

TiO₂ Composite Films with Nanoparticles and Nanotubes for Efficient Light Harvesting in Perovskite Solar Cells

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The flakes of TiO₂ nanotube arrays (TiO₂ NA's) have been incorporated into mesoporous TiO₂ films in perovskite solar cells and we investigated them for light harvesting. Both normalized reflectance and incident photon-to-current efficiency (IPCE) were increased at longer wavelengths (570–800 nm) by the presence of the flakes of TiO₂ NA's in the cells, implying that the main role of the flakes of TiO₂ NA's is that of light harvesting in perovskite solar cells. We determined that the best energy conversion efficiency of the perovskite solar cells with the flakes of TiO₂ NA's is 15.335%, which occurs for 9wt% the flakes of TiO₂ NA's in a composite layer. This is an improvement of 8.28%, arising from light harvesting, compared to perovskite solar cells without the flakes of TiO₂ NA's.