Atomic Layer Deposition and Perovskite Solar Cells

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Hybrid organic-inorganic perovskite solar cells are heavily researched due to their potential to offer both high conversion efficiency and low cost. In 2019, within 10 years of their first use, organic-inorganic perovskite-based solar cells achieved record power conversion efficiency of 25.2 % in a single junction device surpassing the performance of the most popular and longest-developed crystalline silicon solar cells. Despite such rapid improvement, their stability remains a crucial issue towards commercialization. Specifically, perovskite solar cells degrade under outdoor conditions such as humidity, oxygen, elevated temperature, UV light, intense light irradiation, and also when they are exposed to electric fields.

Many avenues to improve the stability of these cells are being investigated with the added constraint of retaining or reaching a high efficiency. One avenue that is seen as very promising is the use of inorganic thin films in the design of the device. Atomic layer deposition (ALD) with its excellent control of film growth, high-quality films and low temperature depostion is seen as a key technology to this end.

In this paper, I will give a brief introduction to the ALD method: basics, history, reactors, and possible applications followed by presenting my research towards an application of room temperature ALD prepared aluminium oxide films on different perovskite substrates and their impact on the perovskite solar cells efficiency and stability. My studies in collaboration with partners from University of Oxford, Helmholtz Centre Berlin and Technical University in Darmstadt have shown that an ultrathin aluminium oxide film grown by ALD at room temperature using trimethylaluminum and water as Al and O precursors on the perovskite layer helps to preserve its and solar cells initial properties [1] during operation. The power conversion efficiency and solar cells stability depends also on the used number of ALD cycles. In addition, power conversion efficiency enhancement over time is observed [2].

[1] M. Kot, C. Das, Z. Wang, K. Henkel, Z. Rouissi, K. Wojciechowski, H. J. Snaith, D. Schmeisser: Room-Temperature Atomic Layer Deposition of Al_2O_3: Impact on Efficiency, Stability and Surface Properties in Perovskite Solar Cells. *ChemSusChem* 9 (2016) 3401.

[2] M. Kot, L. Kegelmann, C. Das, P. Kus, N. Tsud, I. Matolinova, S. Albrecht, V. Matolin, D. Schmeisser: Room-temperature atomic-layer-deposited Al_2O_3 improves perovskite solar cells efficiency over time. *ChemSusChem* 11 (2018) 3640.