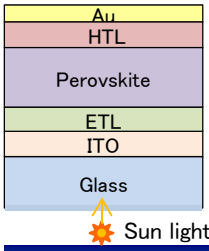
Surface analysis of power generation layer for Perovskite Solar Cells

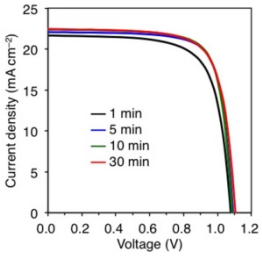
Since the Perovskite Solar Cell (PSC) has high efficiency and simple manufacturing process, it is expected as the next generation solar cell. X-ray diffraction (XRD), SEM (Secondary Electron Microscopy), and SSRM (Scanning Spread Resistance Microscopy) can evaluate the crystal structure, the form of the surface, the distribution of element, and spread resistance.

Power generation characteristics of PSC



Table; Characterization results for each annealing time

Annealing time (min.)	Jsc (A cm^{-2})	Voc (V)	FF (%)	PCE (%)
1	21.7	1.07	0.72	16.6
10	22.6	1.07	0.76	18.4
30	22.4	1.10	0.74	18.2



Figure; J-V curve for each samples

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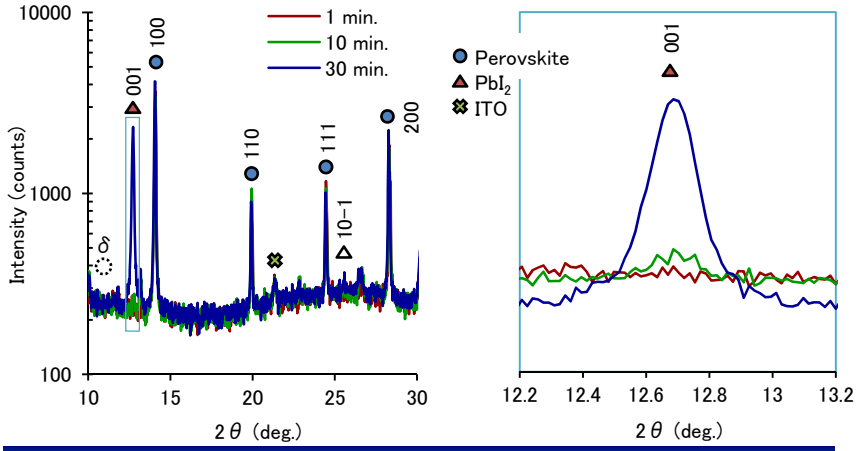
The values of Jsc, Voc, FF, and PCE improved with increasing annealing time. The samples that dried and annealed after formation with glass /ITO /ETL /perovskite were measured by XRD, SEM, and SSRM.

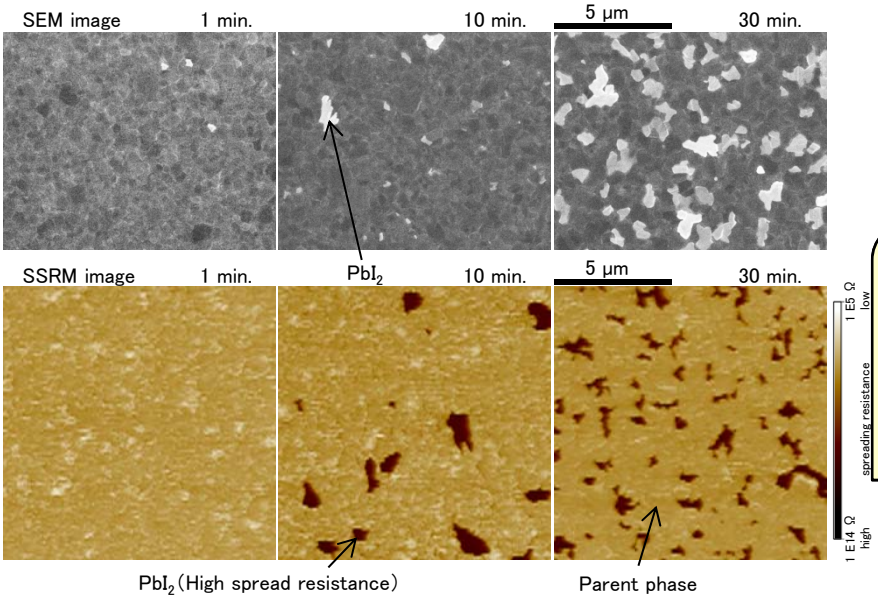
XRD analysis of crystal structure and orientation



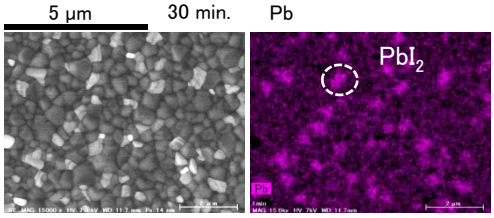
From the XRD measurement result, the intensity of PbI_2 has the difference between (001)▲ and (10-1)△ by 30 minutes profile. Therefore, the crystal of PbI_2 phase is grown on the (001) plane parallel to the substrate plane. In addition, different phase such as δ-phase ($FAPbI_3$) was not formed in any sample.

Measurement condition
- Measurement temp. room temp. (～ 1400 ℃)
- Atmosphere Ar(N_2 etc)

Surface morphology observation and SSRM measurement



SEM-EDX analysis of surface



SEM images and SEM-EDX analysis have shown that the region of PbI_2 increased on perovskite layer. SSRM measurements represented that the spread resistance of parent phase of 30 minutes increased more than one of the others.

Measurement condition
- Measurement temp. Room temp (SEM:～400 ℃)
- Atmosphere Ar gas or vacuum

Sample was provided by Dr. Wakamiya, Kyoto univ., Japan

The combination of XRD, SEM-EDX, and SSRM measurements is very helpful for the improvement of process, materials and devices of PSC.

Toray Research Center, Inc.