Perovskite solar cells, one of the emerging photovoltaic technologies, have attracted much attention because of improving high efficiency and their peculiar properties such as slow electrical responses and dependence on bias-voltage history, which cause hysteresis in I-V performance [1]. However, these unique properties make precise performance characterization of these devices difficult. In order to deal with this difficulty, appropriate characterization protocols have been developed [2]. On the other hand, photo-response, which is also a key aspect that determines the performance property of the solar cells, should also be clarified in order to establish precise performance characterization protocols. Therefore, in this work, from a viewpoint of photo-response, we investigated spectral responsivity and temporal photo-responses in perovskite cells.

Figure 1 shows spectral responsivities (or external quantum efficiencies (EQE)) of a perovskite solar cell measured at various chopped frequencies of monochromatic light and bias-light conditions. The observed EQE curves, in particular, their normalized spectral shapes were almost independent of the modulation frequency in a range from dc to 85 Hz. In order to investigate photo-responses of the perovskite solar cell, temporal waveforms of the output photocurrent by the modulation light illumination were directly observed. Figure 2 shows the temporal waveforms of the short-circuit photocurrent of the perovskite cell generated by monochromatic light ($\lambda = 550$ nm and illumination power of $4 \times 10^{15}$ photon/s·cm²) at different modulation frequencies. The output waveforms were almost independent of the modulation frequency. Similar modulation-frequency-independent photo-responses were observed at monochromatic-light wavelengths of 400 and 700 nm, and not only at non-bias-light condition but also with 1sun bias-light illumination. The rise (or fall) time of the photo-responses of the perovskite cell was much faster than 1.1 ms determined by the optical chopper used in this preliminary experiment, which is in contrast to quite slow electrical responses of the orders from seconds to minutes observed in I-V performance. The coexistence of fast photo-responses and slow electrical responses might be a noteworthy property of the perovskite cells, which is not seen in other slow-response solar cells [3].

At the conference, further results of measurements and quantitative analyses will also be presented.

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