Supplementary Information

Multi-Stacked Detectors with Transparency-Controlled Polymer:Nonfullerene Bulk Heterojunction Sensing Layers for Visible Light Communications

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Figure S1. (a) Optical transmittance spectra of the BHJ (PBDB-T:IT-M) films according to the film thickness. Considering the electroluminescence spectrum of the white LED lamp (green line), the white light from the LED lamp can sufficiently pass through the top and middle OPD cells in the multi-stacked detectors. (b) Optical transmittance spectrum of the 30 nm-thick Ag electrode coated on glass substrate (note that the optical transparency reached ca. 56 % at the wavelength of 600 nm).
**Figure S2.** Illustration for the accelerated charge transport in the BHJ (PBDB-T:IT-M) layers by increasing (negatively) the applied voltage ($V_{\text{APP}}$): (a) $V_{\text{APP}} = 0$ V, (b) $V_{\text{APP}} = -0.5$ V.
Figure S3. Comparison for the current signals (left, taken from Figure 6) from the top (a), middle (b), and bottom (c) cells in the multi-stacked detectors. The single current signals (left) were normalized to examine the rise and decay slopes according to the incident light intensity (see graphs on the right).
**Figure S4.** Projected photocurrents (open symbols) for the prediction of frequency-dependent signals that can be detected by the top, middle, and bottom OPD cells in the multi-stacked detectors. Note that the projection was carried out by assuming the white light pulse modulation up to 60 Hz (see the dashed green line).
Figure S5. Comparison for the width of photocurrent signals according to the frequency of white light from the LED lamp at the highest (left) and lowest (right) $P_{IN}$ conditions. Note that the present pulses of white light are generated by optically chopping the source light from the LED lamp. It is clear that the narrower the pulse width, the lower the photocurrent.
Figure S6. Comparison of the enlarged photocurrent signals, which correspond to the first two pulses in “U” in Figure 5, measured by each OPD cell (TC: top cell, MC: middle cell, BC: bottom cell) in the multi-stacked detectors in Figure 5. The three photocurrent signals showed good synchronization without large time lags.
Figure S7. Test result for actual Li-Fi signal communications using the present multi-stacked detectors integrated with three OPD cells upon illumination with the programmed LED light ($P_{\text{IN}} = 8.8 \text{ mW/cm}^2$): (a) Incident white light pulse pattern with “KNU” information, (b) current signals measured by each OPD cell in the multi-stacked detectors. Note that the pulse width was controlled as wide as 28 s in order to make clear patterns in the present experiment but it can be extremely reduced down to microscale in the practical (commercialization) stage by employing sophisticated electronic circuits for the control of LED lamp.