Using Silver-Doped TiO_2 Electron Transport Layer to Enhance Photovoltaic Performance of Perovskite Structured Solar Cell

Ying-Han Liao, Shun-Hsiang Chan, Tzu-Hao Lin, Ming-Chung Wu*

Department of Chemical and Materials Engineering, Chang Gung University, Taiwan
*E-mail address: mingchungwu@mail.cgu.edu.tw

1. Introduction

In the recent years, solar cells, such as copper indium gallium diselenide, dye-sensitized solar cells organic photovoltaic and perovskite solar cells are developed rapidly and focus on high efficiency, low cost, and easy fabrication process. For perovskite solar cells, it shows the most developed potential for its high efficiency which increased rapidly from 3.8 to 22.1% [1]. In order to increase the power conversion efficiency (PCE), we used the metal ion-doped TiO_2 compact layer as electron transport layer due to the its lots of advantages, including chemical stability, low cost, and high electron transporting characteristics [2, 3]. In this work, silver-doped TiO_2 compact layer was fabricated by sol-gel method. The perovskite solar cells with silver-doped TiO_2 electron transport layer could enhance the short-circuit current density (J_{sc}) and PCE of perovskite solar cells.

2. General Instructions

For the synthesis of Ti precursor solution, titanium isopropoxide ($Ti(OCH(CH_3)_2)_4$, TTIP, > 97%) was added to ethanol. In another beaker, 2.0 M HNO_3 solution was added to ethanol, and then added to Ti precursor solution in ice bath with continuous stirring. For the synthesis of silver precursor solution, silver nitrate ($AgNO_3$) was dissolved in ethanol until it was completely dissolved in continuous stirring. Then, the silver precursor solution was added to Ti precursor solution with various concentrations by ice bath and continue stirring until the silver-doped TiO_2 precursor solution realized room temperature. Then silver-doped TiO_2 precursor solution was spin-coated on FTO glass and calcined to form the silver-doped TiO_2 compact layer. The perovskite film was use the perovskite precursor solution with spin-coating on the silver-doped TiO_2 compact layer. Next, the spiro-OMeTAD solution was spin-coated over on the perovskite layer. Finally, silver gold electrode was used vapor deposition on device surface with 0.09 cm^2 active area.

The perovskite solar cell based on the structure is FTO/silver-doped TiO_2/perovskite film/spiro-OMeTAD/Ag electrode as shown in **Fig. 1(a)**. **Fig. 1(b)** shows the *J-V* curve characteristics of perovskite solar cells with various of silver-doped TiO_2 compact layer. The J_{sc} of silver-doped TiO_2 increased from 19.5 to 21.5 mA/cm^2 with increasing silver doping concentration from 0.0 to 1.0 mol%. The PCE of champion device with 1.0 mol% silver-doped TiO_2 is 13.3%.

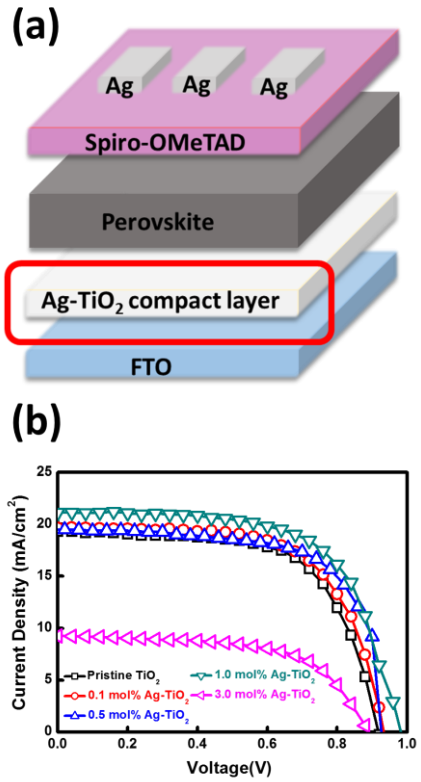

Fig. 1 **(a)** The schematic diagram of PSC structure, and **(b)** the *J-V* curves of the PSC with various silver-doped TiO_2 compact layers.

3. Conclusions

In summary, we successfully fabricated silver-doped TiO_2 compact layer as the electron transport layer of perovskite solar cells. After optimizing the processing parameters of perovskite solar cells, the PCE of the champion device with 1.0 mol% silver-doped TiO_2 compact layer is up to 13.3%.

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