INFLUENCE OF OPTICALLY TRANSPARENT POLYMERS ON STABILITY OF ORGANIC-INORGANIC PEROVSKITE $CH_3NH_3PbI_3$

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Solar energy is one of the most promising sources of renewable energy in the last few decades. In addition to existing materials, new highly efficient materials are being searched for the conversion of solar energy, but with a simpler technology for their production. Recently, organic-inorganic perovskites $CH_3NH_3PbI_3$ have attracted considerable attention as light-absorbing layers for the creation of highly efficient and relatively inexpensive elements for the conversion of solar energy. Nowadays, the power conversion efficiency of elements based on perovskites is 25.2%. The low stability of organic-inorganic perovskites is the main obstacle to the large-scale production of perovskite solar cells (PSCs)[1-3]. The main factors that lead to the degradation of organic-inorganic perovskites are moisture, oxygen, ultraviolet (UV) light, and temperature [4]. To increase the stability of organic-inorganic perovskites to external factors, it is proposed to use optically transparent polymers of three types: insensitive to moisture (polyvinyl butyral PVB), insensitive to oxygen (cycloolefin copolymer COC), and sensitive to moisture and oxygen (polyvinylidene chloride PVDC). PSCs can take a leading position in photovoltaic technologies, but it is necessary to increase their stability.

The aim of the work was to investigate the properties of organic-inorganic perovskite $CH_3NH_3PbI_3$ films without and with an applied polymer layer.

Organic-inorganic perovskite $CH_3NH_3PbI_3$ films were synthesized by a one-step method of deposition at ratio of initial reagents PbI_2:CH_3NH_3I – 1:3 in dimethyl sulfoxide (DMSO) solvent. Perovskite films with an applied layer of optically transparent polymers: PVB, COC, PVDC were obtained. The stability of these films to the action of moisture and oxygen (under illumination) was determined by the X-ray diffraction method based on the content of additional phases formed during the degradation of the films under the influence of external factors **(Figure 1).** The diffractograms of films were taken at certain time intervals during 150 days.

The organic-inorganic film of perovskite (1:3) degrades with the formation of two additional phases: $CH_3NH_3PbI_3 \cdot H_2O$ and PbI_2 under the influence of moisture and oxygen. The peaks of these phases are observed on the X-ray diffractograms on the 5th day after the synthesis of the films. For the perovskite/COC film, the organic-inorganic perovskite decomposes into one additional phase, $PbO \cdot xH_2O$. Peaks of this phase appear on X-ray diffractograms after 100 days of exposure to external factors on the film. For the perovskite/PVDC film, the formation of 2 intermediate phases is observed: $CH_3NH_3PbI_3 \cdot H_2O$ and PbI_2·DMSO. These phases are observed on X-ray diffractograms for 30 days under the action of moisture and oxygen on the film. For the perovskite/PVB film, perovskite

degradation under the influence of moisture and oxygen occurs due to the formation of additional phases: $PbO \cdot xH_2O$, $PbI_2 \cdot DMSO$ on the 30th day.

