学 位 論 文 内 容 の 要 旨

Dissertation Abstract

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学 位 論 文 題 名

Title of dissertation

Crystal size, photoluminescence and electroluminescence optimization of $MAPbBr_3$ perovskite microcrystals

（$MAPbBr_3$ ペロブスカイト微結晶の結晶サイズ、フォトルミネッセンスおよびエレクトロルミネッセンスの最適化）

Lead halide perovskites have been the most attractive semiconductor material for light-harvesting and light-emitting applications, which is attributed to the excellent properties, such as high photoluminescence yield, large absorption coefficient, low formation energy, and tunable bandgap. However, there are still issues to limit its large-scale application, like instability and efficiency roll-off. In this thesis, I mainly focus on the study of isotropic and high-quality perovskite microcrystal synthesis, light-induced ion migration and its affection on the electroluminescence blinking, and time-resolved electroluminescence of $MAPbBr_3$ microcrystals. It is summarized in five chapters. In Chapter 1, I introduce the general information of halide perovskite. First, I introduce the structure of one-unit cell, compositions and stability factors of perovskite . Following, I introduce different size of halide perovskite synthesis methods, including micro-sized single crystal, nanocrystal and quantum dots. Then I introduce the characterizations of halide perovskite, including the optical property, bandgap, charge carrier dynamic, blinking. Finally, I introduce the applications of halide perovskite, especially on solar cells and light-emitting diodes. I also express my study motivation. In chapter 2, I introduce the materials, sample preparation methods and instruments I used throughout all the studies. I synthesize the $MAPbBr_3$ microcrystals by various methods, they are RTC, AVC, ITC, modified-ITC, blade-coating methods. I investigate the morphology of obtained microcrystals by optical microscope and fluorescence microscope. I study the photoluminescence and electroluminescence blinking by single particle micro spectroscope, the photoluminescence and electroluminescence decays by time-resolved photoluminescence and electroluminescence spectroscopy. In chapter 3, I study the isotropic high quality $MAPbBr_3$ microcrystals synthesis. I investigate

the additive *N*-cyclohexyl-2-pyrrolidone ratio and reaction temperature affection on the crystal size, shape, quality and density. I also discuss the crystal nucleation theory and crystallization kinetics. Finally, I expand the modified ITC method to various type halide perovskite. In chapter 4, I study the light-soaking affection on the photoluminescence lifetime and electroluminescence blinking, the ON and OFF probability distribution of electroluminescence blinking is statistically studied. The mechanism of light-induced halide ion migration and trap healing is discussed. In chapter 5, I study the time-resolved electroluminescence of $MAPbBr_3$ microcrystal. First, I measure the optical spectra and electroluminescence decay of commercial blue, green and red color LEDs, the instrument reliability is confirmed by this measurement, and it can be standard and comparable results for the following experiments. Then I study the optical spectra and electroluminescence and photoluminescence decays of $MAPbBr_3$ microcrystal. Following, I investigate the influence of MABr treatment on electroluminescence and photoluminescence decays of $MAPbBr_3$ microcrystal. Finally, the mechanism of halide ion vacancy filling enhanced electroluminescence and photoluminescence decays increase is discussed.