Application of ZnO Nanorods Array to the Perovskite-Type Solar Cells: Fabrication of Perovskite Layer

Albertus Bramantyo[1], Masayuki Okuya[2], Kenji Murakami[2*] , Nji Raden Poespawati[3], and Arief Udhiarto[3]
[1]Graduate School of Science and Technology and [2]Graduate School of Integrated Science and Technology, Shizuoka University, and [3]Dept. of Electrical Engineering, University of Indonesia
*** E-mail: murakami.kenji@shizuoka.ac.jp**

1. Introduction

Perovskite layer offers electrical and optical quality to be applied in photoluminescence, chemical sensor, photovoltaic, and other devices. Although the metal oxides such as TiO_2, ZnO, etc. have been used as a photoelectrode, ZnO material was chosen in the present study due to easiness of fabrication and less complexity compared to TiO_2. For the perovskite layer an organo lead halide perovskite ($CH_3NH_3PbI_3$) was chosen. In this report, the perovskite layer has been fabricated by 1-step or 2-step spin coating, and the properties are compared and characterized by using FE-SEM with elemental analysis, and XRD measurements.

2. Experimental

A seed layer solution was prepared from a mixture of zinc acetate dihydrate with 2-methoxyethanol. The solution was stirred and heated at 60°C for 30 min after combining 10 drops of ethanolamine as a stabilizer. The deposition of the solution by spin coating on the cleaned FTO glass substrates was done and followed by a heat treatment at 100°C for 10 min. The cycle of spin coating and heating was repeated 3 times before a final annealing at 350°C for 1 h. Chemical bath deposition was used to grow the ZnO nanorods array (NRA) at 85°C for 3 h. The substrates with ZnO NRA were washed by distilled water for 30 min to reduce the leftover rods on top of the substrates. For the 1-step spin coating, the $CH_3NH_3PbI_3$ ($MAPbI_3$) solution was formed by combining 0.88 M PbI_2 solution with 2.64 M CH_3NH_3I (MAI) powder in 1 mL N,N-DMF solvent. The 2-step process consists of two separate solutions of 1.0 M PbI_2 in 1 mL N,N-DMF solvent (heated at 120 °C) and MAI solution made from 20 mg of MAI powder in 2 mL isopropanol solvent (heated at 60 °C). The spin coatings for 1-step and 2-step were done with a speed of 2000 rpm.

3. Results and Discussions

The FE-SEM observations indicate that more surface area of the perovskite layer fabricated by 1-step process is covered by larger particles compared to that by 2-steps process. The cross sections of two layers do not show a significant difference. The XRD profiles indicate that a significant amount of leftover PbI_2 is detected from the perovskite layer by 2-step process.

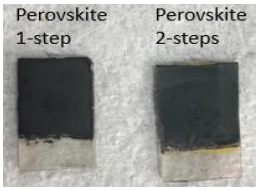

Fig. 1 Photos of the perovskite layers on top of the ZnO nanorods array with FTO substrates.

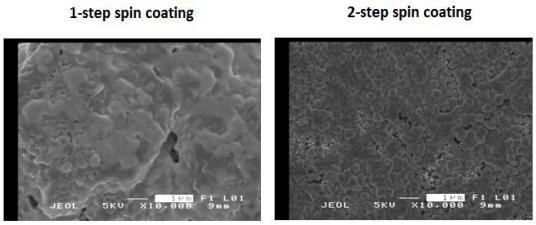

Fig.2 FE-SEM images of the surface of perovskite layers fabricated by 1-step (left) and 2-step (right) spin coating method.