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Enhancement of Perovskite Solar Cells Performance using Electrochemically Grown TiO2 Quantum Dots

Abstract
Perovskite solar cells (PSCs) are among the rising technologies for clean energy harvesting. Although the platform is performing better, cheaper and can be more efficiently fabricated than the Si-based solar cells, the device suffers from low stability and durability against the ambient conditions. A general PSCs consists of consist of five layers: including Fluorine doped Tin Oxide glass (FTO), Electron transporting layer (ETL), Perovskite Layer (PSVK), Hole transporting layer (HTL) and Electrode. It has been reviewed that the PSVK/ETL or PSVK/HTL interfaces are most responsible for defects resulting in lowered performance and stability due to higher charge recombination rate through higher number of pinholes. In this work the team aimed to modify the PSVK/ETL layer using TiO2 Quantum Dots (QDs) by varying concentration of TiO2 QDs grown via electrochemical process in KCl-based solution (0%, 2.5%, 5%, 7.5%, 10%) mixed in TTIP. TiO2-based ETL is coated and passivated along with with perovskite layer in conventionally structured PSCs. KCl in base solution of QDs is also used to aid with the passivation while methylammonium formamidinium lead iodide (MAFAPbI3) is used as PSVK layer. The results showed that with optimal percentage of TiO2 QDs can improve efficiency perovskite solar cells. Performance of our reference PSCs shows photoconversion efficiency (PCE) of 14.05 % while with 7.5% of TiO2 QDs passivation on PSCs shows highest performance of 15.72%. This is likely due to the TiO2 QDs formula passivating and reducing the pinholes between PSVK/ETL junction improving electron transport. Additionally, the choice of the electrolyte such as KCl can also aid in TiO2 QDs passivation in the PSC connecting the QDs with the PSVK layer through K+ and Cl- ions. The passivated PSCs with 7.5% condition also lasted for longer than 200 hours proving its improved stability. Sufficient TiO2 QDs in base solution mixed with TTIP has been used to passivate perovskite layer improve efficiency and stability of perovskite solar cells decreasing defect of PSVK/ETL junction.

Keyword: Quantum Dots, TiO2 QDs, TTIP, Perovskite solar cells, Electrochemical Process

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