Impact of Film Thickness on the Structural and Linear/Nonlinear Optical Properties in Highly Oriented $Cs_3Bi_2I_9$ Perovskite Films

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Abstract

This study presents the successful preparation of highly oriented $Cs_3Bi_2I_9$ films with different thicknesses using sol–gel spin-coating method. X-ray diffraction analysis confirmed a single hexagonal crystal phase with a high orientation along the direction. The crystallite size in the range of 27 and 41 nm increases with increasing film thickness. The bandgap energy ranged from 1.91 to 1.97 eV and was found to decrease with increasing film thickness, which was associated with the film relaxation with increasing film thickness. The refractive index, absorption index, complex dielectric coefficients, complex optical conductivity coefficients, and the ratio of free charge concentration also were found to increase with film thickness. The first-order linear optical susceptibility ranged from 0.22 to 0.38, the non-linear optical susceptibility $\chi^{(3)}$ and the nonlinear refractive index parameters $n^{(2)}$ were respectively within the range of 0.4–3.77 $\times 10^{-12}$ esu 0.96–7.97 $\times 10^{-11}$ esu, the highest value of all the parameters was found in the visible region at 500 nm. These findings position $Cs_3Bi_2I_9$ as a highly promising material for optoelectronics.

Keywords

Inorganic Lead-free Perovskite, Non-linear Optical Parameters, Highly Oriented Films, Dispersion Oscillator Analysis