Roll-to-Roll Printed Silver Nanowire Semitransparent Electrodes for Fully Ambient Solution-Processed Tandem Polymer Solar Cells - DTU Orbit (10/08/2019)

Silver nanowires (AgNWs) and zinc oxide (ZnO) are deposited on flexible substrates using fast roll-to-roll (R2R) processing. The AgNW film on polyethylene terephthalate (PET) shows >80% uniform optical transmission in the range of 550-900 nm. This electrode is compared to the previously reported and currently widely produced indium-tin-oxide (ITO) replacement comprising polyethylene terephthalate (PET)|silver grid|poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS)|ZnO known as Flextrode. The AgNW/ZnO electrode shows higher transmission than Flextrode above 490 nm in the electromagnetic spectrum reaching up to 40% increased transmission at 750 nm in comparison to Flextrode. The functionality of AgNW electrodes is demonstrated in single and tandem polymer solar cells and compared with parallel devices on traditional Flextrode. All layers, apart from the semitransparent electrodes which are large-scale R2R produced, are fabricated in ambient conditions on a laboratory roll-coater using printing and coating methods which are directly transferrable to large-scale R2R processing upon availability of materials. In a single cell structure, Flextrode is preferable with active layers based on poly-3-hexylthiophene(P3HT):phenyl-C61-butyric acid methylester (PCBM) and donor polymers of similar absorption characteristics while AgNW/ZnO electrodes are more compatible with low band gap polymer-based single cells. In tandem devices, AgNW/ZnO is more preferable resulting in up to 80% improvement in PCE compared to parallel devices on Flextrode. Rolling in tandem: Roll-to-roll rotary screen printing of silver nanowires (AgNWs) and zinc oxide (ZnO) is realized on flexible substrates enabling large-area semi-transparent electrodes with >80% transmission. This electrode is employed in all-ambient roll-coating of single and tandem polymer solar cells. AgNW/ZnO proves highly suitable especially for tandem structures while the traditional indium-tin-oxide replacement - Flextrode - remains unbeaten in single cells with wide band-gap polymers.

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