Flexible Organic Solar cells for indoor energy harvesting: predicting the photocurrent in complex environments

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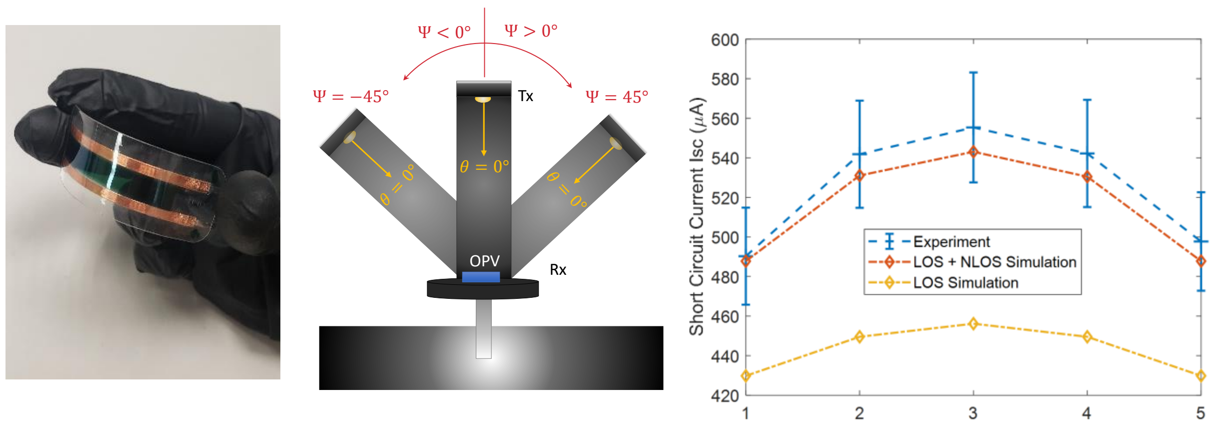
Abstract.
Organic photovoltaic (OPV) devices have shown important progress during the last decade, enabling state-of-the-art efficiencies under standard solar spectrum approaching 20%. While challenges associated with better performing active layer and interfacial materials and long-term stability remain important under full sunlight, OPV are also particularly relevant for low-cost applications under low light intensities, such as for indoor applications, where they outperform most of the conventional photovoltaic technologies [1]. Especially, their flexibility and tunability, associated with low energy footprint process, make them ideal to be integrated on novel and autonomous Internet-of-Things (IoT) devices, for which they are also exploited for simultaneous wireless optical data reception purposes [2]. Such applications require a precise estimation of their performance under complex environments, involving curved surface, shadowing, hybrid line-of-sight (LOS) and non-line-of-sight (NLOS) configurations, noise, and mobility constraints. In this context, anticipating the expected current and power photogenerated by flexible OPV devices is crucial. In this work, performed in the frame of the OPV4COM project (ANR), we present our methodology towards the prediction of OPV performance in complex environments thanks to a combination between device metrology under LED illumination and simulation of the optical channel using an innovative Monte-Carlo ray-tracing simulator (RaPSor) [3], [4]. Especially, after experimental validation of the predicted photocurrent in LOS and NLOS configurations on flat devices, we discuss the performance of flexible OPV cells printed by inkjet and the impact of curvature radius on the device field of view and associated performance. This methodology opens the way to the full integration of OPV modules into "Green IoT" scenarios involving simultaneous energy harvesting and wireless optical data reception, for applications in Industry 4.0, e-Health or Smart Home/Cities.



Left: Flexible OPV printed by inkjet (Dracula Technologies). Center: principle of the experimental metrology of the angular response of OPV device under LED illumination. Right: Experimental and predicted photocurrent delivered by the OPV device as a function of illumination scenario.

References

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