電気泳動法の改良と熱処理による色素増感太陽電池の特性改善

Modified electrophoretic deposition and postdeposition treatments for improving the performance of a dye-sensitized solar cell

名工大　H. C. M. Shamimul、加藤慎也、岸直希、○曽我哲夫

Nagoya Institute of Technology, H. C. M. Shamimul, S. Kato, N. Kishi, °T. Soga

E-mail: soga@nitech.ac.jp

Introduction

Titanium oxide (TiO_2)-based dye-sensitized solar cell (DSCs) are under intense exploration in many research laboratories, owing to their creditable efficiency (~11%) and the potential for low-cost production [1]. In this investigation, we report fabrication of TiO_2-based DSC photoelectrode using a modified electrophoretic deposition technique along with different postdeposition treatments. The performance of the device has sequentially improved by optimizing the number of deposition layers (for EPD), applying a modified EPD technique, and using different postdeposition treatments. The maximum η of 4.98% has found for the cell prepared by hot-compression along with 450 ºC sintering.

Methodology

EPD suspension was prepared according to our previous work [2]. In this investigation, after each layer of deposition, the photanodes are dried in a hot-plate at a temperature of 100 °C for few minutes and has been inserted inside the suspension by changing the direction. Thus, we named this technique as four layer four side EPD (4L4SEPD). Different postdeposition treatments were applied for the photoelectrodes including the sintering, compression (40 MPa), and hot-compression (40 MPa compression with heating from room temperature to 90 ºC). Ru complex dye N719 was used as a sensitizer, a Pt-coated glass as counter electrode and iodide/triiodide redox (Solaronix Iodolyte AN-50) as the electrolyte. The cells were characterized by photocurrent voltage (*I-V*), scanning electron microscopy (SEM), UV transmittance, and electrochemical impedance spectroscopy (EIS) analysis.

Results and discussions

SEM image confirms that the four layer EPD ensures a crack free surface. Suitable compression temperature further improves the surface morphology compared to the sintered cell or the room temperature compressed cells. The thickness measurement confirms that the 4L4SEPD ensures a homogeneous layer photoelectrode and the photovoltaic performance has also be improved. Fig. 1 shows the *I-V* plot of the cells prepared by 4L4SEPD along with different postdeposition treatments. About 16%, 39%, and 70% enhancement in efficiency (η) has been achieved in DSC devices with compression, hot-compression, and hot-compression followed by sintering, respectively as compared to the sintered device. The transmittance spectra and EIS analysis have been investigated for the cells to observe the effect of heating during the compression and different postdeposition treatments. Optimum compression temperature reduces the interparticle distance and gives a compact layer photoelectrode. Thus, it reduces the electron transport resistance inside the photoelectrode and photoelectrode-dye interface.

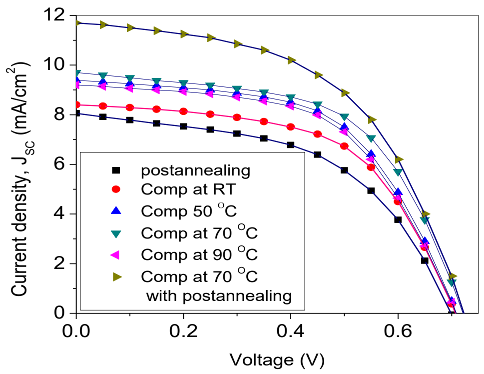

Fig. 1 *I-V* curves of the DSCs prepared by different postdeposition conditions.

Conclusion

In summary, the aforesaid observations elucidate that modified EPD along with hot-compression treatment improves the performance of a DSC.

References

[1] M. Grätzel, Chem. Lett., vol. 34, pp 8, 2005.
[2] M. S. H. Choudhury, N. Kishi, and T. Soga, Jpn. J. Appl. Phys., vol. 55, pp. 01AE13, 2016.