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Title of the doctoral dissertation: **Development of strategies for improving stability of solar cells based on metal-halide perovskites.**

Abstract

Metal-halide perovskites (MHP) are currently considered the most promising materials for solar cell production due to their unique properties, such as tunable bandgap, high absorption coefficient, and long charge carrier lifetime. Devices based on these materials have made significant progress in increasing power conversion efficiency (PCE), exceeding 27%. Nevertheless, despite considerable success in improving performance, achieving long-term stability of perovskite solar cells (PSC) remains challenging.

The primary focus of the dissertation was to develop and optimize procedures for fabricating stable solar cells based on metal-halide perovskites. In the first part of the dissertation, research was carried out on the modification of electron transport layers (ETL) composed of aluminum-doped zinc oxide (AZO), prepared using atomic layer deposition (ALD). Three electron transport layers were analysed, i.e. ZnO and two AZO layers terminated by Et_2Zn+H_2O (AZO-1) and Me_3Al+H_2O (AZO-2). The study showed that controlled termination of the ALD process (particularly with Me_3Al+H_2O) can significantly improve the thermal stability of the perovskite film, resulting in higher stability and efficiency of the PSC.

In the second part, the potential of 1,3-disubstituted urea derivatives, namely 1,3-diphenylurea (Ph_2Ur) and 1,3-di(tert-butyl)urea (tBu_2Ur), as novel passivating agents for defects within the triple-cation (CsFAMA) perovskite layer was investigated. The study showed that well-designed urea-based compounds can effectively passivate uncoordinated Pb^{2+} defects and improve the physicochemical properties of perovskite films. As a result, the use of these urea derivatives increased the efficiency and, in case of Ph_2Ur, also the stability of the PSC.

In the last part, the effect of doping the inorganic perovskite $CsPbI_2Br$ with Pd^{2+} ions on the properties of the resulting layers, i.e., $Cs(Pd)_x(Pb)_{1-x}I_2Br$ was investigated. $PdBr_2$ and its solvated

complexes, namely $PdBr_2(MeCN)_2$ and $PdBr_2(PhCN)_2$, where MeCN and PhCN denote acetonitrile and benzonitrile, respectively, were used as the source of Pd^{2+} ions. The study showed that Pd^{2+} ions are incorporated into the structure of the $CsPbI_2Br$ perovskite. At the same time, it was demonstrated that using solvated complexes (especially complex $PdBr_2(PhCN)_2$) has a more favorable effect on the morphology and phase stability of the perovskite layer, which results into improved efficiency and stability of the PSC.