Synthesis, Optical Properties and Applications of Two-Dimensional Perovskites and Their Heterostructures

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（様式３）Form 3

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論 文 名　：Synthesis, Optical Properties and Applications of Two-Dimensional Perovskites and Their Heterostructures

（二次元ペロブスカイトとそのヘテロ構造の合成、光学物性、ならびに応用に関する研究）

Title

区　　分　：甲

Category　　Kou

論 文 内 容 の 要 旨

Thesis Summary

Organic-inorganic hybrid halide perovskites have attracted great attention in photovoltaic applications due to their exceptional properties, such as high optical absorption, long carrier diffusion lengths, strong luminescence, and tunable bandgap. Generally, hybrid halide perovskites have bulk structures. Recently, two-dimensional (2D) hybrid halide perovskites have emerged as a new addition to the 2D materials family having dielectric quantum confinement and improved stability. Although the 2D perovskites have been synthesized by several method such as solution deposition, a reliable method for growing high quality and large area 2D perovskite is still lacking. Another problem is the solubility of perovskites in common polar solvents that are used in lithography. This hinders the advanced device applications of perovskites, which require complex patterning.

This thesis is composed of three main researches related to 2D perovskites. Here, chemical vapor deposition is used to synthesize highly reproducible, high-quality 2D perovskites and their heterostructures. In Chapter 1, bulk and 2D perovskites are introduced. Motivation and purpose of this work are explained. In Chapter 2, properties and fabrication methods of perovskite are explained in detail. Main challenges in perovskite research are also discussed. In Chapter 3, a 2D perovskite as thin as 3 nm grown on monolayer WS2 is reported. To overcome the limitations in device fabrication, a novel lithography method is developed. In Chapter 4, effect of synthesis method on the perovskite morphology and on the optical properties are investigated. Hot photoluminescence emission from the layered 2D perovskite is reported. In Chapter 5, a novel type-I heterostructure of 2D perovskite and WS2 is synthesized. The optical properties of this heterostructure is studied. 2D perovskite grown on WS2 showed improved phase stability owing to strain induced by epitaxial growth. Finally, in Chapter 6, findings are concluded, and future prospects of perovskite are discussed.

The results presented in this thesis provide a better understanding on perovskite growth and how growth conditions and/or growth approach affect the intrinsic properties of perovskites. This work gives a thorough assessment of the issues facing the perovskite research and opens a new venue for the advanced and complex device applications of perovskites.