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# Report

**on the thesis presented by Lozhkina Olga Aleksandrovna, entitiled "Synthesis and Optical Properties of Halide Perovskites Single Crystals and Heterostructures" for degree of a Candidate of Physical and Mathematical Sciences in 1.3.8. Condensed Matter Physics – The Saint-Petersburg State University.**

Halide perovskites undoubtedly stand at the frontiers of physical sciences, and have been considered as a promising candidate for cheaper and more effective optoelectronic devices. This thesis focused on the photoluminescence properties of halide perovskites single crystals and heterojunction single crystals. For the first time, the observation of well resolved phonon replica peaks was achieved; for the first time, low temperature Raman spectra of halide perovskites single crystals were recorded and correlated with the simulated phonon modes; the first low temperature photoluminescence spectra of $Cs_2BiAgBr_6$ and Bi-doped $CsPbBr_3$ was reported; the first stable abrupt heterojunction between two halide perovskites was synthesized and analyzed comprehensively. These works demonstrate the possibility of solution synthesis of ionic semiconductor structures that may have potential applications in semiconductor optics applications. Therefore, the research presented in the thesis has both theoretical and practical significance for the subject of study.

In the first chapter the thesis begins by offering a comprehensive and thoughtful literature review on the general background of semiconductor electronics technology, and on the latest advancements on halide perovskites in terms of structure, stability, point defects, doping and heterostructure synthesis.

In the second chapter the thesis introduces the theoretical base about the semiconductor band structure and excitons. Basic knowledge on impurities and defects, optical absorption, excitonic photoluminescence, phonon replicas in photoluminescence spectra are concisely presented.

In the third chapter, the thesis reports the synthesis and characterization methods of halide perovskites single crystals. Synthesis procedures of five kinds of halide perovskites single crystals and one kind of single crystal heterostructure are included in this part.

In the fourth chapter, the main results and discussion of the thesis is presented. Low-temperature photoluminescence of $MAPbBr_3$, $CsPbBr_3$, $Cs_2AgBiBr_6$ and $MAPbI_3$ single crystals are reported and carefully analyzed, exciton bind energy are obtained. Low-temperature Raman spectra of these single crystals are measured and phonon replicas of halide perovskites single crystals are identified. Optical properties of Bi-doped $CsPbBr_3$ single crystals are investigated in comparison to the powders sample. $MAPbBr_3$/CsPbBr3 single crystal heterostructure is synthesized and the photoluminescence spectra are recorded and analyzed in comparison to the single components.

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Overall, the thesis presents a unique and important research on the optical properties of halide perovskites single crystals. The results of the research have resulted in 3 first-authored papers and 6 conferences reports. The main conclusion of the thesis will undoubtedly inspire the research on halide perovskites, and will be an important reference to the researchers working on the halide perovskites materials and devices.

Considering the high quality of both research contents and writing skill, I can fairly conclude that the thesis entitiled “Synthesis and Optical Properties of Halide Perovskites Single Crystals and Heterostructures”, by Lozhkina Olga Aleksandrovna, deserves to be awarded the degree of Candidate of Physical and Mathematical Sciences.

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