Cinku legiruotas cezio švino jodido perovskitas optoelektroniniams taikymams

Zinc alloyed cesium lead iodide perovskite for optoelectronic applications

Abdul Mannan Majeed, Edvinas Radiunas, Patrik Ščajev
Institute of Photonics and Nanotechnology, Faculty of Physics, Vilnius University, Sauletekio Ave. 3, LT-10257, Vilnius, Lithuania
patrik.scajev@ff.vu.lt

Alloying engineering is an effective technique which is applied extensively to enrich semiconductors and modulate their intrinsic properties for electronic and optoelectronic applications. In this work we investigate the synthesis, deposition and characterization of lead iodide doped perovskite thin films. In this work we analyze the effect of Pb substitution by Zn [1] to the structural, optical, chemical and morphological properties of solution processed mixed cesium lead perovskite ($CsPb_xZn_{x-1}I_3$). These mixed perovskite thin films were deposited on the RCA cleaned and ozone treated glass substrates by using the spin coating technique in nitrogen filled glovebox. The degradation of the processed thin films shows that x = 0.3-0.6 provides the most stable brown samples. Lower zinc content provides yellow perovskite phase while at higher Zn concentrations mixed phases are observed and discoloration appears.

The surface morphology of the samples has been investigated by using scanning electron microscope (SEM) and showed that the variations in the concentration from 30% to 60% of Zn changes the grain size. Atomic force microscopy (AFM) images showed sample thicknesses up to 400 nm and roughnesses ten times smalller (Fig. 1). The variation of the chemical composition in the perovskite layers was analyzed and confirmed by using EDX (Energy Dispersive X-ray). Samples for the optical characterisation were incapsulated with cover glasses to prevent water and oxygen induced degradation. The band gap energy was obtained from absorbance in the visible and short infrared region by using absorption spectrometer. Cutoff at about 700 nm was observed due to the direct interband transitions. The influence of the light on the degradation and restoration of these perovskite films has been analyzed at different time intervals by using photoluminescence spectra and decay times. For the Zn in 30% to 60% range, the most stable single perovskite phase appeared.

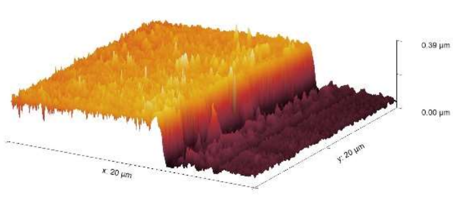

Fig. 1. AFM cross section for x = 0.6 layer.

The measurements of the time-resolved photoluminescence decays at peak ~700 nm wavelengths provided the longest carrier lifetimes of 400 ns in the x = 0.3-0.6 layers confirming their best alloy composition. Layers with the best composition and morphology provided narrow amplified spontaneous emission peak [2] at 710 nm (Fig. 2), which indicated high electrical and optical quality.

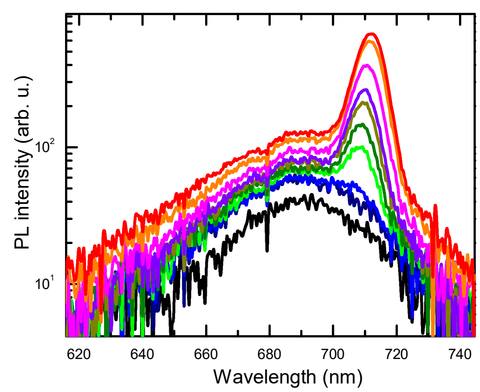

Fig. 2. Amplified spontaneous emission spectra at different intensity pulsed excitations.

Keywords: perovskites, alloying, carrier lifetime, amplified spontaneous emission.

References

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