Material characterization of lead free air stable Cs_2SnI_6 and its quantum dot for perovskite solar cells

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Introduction

Tin(Sn) based perovskite solar cells are relatively more environmental friendly compared to lead(Pb) based counterparts. Attempts have been made to replace Pb with Sn in perovskite structure such as $MASnI_3$, $CsSnI_3$ etc. [1, 2]. However, Sn based perovskite materials are very sensitive to the ambient atmosphere. Recently Cs_2SnI_6 (Fig.1) have been introduced as a variant of perovskite capturing interest among researchers owing to its better moisture and air stability [2]. Here, in this study first time efforts are being directed for measuring the physical properties of the material and quantum dot to evaluate the potential as a light absorber in solar cells.

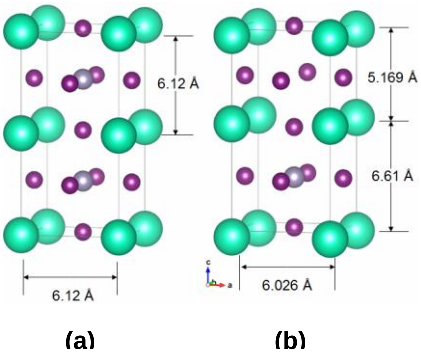

Fig. 1 (a) $CsSnI_3$ (b) Cs_2SnI_6 structure

Experiments

Bulk & Quantum dot (QD) of Cs_2SnI_6 was synthesized. The characterization of thin films was done using Hall-Effect(HE), Microwave photoconductivity decay(MPD) and Photoluminescence(PL) study. Ultraviolet-visible spectroscopy(UV), X-ray diffraction(XRD) and transmission electron microscopy(TEM) were used to confirm the formation of the material and quantum dot.

Results and Discussion

Fig. 2 is the TEM image which shows the successful formation of quantum dot of the material. HE measurement shows n-type nature of Cs_2SnI_6 material when doped with Sn^{2+} depicts p-type semiconductor behavior. Carrier mobility value of $4.64 cm^2/V\text{-}sec$ was obtained for bulk material which is comparable to high quality thin film $MAPbI_3$. Carrier concentration obtained was in the range of $10^{14}/cm^3$ which is less than $MAPbI_3$ based perovskite materials. Further PL study shows the low value of carrier life time in the range of 10-15 ps for these materials owing to the possibility of high trap states.

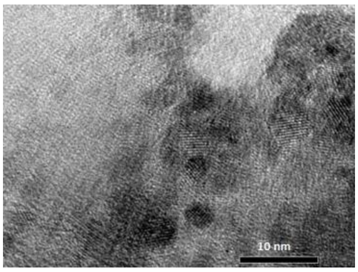

Fig. 2 TEM image for QD

References

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2. C. C. Stoupmpos & M. Kanatzidis et.al, *Inorg. Chem.* 2013, 52, 9019−9038.