**SUPPORTING INFORMATION For**

**Evidence for Extraction of Photoexcited Hot Carriers from Graphene**

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**Device structure and electrical properties of the device:**

The device geometry is shown in figure S1(a). Single layer graphene was transferred on the pre-patterned substrate, which consists of 50 nm thick Al₂O₃ back gate dielectric and a pair of split local bottom gates. In addition, graphene is contacted with Ti/Au (5/50 nm) metals and the entire device is covered by 50 nm thick Al₂O₃. Applying gate voltages, V_{g1} and V_{g2}, will dope graphene sections above the split gates respectively. Figure S1(b) shows the two dimensional resistance plot of the graphene device and it is evident that pn, np, pp and nn junctions can be formed between the split bottom gates. Each region can be separated by a straight horizontal and vertical gray dashed line.

**Scanning photocurrent spectroscopy¹²:**

Figure S2(a) shows the schematic of the scanning photocurrent experimental setup. The mirror mounted before the objective lens can scan angle in dual axis. Thus, the
position of the focused laser spot on the graphene device can be changed in two dimensions. In addition, two beam splitters (BS, 98% transmission, 2% reflection) are incorporated in the setup in order to collect reflected light from the device to the CCD camera and photodiode simultaneously. The image from the CCD camera and the measured signal from the photodiode can provide the information about the position of laser spot. Fig. S2(b) shows the optical microscope image of the device, and Fig. S2(c) shows the scanning reflection image detected by the photodiode.

The scanning photocurrent system was coupled with either CW or pulse laser light source. CW laser has a center wavelength of 900 nm, generated by semiconductor laser diode. For the pulse laser, the center wavelength is at 800 nm, generated by a Ti:Sapphire laser (150 fs pulse width and 76 MHz repetition rate). The laser beam was focused to 1.5 µm by a 50 x objective lens with NA = 0.55. To measure spatially resolved photoresponse, the scanning mirrors system was mounted before the objective to raster scan the position of laser spot. When measuring the photocurrent from the device, the laser beam was chopped (184 Hz) by mechanical chopper and the short circuit photocurrent was detected by lock-in amplifier. All of the photocurrent measurements were performed at ambient conditions.

References:
Supporting figures:

**a**

Schematic drawing of the graphene device structure.

**b**

Two dimensional color plot of the device resistance under different $V_{g1}$ and $V_{g2}$ bottom gates voltages.

*Figure S1 Graphene device structure and device electrical properties. a,* Schematic drawing of the graphene device structure. *b,* Two dimensional color plot of the device resistance under different $V_{g1}$ and $V_{g2}$ bottom gates voltages.
Figure S2 Scanning photocurrent spectroscopy. a, Schematic drawing of the experimental setup. b, Optical microscope image of the graphene device. (c) Reflection image of the graphene device detected by the photodiode. Scale bar, 10 µm.
Figure S3 Gate dependent photocurrent map under pulse laser excitation.

In each photocurrent map, $V_{g1}$ is swept from -10 V to 10 V with $V_{g2}$ fixed at different gate voltages. The excitation pulse laser power is 2 mW. a, $V_{g2}$ fixed at -20 V. b, $V_{g2}$ fixed at -
15 V. c, $V_{g2}$ fixed at -10 V. d, $V_{g2}$ fixed at -5 V. e, $V_{g2}$ fixed at 0 V. f, $V_{g2}$ fixed at 5 V. g, $V_{g2}$ fixed at 10 V. h, $V_{g2}$ fixed at 15 V. i, $V_{g2}$ fixed at 20 V.