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In-line high precision optical metrology for mass production of Organic Electronics

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Abstract

Optical metrology has the potential to revolutionize the manufacturing of high performance Organic Electronic devices on plastic substrates, as Organic Photovoltaics (OPVs), Organic Light Emitting Diodes (OLEDs), Organic Thin Film Transistors (OTFTs) etc, by large-scale Roll-to-Roll (R2R) manufacturing processes. Its unique advantages include non-destructive character, high measurement speed and sophisticated modelling methodologies that can provide significant information on the optical and structural properties, thickness and blend morphology of R2R printed nanomaterials in complex device architectures. This information is essential for the optimization of the morphology and thickness of the OE device nanolayers in order to manufacture OE devices with high performance and lifetime.

In this work, we present the innovative implementation of optical metrology tools (such as Spectroscopic Ellipsometry - SE in the visible to far ultraviolet spectral region, and Raman Spectroscopy -RS) on a unique R2R printing pilot line for the fabrication of polymer nanomaterials and OPV devices onflexible substrates that have the form of web rolls. The SE technique is combined with sophisticated modelling procedures and methodologies to obtain information on the optical properties, blend morphology, thickness homogeneity, surface roughness and quality of the different organic nanomaterials for OPVs in normal and inverted architectures. These include the transparent electrodes (e.g. PEDOT:PSS), and the bulk heterojunction (BHJ) photoactive layers that consist of electron donors (e.g. polythiophenes) and electron acceptors (e.g. $PC_{60}BM$, $PC_{70}BM$, $IC_{70}BA$, etc.). In addition, we present the advances on the Raman investigations of the bonding structure, quality and homogeneity of the printed OPV nanolayers on the plastic web roll of length of several meters.

Finally, the implementation of in-line optical metrology in the unique r2r printing pilot line will revolutionize the large scale production of printed OE devices (OPVs, OLEDs, OTFTs, etc.)with tailored properties, high performance and lifetimefor commercialization to real-life consumer applications.