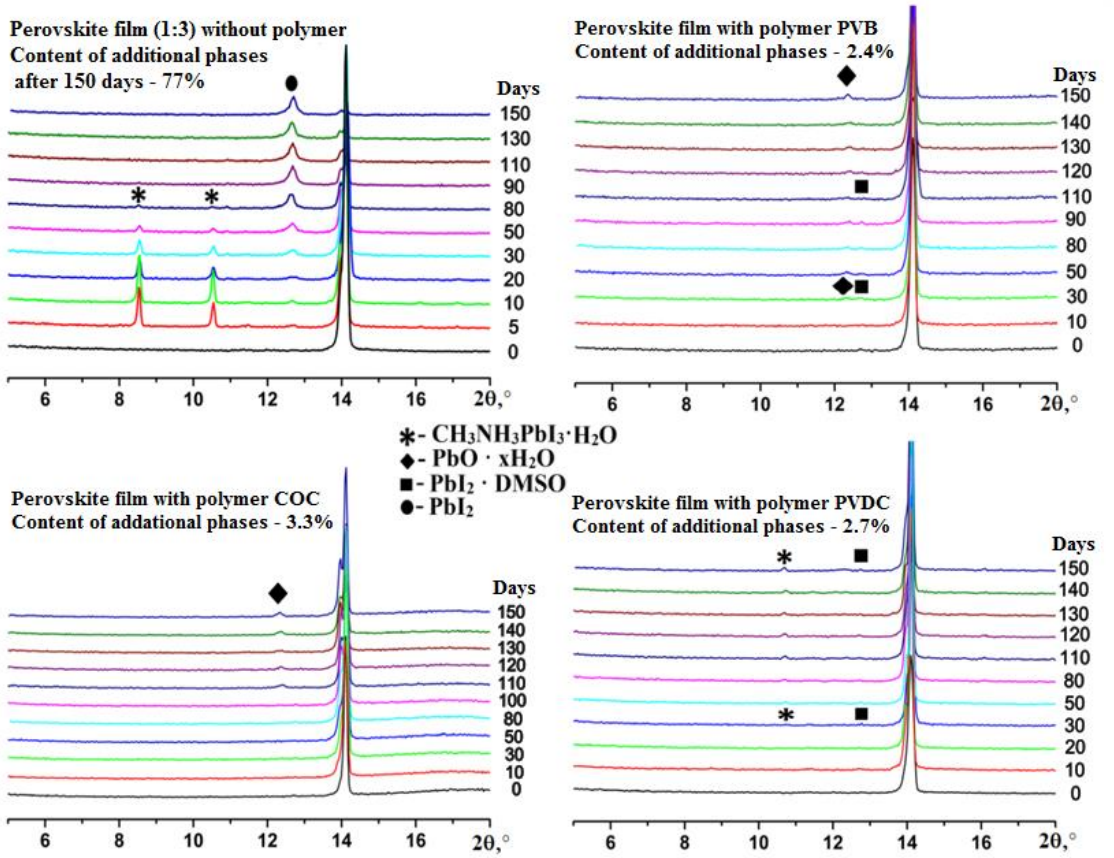

Figure. 1. X-ray diffraction patterns of films obtained at a ratio of starting reagents of 1:3 in DMSO solvent and perovskite/polymer films: PVB, COC, PVDC.

The dependence of the content of additional phases on the time of influence to moisture and oxygen was obtained on the basis of XRD analysis (**Figure 2**).

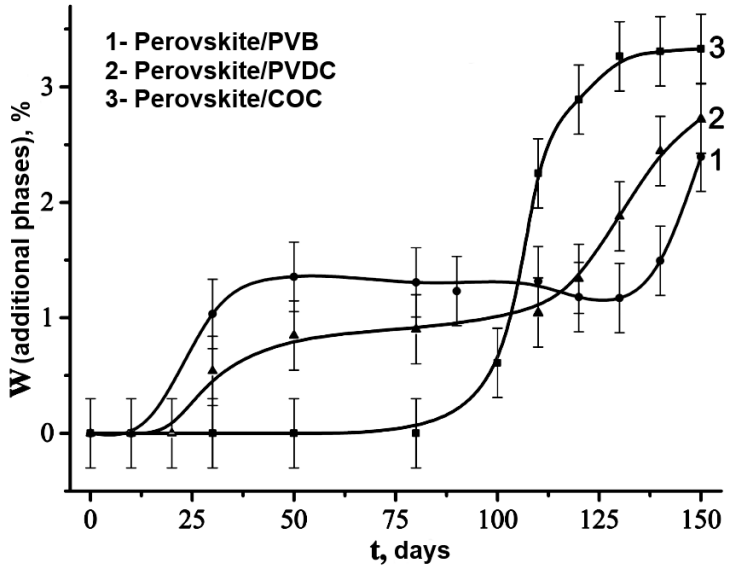

Figure 2. The content of additional phases during the degradation of perovskite/polymer films: 1 – PVB, 2 – PVDC, 3 – COC depending on the time of influence to moisture and oxygen.

In summary, it was proposed to increase the stability of organic-inorganic perovskite films to moisture and oxygen (under illumination) to use optically transparent polymers: polyvinyl butyral (PVB), cycloolefin copolymer (COC), polyvinylidene chloride (PVDC). It was shown that the perovskite film degrades by 77% under the influence of moisture and oxygen within 150 days. While perovskite/polymer films under similar conditions degrade by 2.4 - 3.3% depending on the type of polymer. The use of COC, PVDC, and PVB increases the stability of the films to the action of moisture and oxygen (under illumination) by 23, 28, and 32 times, respectively.

References:

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