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The Effect of Heat Treatment on Bismuth Oxyiodide Thin Films for Lead-Free Perovskite Solar Cells

Abstract

Lead-free bismuth oxyiodide (BiOI) perovskite solar cells (PSCs) have been successfully fabricated using successive ionic layer adsorption and reaction technique. The effect of heat treatment temperature on thickness, conductivity and microstructure of BiOI thin films has been studied prior to the device fabrication. The BiOI film morphology formed flake agglomeration like flower platelets for as deposited BiOI film. However, the agglomeration and the flakes were shattered when the BiOI was annealed above 450°C. This is associated with the trend in conductivity measurement where BiOI achieved the optimum conductivity when it was heat treated at 350°C and reduced as the heat treatment exceeded 450°C. This could be due to the reduction of grain boundaries because of development of the flake sizes during the heat treatment, material sublimation and particle aggregations that developed higher resistance in the BiOI layers. The device performance under optimum heat treatment has been characterized using I–V measurement under a solar spectrum simulator with AM 1.5 illuminations. BiOI PSCs treated at 350°C showed ~ 6% efficiency. This study provided better understanding on BiOI thin film behaviors under several heat treatments, and it has potential to be applied as lead-free PSCs.

Keywords

Agglomeration; Bismuth compounds; Grain boundaries; Heat resistance; Heat treatment; Lead compounds; Morphology; Perovskite; Thin films