High performance of broadband room-temperature Si detector beyond cut-off wavelength

Supplementary Information

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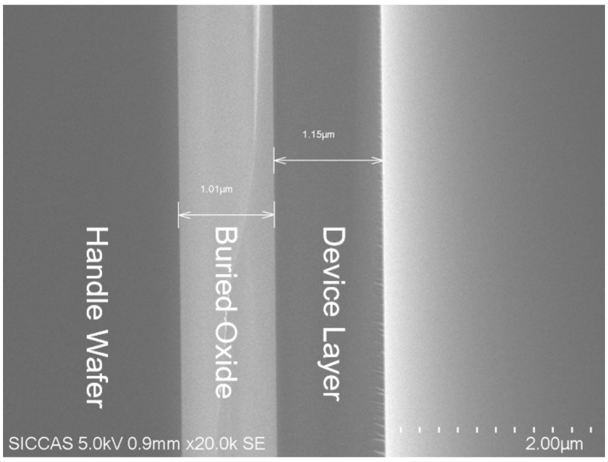

Figure S1. SEM cross-sectional view of SOI material. The p-type Si of the device layer has a thickness of 1.15 μm.

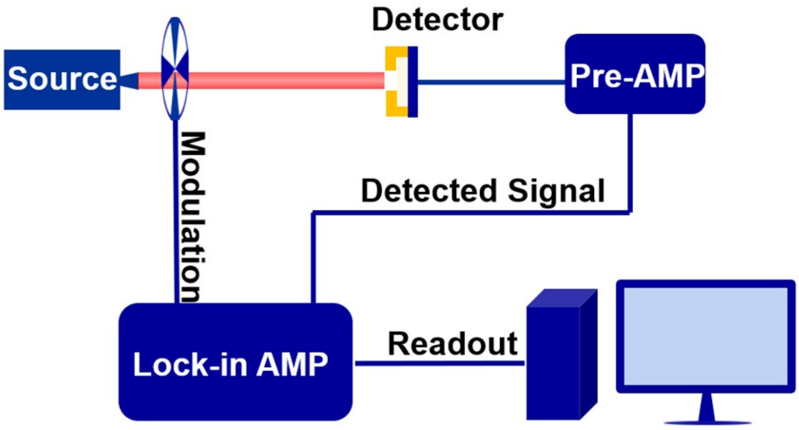

Figure S2. Schematic diagram of 3D MSM structured Si detector photoelectric response test. The detector is illuminated by the modulated source and the resulting photocurrent is amplified by a preamplifier and read out by a lock-in amplifier.

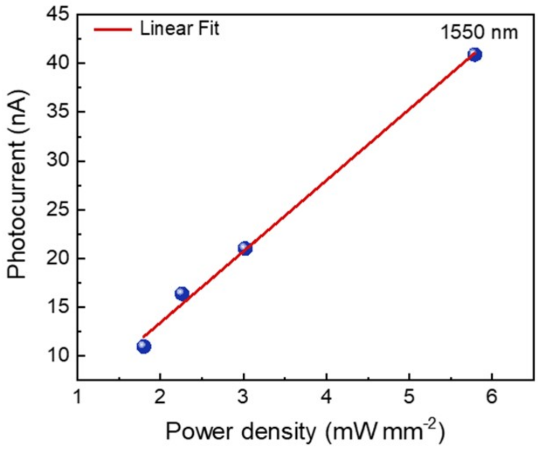

Figure S3. Photocurrent of Si detectors at 0.7 V at different 1550nm laser power densities. The photocurrent of the Si detector is linearly related to the power density at 1550 nm.

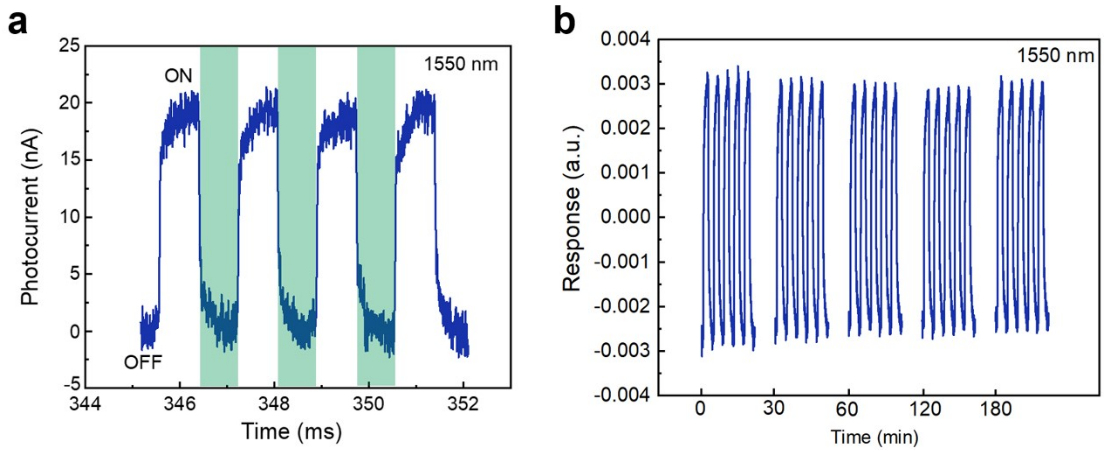

Figure S4. Waveform and stability of Si detector at 1550 nm. a) The photocurrent waveform of Si detector at 1550 nm at 0.7 V. b) The photoresponse stability measured on the Si detector under continuous irradiation at 1550 nm at 0.7 V. As shown in the figure, 94% of the initial light response remained good during 3 hours of exposure.

