ABSTRACT

As a result of the rapid growth of industrialization around the world, global warming has emerged as a major environmental concern. To prevent global warming from exceeding 1.5°C, we need to generate 80% of our current energy from zero-emission sources by 2030 and 100% by 2050. The only way to accomplish this is to increase renewable energy usage. Due to its availability, sustainability, and accessibility, solar energy stands out as the most applicable alternative to fossil fuels among all other existing renewable energy supplies. Despite their high fabrication temperature (>1000°C), Silicon-based technology has dominated the solar energy market for the past few decades. Modern solar energy researchers are thus especially interested in developing low-temperature process photoactive materials that can reduce the fabrication cost without compromising power conversion efficiency (PCE). Interestingly, since the first emerged in 2009 with only 3.8% PCE, hybrid organic-inorganic metal halide perovskite (HOIP) have attracted a great deal of attention in the photovoltaics (PV) field. Due to the significant development within HOIP research, the corresponding PCE went beyond 25% within a few years. One of the practical approaches to achieve high PCE includes the use of organic material, which generally acts as charge extractor from the perovskite photoactive layer. However, the cost of organic-based hole transporting materials (HTMs) and their long-term environmental stability could hinder their further commercial application. Thus, there is an urgency of introducing a new approach to replace the organic-based HTM within PSC. In this regard, different types of PSC are being fabricated without the use of any organic HTM material and discussed in this thesis. In particular, first I synthesized hybrid perovskite ($MAPbBr_3$) with equal molar ratio of organic and inorganic precursors and uses it for HTM-free PSC application utilizing two device architectures, i.e., with and without TiO_2 as electron transport material. In addition, mixed halide perovskites are synthesized by varying molar ratio of organic and inorganic precursors. Unequal molar ratio of precursors leads to perovskites with higher PCE and improved stability as compared to the 1:1 molar ratio of precursors. To further improve the PV performances, additive incorporation within HOIP and total inorganic based perovskite are also being explored. In the case of $MAPbI_3$-based HOIP, $MAPbI_3$-20FACl shows the best PCE among the other compositions of FACl. On the other hand, for $CsPbIBr_2$-based total inorganic perovskite, $CsPbIBr_2$-10MACl shows a higher PCE than the other compositions.

In summary, this thesis focuses on the development of perovskite materials for the solar cell application without the use of any organic charge extracting layer.

Keywords: Solid state synthesis, perovskite, $MAPbBr_3$, $MAPbI_3$, $CsPbIBr_2$, additive incorporation, low dimensional perovskite, perovskite solar cell