

Improving the Efficiency of Plasmonic Organic Solar Cells via Urchin-Like Gold Nanoparticles

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Recently, plasmonic properties of gold nanoparticles (AuNPs) have widely been used for organic solar cells. In our work, urchin-like gold nanoparticles (UL-AuNPs), which have gold nanothorns on its surface, were synthesized by one-pot wet-chemical method and also no capping agent or stabilizer. The particles sizes of UL-AuNPs are in the range of 60 – 80 nm confirmed by TEM images, and UV-vis. absorption peak wavelength of UL-AuNPs is at 730 nm as shown in Fig. 1. These materials could help to increase the light accumulation in OPSCs as a light tapping materials because of the large absorption and light scattering from plasmonic properties to enhance the excitons generation and improve efficiency of OPSCs. The UL-AuNPs with various concentrations were included in thin film layers of poly (3, 4-ethylenedioxythiophene): poly (styrene sulfonate) (PEDOT: PSS) as hole transport layer which was confirmed by UV-Vis spectrophotometer and AFM. The fabrication process of OPSCs on ITO/glass substrates is as follows; PEDOT: PSS with UL-AuNPs was spin-coated on ITO substrates. Then, (phenyl-C61-butyric acid methyl ester) (PCBM) blended with (poly (3-hexylthiophene)) (P3HT) was spin-coated as the active layer on the PEDOT: PSS layer; followed by the deposition of the aluminum electrode by vacuum evaporation technique. The photovoltaic parameters, J-V properties and impedance spectrum of fabricated devices were observed. These results show that the suitable concentrations of UL-AuNPs with blending in PEDOT: PSS increased the solar cell efficiency (η) from 4.7-10% when comparing with reference cells. The effect of the concentration, particles dispersion of UL-AuNPs on hole transport layer and also comparison with spherical gold nanoparticles in the same particles size were studied.

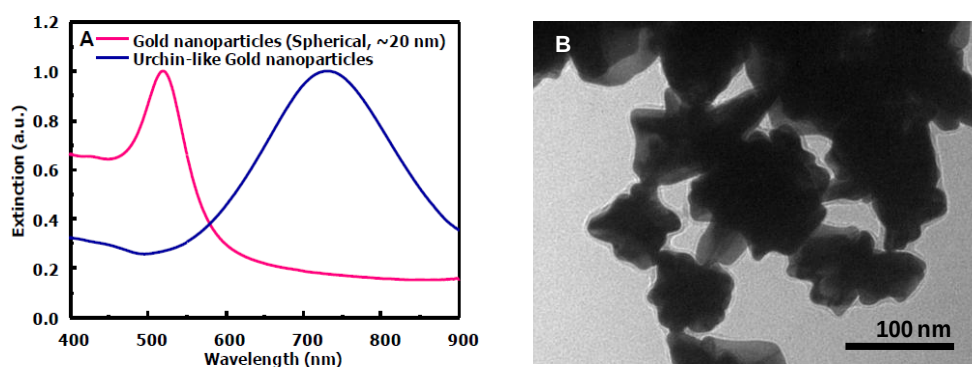


Fig. 1 A: UV-visible spectra of UL-AuNPs compared with standard gold nanoparticles. B: TEM image shows that the detailed structure and size of UL-AuNPs, this was similar to sea-urchin which consisted of gold nanothorns.