show that, similarly to thin films, minimal losses are sustained, despite the scattering originating from residual defects. Therefore, we argue that this method can be the key to achieving high power-retaining solar cells with arbitrary colored pixelated images and enable further implementation for photovoltaic applications.

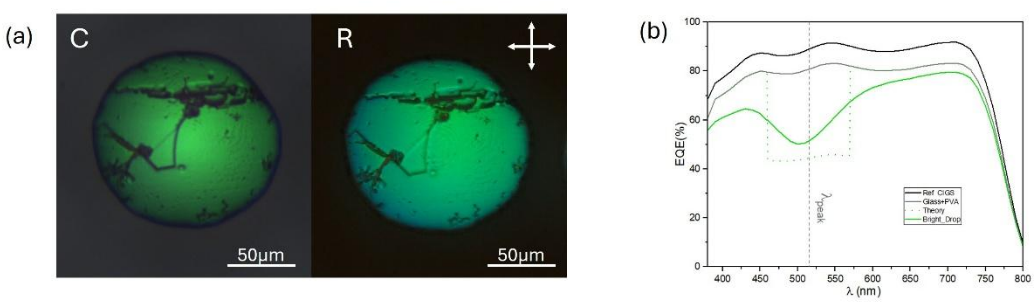

Figure1. (a) Confocal microscope image in bright field mode of a CLC cap on the left and the same cap observed under crossed polarizers in reflection mode on the right. (b) External quantum efficiency of a CIGS solar cell measured at the location of the substrate and colored cap that were added on top of it.

References

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