# Controlling Thickness of $TiO_2$ Electron Transport Layer in Lead Halide Perovskite Solar Cell by Spray Layer-by-Layer

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Lead halide perovskite[1,2] solar cells have emerged as a new high efficiency solar cell with low fabrication cost, simple fabrication process. In previous experiment, we succeed to fabricated $TiO_2$ by Spray-LBL use as electron trasport layer in organic thin film solar cell (BHT solar cell)[3]. However, perovskite solar cell also have electron transport layer. For this matter, we fabricated and controlled the thickness of electron transport layer manufactured by Spray-LBL.

In this experiment, the $TiO_2$ layer is deposited by Spray-LBL method on FTO and annealed at 450°C then the active layer of Perovskite solar cell is fabricated by spin coating and dipping in methylammonium iodide solution and hole transport layer. On the top of device, we sputtered gold for electrode contact. The schematic of this solar cell module is shown in Figure 1.

Figure 2 shows the SEM cross section of lead halide perovskite layer on $TiO_2$ layer when fabricated by Spray LBL method, cross section image shows very good uniformity and stability of $TiO_2$ layer. This picture observes the different crystalline structure of each layer (FTO,$TiO_2$ and perovskite layer). Figure 3 shows the surface morphology of lead halide perovskite layer. We observed the good crystalline quality and grain dimension of perovskites.

As a result, we found that this fabrication method is efficient for controlling the film thickness and the structure of electron transport layer and is suitable for perovskite solar cell.

**<References>**

[1] M. Liu, M. B. Johnston, H. J. Snaith, Nature 2013, 501, 395-398.

[2] M.M. Lee, J. Teuscher, T. Miyasaka, T.N. Murakami, H.J. Snaith, 2012, *Science*, *338*(6107), 643-647.

[3] A. Ariyarit, K. Manabe, K. Fukada, K.H. Kyung, K. Fujimoto and S. Shiratori, RSC Adv., 2015, 5, 52427–52435

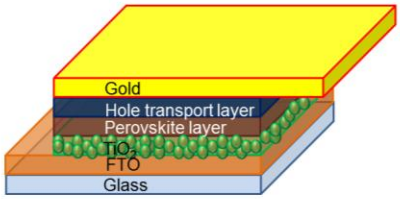


**Figure 1.** The schematic of this solar cell module

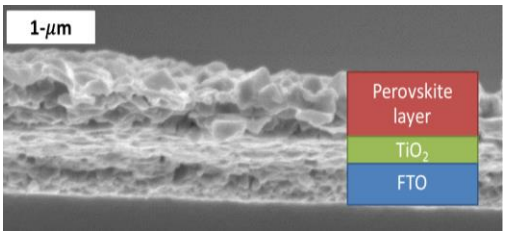


**Figure 2.** Cross section of FTO/$TiO_2$/Perovskite layer

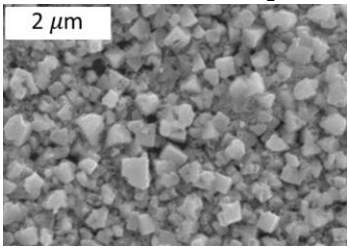


**Figure 3.** SEM image of surface morphology of perovskite layer