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Development of Al_2O_3 thin film on polydimethylsiloxane (PDMS) using thermal atomic layer deposition and its application to improve the stability of organic-inorganic solar cells

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Based on our research, we found out that Al_2O_3 layer has a good moisture property. We achieved water vapor transmission rate (WVTR) of 1.84 x 10^{-2} g m^{-2} d^{-1} at 45 °C–100 %RH. For this, we deposited 50nm of Al_2O_3 layer at 95 °C via thermal ALD.

In this work, we formed Al_2O_3 layer on polydimethylsiloxane (PDMS) to improve the moisture barrier property. We employed Ca detector to examine the moisture barrier property of thin film. The WVTR value of 30nm Al_2O_3 layer on PDMS was measured to be ( ). Interestingly, we found out that the WVTR value of Ca/PDMS/Al2O3 has higher value than that of Ca/Al2O3/PDMS. It is attributed to the decrease of moisture path, which is result from the bonding between Al2O3 and PDMS. In order to test the moisture barrier property of PDMS/ Al_2O_3 layer, mesoporous perovskite devices, with spiro-OMeTAD as hole transport layer (HTM) encapsulated by 30 nm Al_2O_3 film on PDMS, are exposed to 45 °C–85 %RH for 400 hours and its stability is monitored. We successfully achieve excellent durability test results for mesoporous $(HC(NH_2)_2PbI_3)_{0.85}(CH_3NH_3PbBr_3)_{0.15}$/Spiro-OmeTAD devices encapsulated by 30 nm Al_2O_3 on PDMS with less than 7% drop in PCE after 400 hours of exposure to 45 °C–85 %RH.