Surface plasmonic effect of hybrid Au nanoparticles incorporating with metallic grating enhanced organic thin-film solar cells

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Optical management is one of the key issues toward achieving high performance in organic solar cells (OSCs) and plasmonic nanostructures have been considerable designed for light harvesting improvement. In this study, an enhancement of OSCs using plasmonic gold nanoparticles incorporating with metallic grating nanostructure, which was a structure of ITO coated glass substrate/PEDOT:PSS:AuNSs:AuNRs/P3HT:PCBM/Al grating electrode, has been investigated. The blu-ray disc recordables (BD-R) were used as the diffraction grating substrate while the mixture solution of gold nanospheres (AuNSs) and gold nanorods (AuNRs) were added into hole transport layer (PEDOT:PSS) to induce the localized surface plasmon resonance (LSPR) within OSCs. UV-visible spectra, current density versus voltage characteristics, and the incident photo-to-current efficiency of the fabricated device were investigated. In comparison with the reference cell, the proposed solar cell exhibited a great improvement in photovoltaic performances by increase the short-circuit current density (JSC) from 6.84 mA.cm-2 to 7.95 mA.cm-2 and improvement of the power conversion efficiency (PCE) from 3.20% to 3.65% with a large enhancement percentage of 16.23% (JSC) and 14.06% (PCE), respectively. As a result, it can be noticed that an increase in light harvesting in the developed devices is induced from AuNPs (AuNSs and AuNRs) through LSPR effect. Additionally, the synergetic effect between LSPR and grating-couple surface plasmon resonance (GCSPR) benefit to have great enhancement OSCs efficiency, therefore, this systematic platform could be further developed in practical application for OSCs.

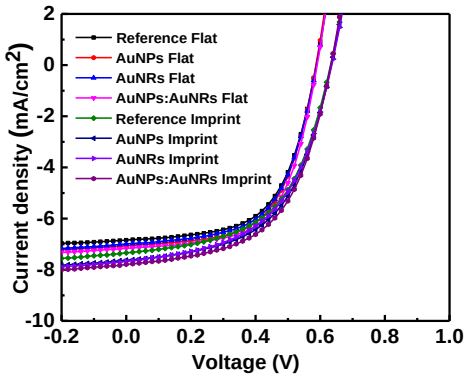

Fig. 1. *J-V* characteristics of the developed photovoltaic devices compared to the reference cell.

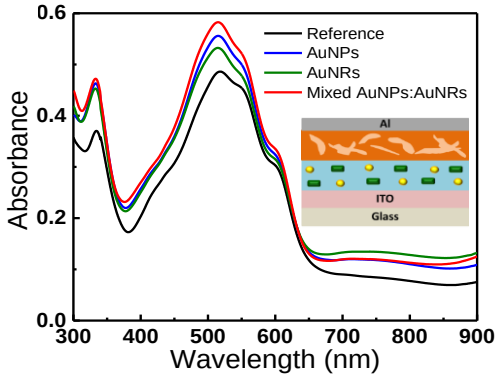

Fig. 2. UV-visible absorption spectra of the solar cell film; glass/PEDOT:PSS/ Metal nanoparticles/active layer.