High Resolution Study of TiO_2 Contact Layer Thickness on the Performance of Over 800 Perovskite Solar Cells

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Abstract:

In this research, we systematically explore the influence of the TiO_2 thickness with nanometric variations over a range of 20–600 nm on the photovoltaic parameters (open-circuit voltage, short circuit current, fill-factor and power conversion efficiency) of $CH_3NH_3PbI_3$ based solar cells. We fabricate several sample libraries of 13 × 13 solar cells on large substrates with spatial variations in the thickness of TiO_2 layers while maintaining similar properties for the other layers. We show that the optimal thickness is ~ 50 nm for maximum performance; thinner layers typically resulted in short circuited cells while increasing the thickness led to a monotonic decrease in performance. Furthermore, by assuming a fixed bulk resistivity of TiO_2 we were able to correlate the TiO_2 thickness to the series and shunt resistances of the devices and model the variation in the photovoltaic parameters with thickness using the diode equation to gain quantitative insights.