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Effect of the heat treatment of $CH_3NH_3PbI_3$ perovskite on its electrical and photoelectric properties

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1. Perovskite thin film preparation

Perovskite ink was prepared in 1.5 M concentration in anhydrous dimethylformamide (DMF from Sigma Aldrich) with CH_3NH_3I (MAI, 99.99% purity from GreatCellSolar) and PbI_2 (ultrapure 99.999% from Sigma-Aldrich). The precursor was heated for 48 hours at 60 ^{0}C and then cooled to room temperature prior to use.

Perovskite photoactive layer was spin coated from the ink by the solvent engineering method in a glove box in Ar atmosphere.

The 90 μl perovskite precursor was spin coated on a 20 mm × 25 mm glass substrate at 5000 rpm for 30 seconds. In 4 seconds after the start of spin coating, 350 μL of anhydrous toluene was poured onto the perovskite layer to induce the crystallization process. As a result, a 350-400 nm thick layer was prepared. Finally, the sample was annealed at 100 ^{0}C for 10 minutes[1].

2. Film characterization

The perovskite structure of obtained film was proven by X-ray diffraction (XRD) data. XRD pattern was measured at room temperature using Rigaku D/Max 2200 Powder X-ray Diffractometer (Cu Kα 1.54 Å) which was equipped by high-temperature chamber for in-situ X-ray diffraction studies at different temperatures.

XRD spectra of studied film at room temperature is shown in Figure S1. The film has a tetragonal perovskite structure at room temperature. Cell parameters determined by XRD pattern analysis are in agreement with literature data[2].

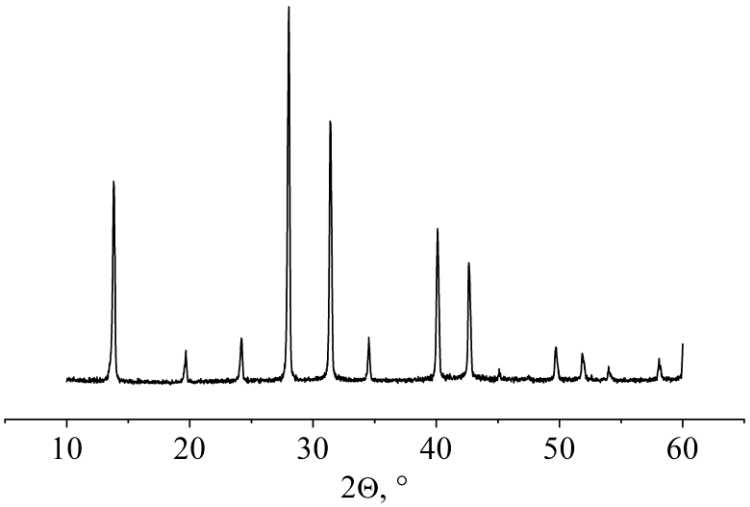

Figure S1 XRD spectra of the MAPI perovskite.

Scanning electron microscopy (SEM) images were taken with a high-resolution Field Emission Scanning Electron Microscope Supra 40 (Carl Zeiss). Figure S2 shows scanning electron microscopy (SEM) image of studied perovskite film. As clearly seen from the figure, film has a polycrystalline nature with average grain size around 350 nm.

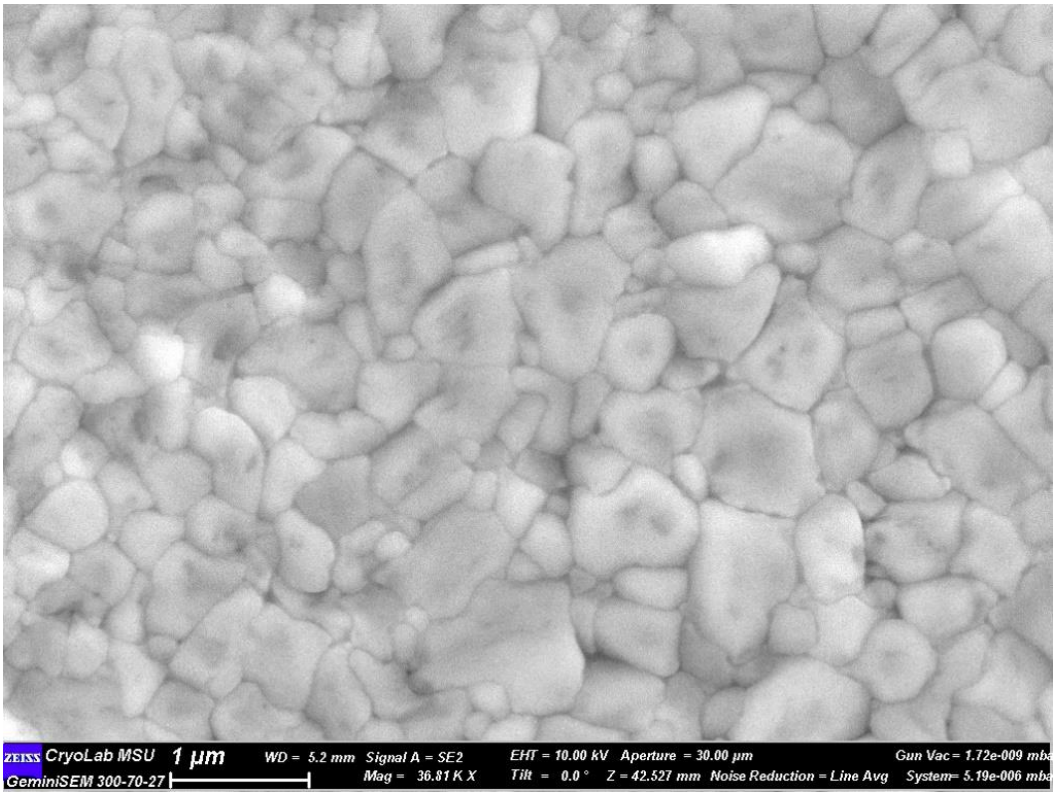

Figure S2 SEM image of the perovskite thin film surface.

The thickness of the films was measured using the interference method for measuring the thickness of the films using an MII 4 interferometer. The resulting thickness was about 300 nm.

3. Measurements conditions

For electrical measurements, gold contacts were evaporated on perovskite film in planar configuration. The electrodes were spaced by 0.1 mm. Due to the contacts configuration, current-voltage characteristics were symmetric under positive and negative biases. A bias of 1 volt was applied for conductivity measurements. This value corresponds to linear part of the current-voltage (I-V) characteristics. For photoconductivity measurements samples were illuminated by a monochromatic beam using Lot Oriel 5270 monochromator.

References

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