

**МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ**  
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**XVI МІЖНАРОДНА КОНФЕРЕНЦІЯ З ФІЗИКИ І ТЕХНОЛОГІЇ**  
**ТОНКИХ ПЛІВОК ТА НАНОСИСТЕМ**  
(присвячена пам'яті професора Дмитра Фреїка)  
**Матеріали**

*Івано-Франківськ, 15-20 травня, 2017*

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*Ivano-Frankivsk, May 15-20, 2017*

**Materials**  
**XVI INTERNATIONAL CONFERENCE ON PHYSICS AND**  
**TECHNOLOGY OF THIN FILMS AND NANOSYSTEMS**  
(dedicated to memory Professor Dmytro Freik)

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## Thin Films of Organic-Inorganic Perovskites $\text{CH}_3\text{NH}_3\text{PbI}_3$ : Control of Microstructure and Properties

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Organic-inorganic metal halide perovskites  $\text{APbX}_3$  ( $\text{A}=\text{CH}_3\text{NH}_3$ ,  $\text{X}=\text{Cl}$ ,  $\text{Br}$ ,  $\text{I}$ ) attract scientific interest as efficient solar energy absorbers [1]. These compounds show excellent photovoltaic parameters together with relatively low production costs [2]. Hybrid lead iodide perovskites can be synthesized from solutions at low temperatures.

Our work shows the effect of starting reagents ( $\text{CH}_3\text{NH}_3\text{I}:\text{PbI}_2$ ) with different ratios in raw solutions on the microstructure, phase composition, absorption, and luminescence spectra of the films of organic-inorganic perovskites  $\text{CH}_3\text{NH}_3\text{PbI}_3$ .

Starting reagents ( $\text{PbI}_2$  and  $\text{CH}_3\text{NH}_3\text{I}$ ) were taken in different ratios, dissolved in DMF, and stirred at 70 °C until optically clear solutions are formed. A relative humidity during synthesis was not above 10%. The resulting solutions were spin-coated on the glass substrates.

It has been found that the temperature range corresponding to the formation of a single-phase product is limited by the incomplete interaction of starting and intermediate phases (below 80 °C) as well as the decomposition of organic-inorganic lead iodide perovskite to form  $\text{PbI}_2$  (above 150 °C). In the case of stoichiometric ratio of starting reagents, the films consist of needle-like particles. When the amount of methyl ammonium iodide increases, the rounded-shape particles and then faceted-shape particles are formed. This is accompanied by more selective absorption in the optical range: the intensity of the spectral band in the range 350-400 nm increases.

This research was supported by the Targeted Research Program of the National Academy of Science of Ukraine "Novel Nanomaterials".

1. Green, Martin A., *et al.* "Solar cell efficiency tables (version 49)." *Progress in Photovoltaics: Research and Applications* 25.1 (2017): 3–13.

2. Zhao, Yixin, and Kai Zhu. "Organic–inorganic hybrid lead halide perovskites for optoelectronic and electronic applications." *Chemical Society Reviews* 45.3 (2016): 655–689.