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Investigation of organolead halide perovskite using infrared spectroscopy

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In recent years, perovskite materials have shown their great potential in the area of organic/inorganic hybrid solar cells. Because of their high light absorbing coefficient and good charge transport properties, they can be used as a light absorber, a charge transporter, or both at the same time [1-3]. With these outstanding characteristics, the efficiency of perovskite solar cells has already surpassed 16% [4]. However, there are still several factors that hindered the perovskite solar cells from replacing the high-cost c-Si solar cells. One of the most important factors is the poor stability. It is suggested that the perovskite material can react with the H_2O in atmosphere and degrade the performance. Yet the detailed process of the degradation has not been investigated. In order to understand the mechanism of degradation and find effective method to obtain high stability of perovskite solar cells, we used infrared spectroscopy in the multi-intra-reflective setup (MIR-IRAS) to in-situ monitor structural changes in perovskite material.

In this work, the investigation of perovskite materials using MIR-IRAS in the mid-IR region is demonstrated for the first time. The IR spectra of lead methylammonium (MA) tri-iodide ($CH_3NH_3PbI_3$) and blended halide ($CH_3NH_3PbI_{3-x}Cl_x$) perovskite before and after annealing was collected to identify the peak of entangled MA ion in the Pb-I (or Pb-I-Cl) network. Combining with the XRD and EDX results, we found that most of the Cl atoms in $CH_3NH_3PbI_{3-x}Cl_x$ evaporated during the annealing process. The final product showed the same IR spectrum as that of tri-iodide perovskite as shown in Fig. 1. The results in this work will be used as a guideline to investigate the degrading mechanism of perovskite solar cells.

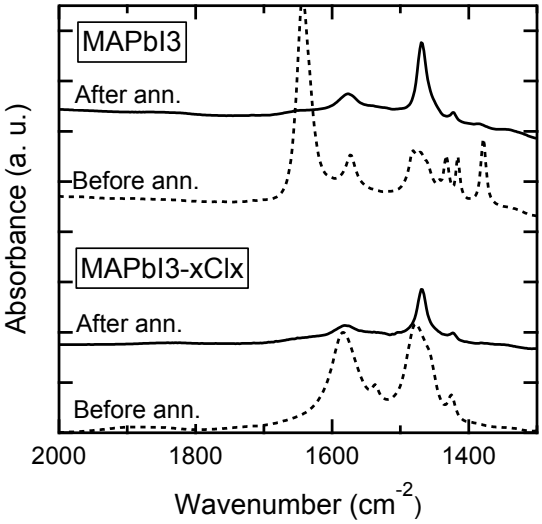

Fig. 1 The MIR-IRAS spectra of non-annealed (dot) and annealed (line) perovskite.

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