Supporting Information for

Integration of Perovskite and Polymer Photoactive Layers for Ultrafast Response, Ultraviolet-to-Near-infrared, Sensitive Hybrid Photodetectors

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Calculation of the transit time

The transit time, which can be defined that carriers have a travel from one electrode to counter electrode under built-in potential or applied bias, was determined by equation (1):

$$t = \frac{D^2}{\mu V} \quad (1)$$

$$V = \frac{Q}{C} = \frac{Q \times D}{A\varepsilon_0\varepsilon_r} \quad (2)$$

Where t is the transit time, μ is the carrier mobility, V is the partial voltage of each layer from the sum of built-in potential and applied bias. Equation (2) is a transformation of definition of a parallel-plate capacitor, it is clearly seen that V is proportional to D/ε_r.

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Table S1 The thickness (D), dielectric constant (ε_r) and mobility (μ) of each layer of perovskite/polymer hybrid photodetector and the calculated transit time of the device.

	D (nm)	ε_r	μ (cm^2/Vs)	transit time (ns)
PTAA	5	4.0	0.01[1]	1.2
$MAPbI_3$	500	32[2]	30	0.16
PDPPTDTPT	60	4.0	8.0×10^{-2} [3]	1.0
BCP	8	2.91[4]	1.1×10^{-2} [5]	0.64

Calculation of the RC time constant

The organic-inorganic hybrid perovskite (OIHP) photodetector structure can be divided into four layers between the ITO and Cu electrode. According to the definition of capacitance in series, the total capacitances are composed four branches expressed by formula (3) and (4):

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} \quad (3)$$

$$C = A\,\varepsilon_0\varepsilon_r / D \quad (4)$$

where C_1 is from PTAA layer, C_2 is from perovskite layer, C_3 is from PDPPTDTPT:PCBM layer and C_4 is from BCP layer, respectively. A is thedevice area; D is thefilm thickness.

Table S2 The calculated capacitances and RC time constants of the perovskite/polymer hybrid photodetectors with various device areas.

Area(mm^2) / C (nF)	7	2	1	0.5	0.1
C_1	499	143	71.3	35.6	7.13
C_2	3.96	1.13	0.566	0.283	0.06
C_3	23.2	6.63	3.32	1.66	0.332
C_4	22.5	6.43	3.22	1.61	0.322
C_{total}	2.92	0.835	0.418	0.209	0.04
t (ns)	147	41.8	20.9	10.4	2.09

