Supporting Information

Time-Resolved Operando Spectroscopy for Dye-Sensitized Solar Cells from Multiple Perspectives

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1. *J-V* Characteristics

J-V characteristics of the DSSCs used in this study are shown in Figure S1. The parameters of *J-V* characteristics were J_{SC} = 11.6 mA/cm^2, V_{OC} = 0.73 V, *FF* = 0.72, and PCE was 5.0%.

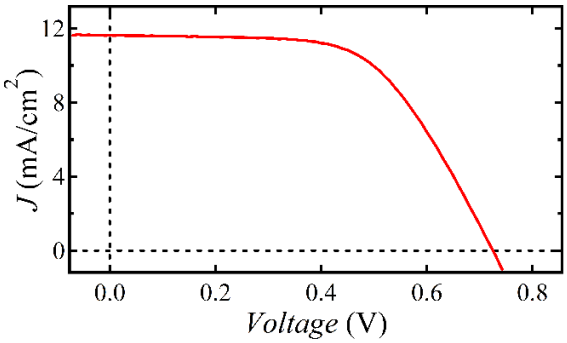

Figure S1. *J-V* characteristics obtained from the DSSC used in this study.

2. PIA spectra for DSSC under the open circuit condition

The PIA spectra for DSSC under the open circuit condition measured by lock-in techniques are shown in Figure S2. Continuous wave laser beam at 473 nm (190 mW/cm^2) modulated with a square wave of 30.1 Hz.

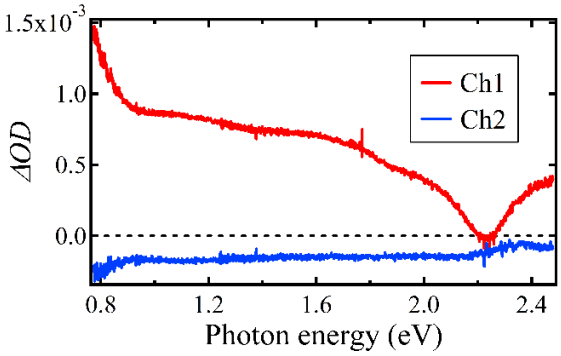

Figure S2. PIA spectra of the N719 DSSC under the open circuit condition measured by lock-in techniques.

3. Hall effect measurement

We performed a Hall effect measurement to investigate the carrier concentration of the FTO electrode. The carrier concentration (n_e) can be calculated by the equation described below:

$$n_e = \frac{IB_Z}{ed_F V_H} \tag{S1}$$

where I (= 34 mA) is the current flowing through the FTO, e is the elementary charge, d_F (= 600 nm) is the thickness of the FTO, B_Z is the magnetic field applied to the FTO, and V_H is Hall voltage. Figure S3 shows the change in V_H when sweeping B_Z of 0 to 0.5 T. The obtained slope (V_H/B_Z) was 2.7×10^{-4} V/T, and therefore $n_e = 1.3\times10^{21}$ cm^{-3} was obtained.

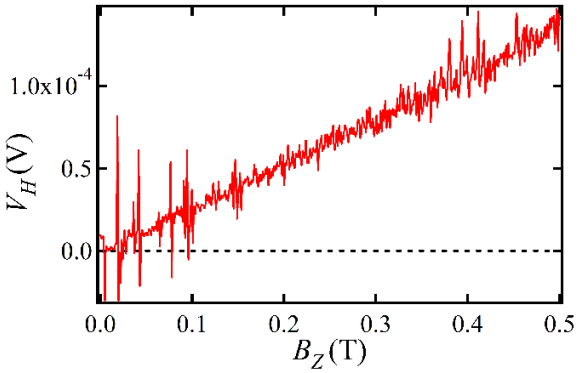

Figure S3. Change in V_H when sweeping B_Z of 0 to 0.5 T.