Degradation studies of $MAPbI_3$ perovskite using cathodoluminescence and microscopy techniques

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In modern times, considering climate change, we desperately look for sustainable energy sources. Photovoltaic cells are one of the most popular solutions to this problem. The widely used type of solar cells are those made of silicon, however, they are not without drawbacks - they are still too expensive and close to their efficiency limit. Moreover, their production is not as ecological as one could wish. In recent years, there has been a strong development of new generations of solar cells made with various materials acting as active layers. One of the most promising candidates for future applications in photovoltaics are hybrid organic-inorganic perovskites. The research shows that they can outperform Si cells in terms of efficiency, the cost of their production is much lower, and there are many ways to produce them in a more eco-friendly way[1].

The biggest problem with perovskites is that they can easily deteriorate under exposure to oxygen, water, and light. It is speculated that the degradation process depends on the size of the crystallites and the number of grain boundaries. In this study, we examined the effect of the perovskite (MAPbI3, where MA stands for methylammonium) synthesis process, carried out at different rates, on the surface morphology of $MAPbI_3$, in order to obtain the largest possible grains, and we followed the degradation process. Scanning electron microscopy and cathodoluminescence (CL) techniques were applied for the study. CL allowed the tracking of the degradation process at a spatial resolution of tens of nanometers, as the luminescence of $MAPbI_3$ and its degradation product PbI_2 are spectrally well separated (710 nm versus 490 nm). In the preliminary studies, it was shown that indeed the degradation is preferential at grain boundaries (Fig. 1).

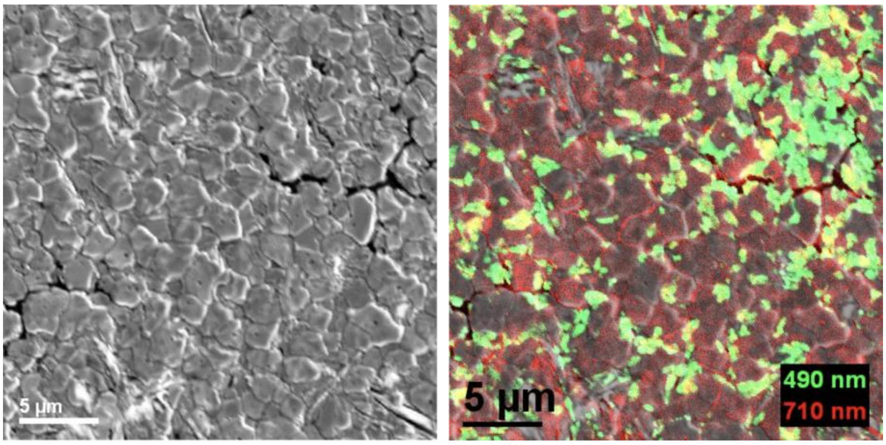

Fig. 1. (left) SEM image and (right) SEM-CL image detected at 490 nm (maximum of PbI_2 luminescence) and 710 nm (maximum of $MAPbI_3$ perovskite luminescence).

[1] X. Fan et al., Perovskite Solar Cells toward Eco-Friendly Printing, *Research 2021**(4)**:1-11* (2021)