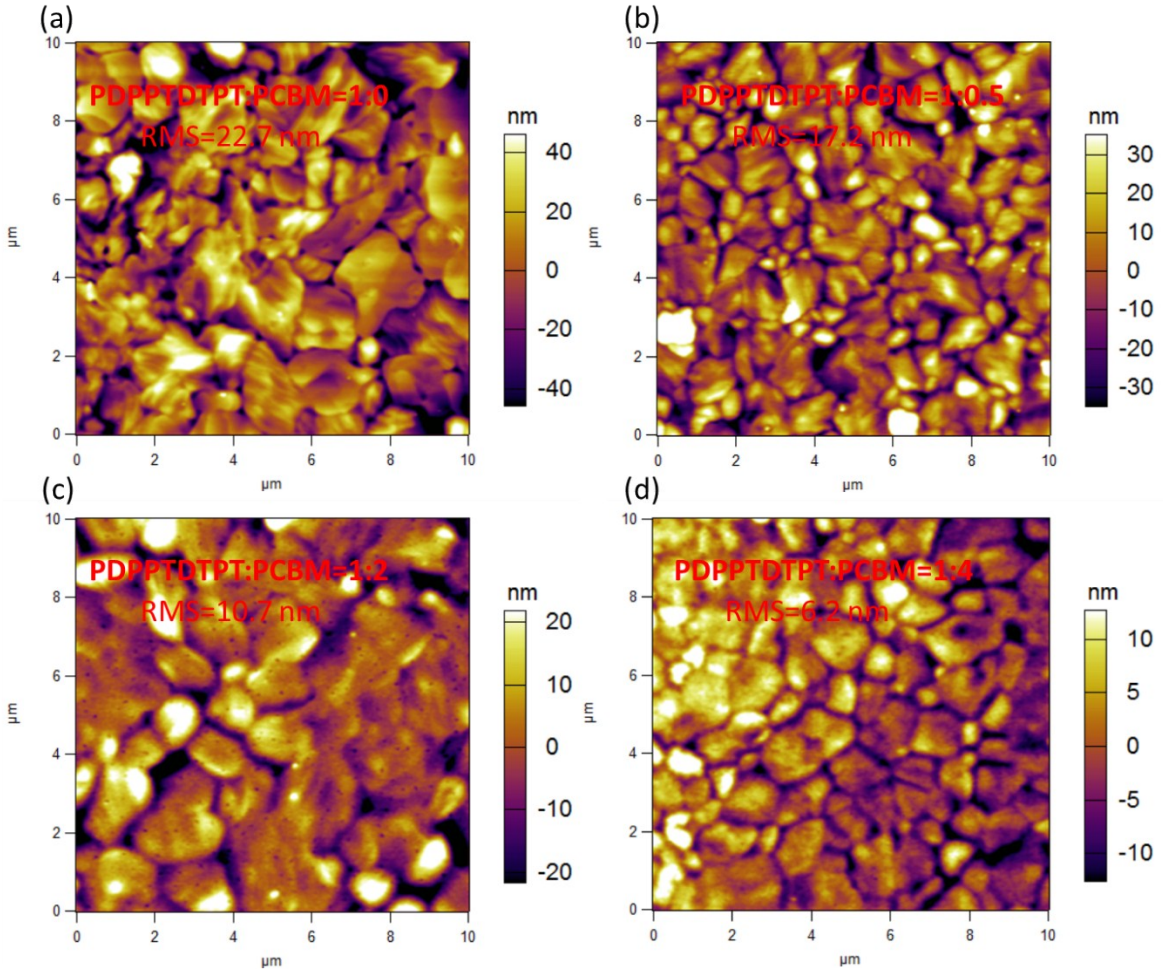

Figure S1 Atomic force microscopy images of perovskite/polymer hybrid photodetectors with various PDPPTDTPT:PCBM ratios.

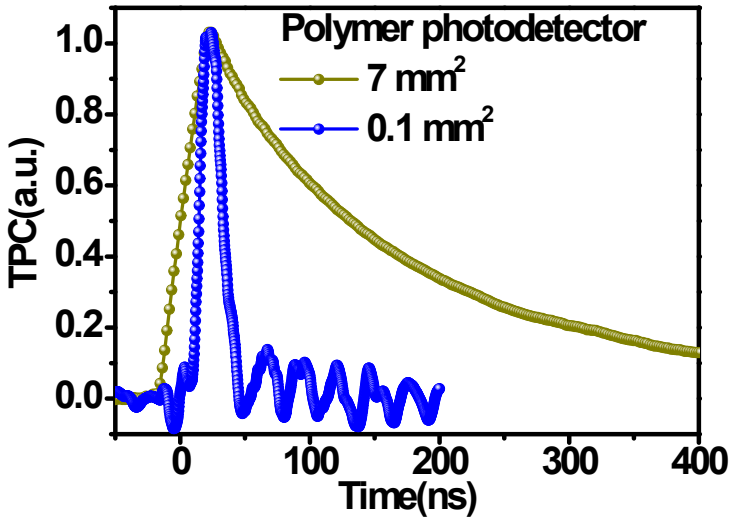

Figure S2 TPC curves of the pure polymer photodetectors with device areas of 7 mm^2 and 0.1 mm^2 under the illumination of near infrared light (800 nm). The response time of devices with areas of 7 and 0.1 mm^2 are 168 and 12 ns, respectively.

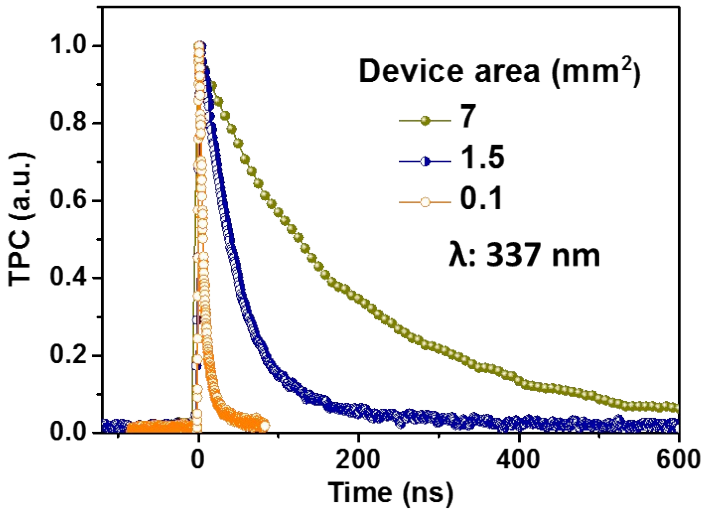

Figure S3 TPC curves of the perovskite/polymer hybrid photodetectors with device areas of 7 mm^2, 1.5 mm^2 and 0.1 mm^2 under the illumination of UV light. The photocurrent decay time of

the hybrid photodetectors with device areas of 7, 1.5 and 0.1 mm^2 to 337 nm UV light are 186, 48.0 and 8.8 ns, respectively.

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