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Synthesis and Characterization of Photosensible $CH_3NH_3PbI_3$ and $CH_3NH_3PbI_{3-x}Cl_x$ Perovskite Crystalline Films[1]

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Abstract—Methylammonium lead-halide perovskites are very promising for applications as solar light-harvesting materials. This paper presents a study on the methylammonium iodide and iodide-chloride perovskite films prepared by spin coating from a liquid precursor. The powder diffraction spectroscopy has detected 10 lattice plane reflections common to a perovskite of a tetragonal crystal structure. The calculated cell parameters are $a = 8.85$ Å and $c = 12.60$ Å. The preparation conditions and their impact on the crystallization process and film morphology are discussed. A red shift of photoluminescence bands at low temperatures was evidenced. A photoelectrical study of perovskite films has revealed their high sensibility to illumination, especially in the visible spectrum, which gives a hint on their applications in photovoltaics.

Keywords: organic-inorganic perovskite, methylammonium lead halide, photo-sensibility

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INTRODUCTION

Today, the energetic deficiency and global ecological crisis (greenhouse effect, environmental pollution) are the most critical issues for science and technology. The necessity to develop convertors of alternative sources of energy is one of the most important scientific tasks. These convertors must be of a high efficiency and stability, low cost, ambient-friendly, etc. [1].

Recently, hybrid perovskites have been found to be promising solar absorbers for applications invarious solar cell structures. Methylammonium lead-halide perovskites exhibit many desirable properties such as a narrow-band-gap, long diffusion lengths, high excitonic lifetimes, and a high-gain photon-mode detection of visible light [2, 3].

The major mechanism of crystallization and morphology control of perovskite materials is not almost clear. The researchers strive to identify possibilities to improve efficiencies via the optimization of a charge carrier lifetime, the mobility and diffusion lengths [4]. An increase of the crystallite size is expected to be favorable for the improvement of the electronic parameters of material [5].

Methylammonium lead-halide perovskites can be grown by a plenty of methods, under various conditions. Usually, these methods are cheaper and more effective than those used for conventional inorganic semiconductors. The growth conditions, in their turn, display a heavy influence on the material characteristics.

In this work, we investigate the impact of the solvent type and organic salt concentration on the perovskite crystallization at a one-step deposition from a liquid precursor. The morphological, structural and photoelectrical properties of samples are investigated. Trap states are expected to be plentiful in a solution-processed crystal. According to [6], the traps have a low capture cross-section and, even if their density is not negligible, they play a minor role in the photovoltaic energy conversion and lightamplification.

EXPERIMENTAL

The perovskite films on the glass substrates have been prepared by spin coating. The glass substrates were cleaned in piranha solution and washed in deionized water. Dry substrates were fixed on the spin-coater and rotated at 2000 rpm, and then the liquid precursor was dropped on and rotated for 30 s. The

[1] The article is published in the original.