

One-pot synthesis of the perovskite / PbS co-sensitizer for heterojunction solar cells

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Recently, the methylammonium lead halide perovskite have gained significant attention due to their promising photovoltaic performance. The power conversion efficiencies (PCEs) of over 20% were obtained with $\text{CH}_3\text{NH}_3\text{PbI}_3$ perovskite solar cells. This perovskite is not difficult to obtain by mixing lead iodide and methylammonium iodide. There are recent reports showed that even lead salts such as pseudo-halide salts, non-iodide salts and non-halide salts tend to form the $\text{CH}_3\text{NH}_3\text{PbI}_3$ perovskite, which indicated the anions exchanges takes place during this process.

The advantages of the methylammonium lead halide perovskite are the large absorption coefficient and diffusion lengths. However, the absorption onset of the $\text{CH}_3\text{NH}_3\text{PbI}_3$ perovskite is limited to 1.58eV. Therefore, co-sensitization with near IR absorber is an effective approach to further increase the spectral response of the perovskite.

PbS are considered to be one of the more attractive near IR absorbers for hybrid solar cells. PCEs of 5-7% were achieved. However, the typically PbS based photovoltaic devices have been fabricated by ex situ method and long chain ligands are required to disperse the PbS in organic solvents. The employment of the ligands that contain long alkyl chains is potentially detrimental to device performance. The replacement of the long chain ligands is always incompletely and adds many difficulties to the fabrication process.

We for the first time report the formation of $\text{CH}_3\text{NH}_3\text{PbI}_3$ /PbS co-sensitizer from lead xanthate (PbXT) and methylammonium iodide (MAI). The materials are model systems for the solution processing of perovskite layers for flexible hybrid photovoltaic devices. Processing is achieved by spin coating a solution containing the $\text{CH}_3\text{NH}_3\text{I}$ and lead xanthate onto a substrate, followed by baking of the film. The effect of compositions and the baking temperature has been explored. Fig.1 shows the absorption spectra of the MAI/PbXT mixing films with different molar ratios. All the samples shows an additional absorption in the near IR regions, which indicated to the existence of the PbS. However, the absorption peaks were shifted with the different components. This may due to the different sizes of the PbS in the samples. Fig.2 shows the absorption spectra of the (MAI-PbXT) mixing film with different baking temperature. When the temperature was lower than 130°C, there were no obvious absorption in the near IR regions. When the temperature was increased to 200°C, the absorption in the near IR region was very strong, which may due to the well-defined PbS nanocrystals. However, the absorption below the 800nm was decreased which may due to the decomposition of the perovskite structure at this high temperature.

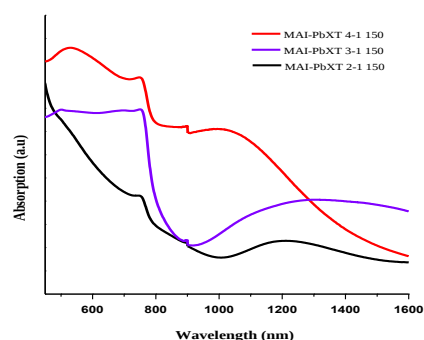


Fig. 1 Absorption spectra of the (MAI-PbXT) mixing films with different molar ratios

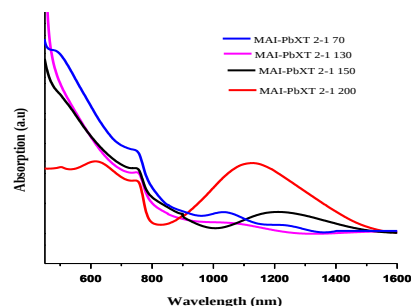


Fig. 2 Absorption spectra of the (MAI-PbXT) mixing film with different baking temperature