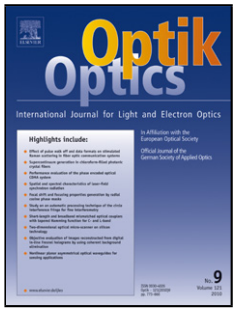

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Superior efficiency achievement for $FAPbI_3$-perovskite thin film solar cell by optimization with response surface methodology technique and partial replacement of Pb by Sn

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Abstract

This study is focused on the partial replacement of Pb by Sn in $FAPb_{1-x}Sn_xI_3$thin films. In addition, preparation and optimization of deposition parameters of $FAPbI_3$-perovskite solar cell synthesis using parametric study as well as response surface methodology (RSM) is focused. All the major quality control parameters (ratio of PbI_2:FAI (3:4-5:4), rotational speed (2500-3500 rpm) of spin coater, and annealing temperature (100-160^oC) are considered for optimization. The parametric study is focused on the optimization of thickness (nm) of $FAPbI_3$ layer. The value of thickness of $FAPbI_3$ film at parametric optimum condition was 463 nm and the efficiency of corresponding device was 10.58%. Furthermore, to achieve further specific optimum condition, RSM was applied. Optimum condition using RSM were achieved to be 417 nm thickness leading to enhanced efficiency of 12.81%. Additionally, replacement of Pb by Sn (with SnI_2) could further lead to improved efficiency and can make the cell less toxic. For Pb replacement by Sn study, molar ratio of PbI_2:SnI_2 was optimized to prepare FA^+ $Pb_{1-x}Sn_xI_3^-$films. The optimum film was $FAPb_{0.5}Sn_{0.5}I_3$, which led to enhanced efficiency of 14.09%. The superior enhancement after Pb replacement is highly encouraging, as it leads to less toxic and highly efficient solar cells at the same time.