Sequentially Hybrid Vacuum-Processed Multi-Cation Halide Perovskite

Felix Battran*, Erik Ahlswede, Michael Powalla

Centre for Solar Energy and Hydrogen Research (ZSW), Stuttgart, Germany

Email address:

felix.battran@zsw-bw.de (Felix Battran), erik.ahlswede@zsw-bw.de (Erik Ahlswede), michael.powalla@zsw-bw.de (Michael Powalla)

*Corresponding author

Abstract

Multi-cation halide perovskites are very promising absorber materials for highly efficient solar cells. Thermal evaporation of perovskite films offers several advantages over solution-based deposition methods such as conformal growth and good control over film thickness and uniformity, also reflected in the widespread use of thermal evaporation in the semiconductor industry. However, we report on an interesting hybrid and a fully vacuum deposition method. The hybrid sequential deposition method consists of a solution-based deposition of a lead-containing precursor followed by vacuum deposition of formamidinium (FAI) to get a $FACsPbI_3$-perovskite film after thermal annealing. The Cs-component was either directly included in the precursor solution or sequential evaporated before the FAI evaporation with distinct differences in film formation. The fully vacuum process consists of three vacuum deposition steps followed by a thermal annealing step. The processes were recently reported to result in very efficient and robust perovskite layers and solar cells. In the X-ray diffraction data, one can see a reduced PbI_2 reflex at 12.7 °after the deposition of Cs and FAI and subsequent annealing. Moreover, the $FAPbI_3$-(100) reflex appears at 14.0 °so it can be concluded that the crystallization to the cubic α-phase perovskite has taken place. Details of process variations and their impact on film and device properties of solar cells in inverted p-i-n architecture will be discussed.

Keywords

Thermal Evaporation, Sequential, Hybrid, Multi-cation, p-i-n Architecture