World Academy of Science, Engineering and Technology
International Journal of Physical and Mathematical Sciences
Vol:13, No:06, 2019

# Development of Perovskite Quantum Dots Light Emitting Diode by Dual-Source Evaporation

**Authors :** Antoine Dumont, Weiji Hong, Zheng-Hong Lu

**Abstract :** Light emitting diodes (LEDs) are steadily becoming the new standard for luminescent display devices because of their energy efficiency and relatively low cost, and the purity of the light they emit. Our research focuses on the optical properties of the lead halide perovskite $CsPbBr_3$ and its family that is showing steadily improving performances in LEDs and solar cells. The objective of this work is to investigate $CsPbBr_3$ as an emitting layer made by physical vapor deposition instead of the usual solution-processed perovskites, for use in LEDs. The deposition in vacuum eliminates any risk of contaminants as well as the necessity for the use of chemical ligands in the synthesis of quantum dots. Initial results show the versatility of the dual-source evaporation method, which allowed us to create different phases in bulk form by altering the mole ratio or deposition rate of CsBr and $PbBr_2$. The distinct phases $Cs_4PbBr_6$, $CsPbBr_3$ and $CsPb_2Br_5$ – confirmed through XPS (x-ray photoelectron spectroscopy) and X-ray diffraction analysis – have different optical properties and morphologies that can be used for specific applications in optoelectronics. We are particularly focused on the blue shift expected from quantum dots (QDs) and the stability of the perovskite in this form. We already obtained proof of the formation of QDs through our dual source evaporation method with electron microscope imaging and photoluminescence testing, which we understand is a first in the community. We also incorporated the QDs in an LED structure to test the electroluminescence and the effect on performance and have already observed a significant wavelength shift. The goal is to reach 480nm after shifting from the original 528nm bulk emission. The hole transport layer (HTL) material onto which the $CsPbBr_3$ is evaporated is a critical part of this study as the surface energy interaction dictates the behaviour of the QD growth. A thorough study to determine the optimal HTL is in progress. A strong blue shift for a typically green emitting material like $CsPbBr_3$ would eliminate the necessity of using blue emitting Cl-based perovskite compounds and could prove to be more stable in a QD structure. The final aim is to make a perovskite QD LED with strong blue luminescence, fabricated through a dual-source evaporation technique that could be scalable to industry level, making this device a viable and cost-effective alternative to current commercial LEDs.

**Keywords :** material physics, perovskite, light emitting diode, quantum dots, high vacuum deposition, thin film processing
**Conference Title :** ICP 2019 : International Conference on Physics
**Conference Location :** Toronto, Canada
**Conference Dates :** June 17-18, 2019