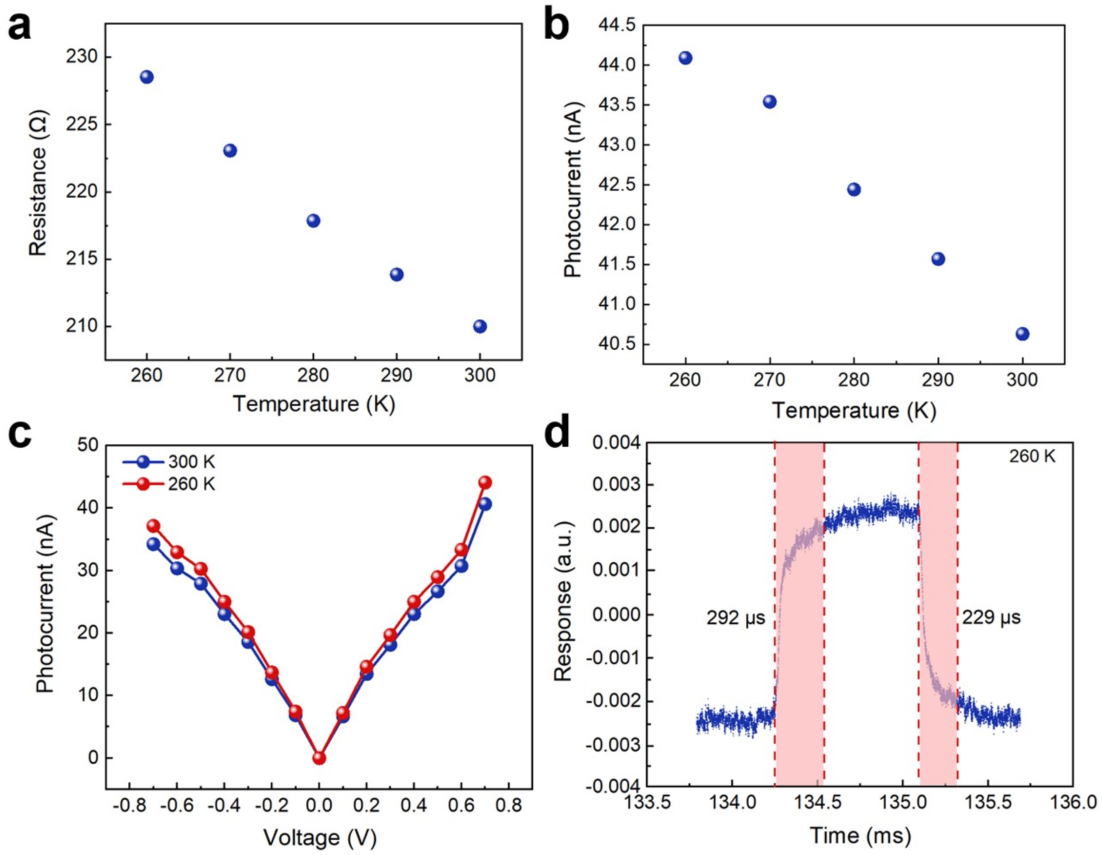

Figure S5. Performance of the Si detector at 1550 nm at 260-300 K. a) The resistance of Si detector at 260 K-300 K. A temperature drop of 40 K changes the resistance of the detector by about 18 Ω. It can be seen that fluctuations in temperature in a room temperature environment do not cause large changes in the resistance of the detector. b) The photocurrent of the Si detector at 260 K-300 K at 1550 nm and 0.7 V. A temperature drop of 40 K changes the photocurrent of the detector at 1550 nm by about 3.5 nA, which shows that temperature fluctuations at room temperature also do not cause large changes in the photocurrent of the detector. c) Photocurrent versus bias for Si detectors at 260 K and 300 K at 1550 nm. There is little difference in the response of the detector at 260 K and 300 K for different bias voltages. d) Response time of the Si detector at 260 K. The response time of the detector at 260 K is only about 8 μs faster than the response time at 300 K. The variable temperature experiment proves that the Si detector has good stability at room temperature environment.

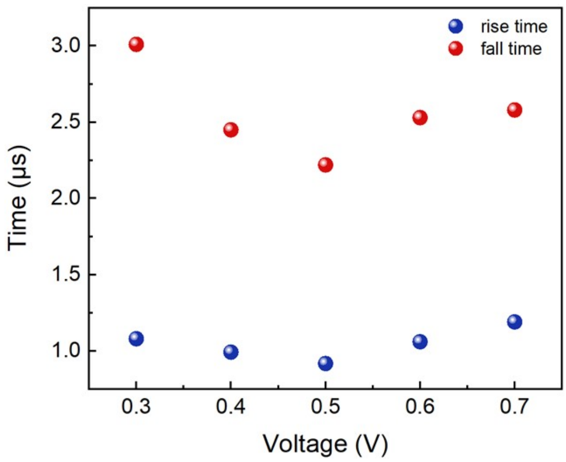

Figure S6. Response time of Si detectors at 0.269 THz with different bias voltages.

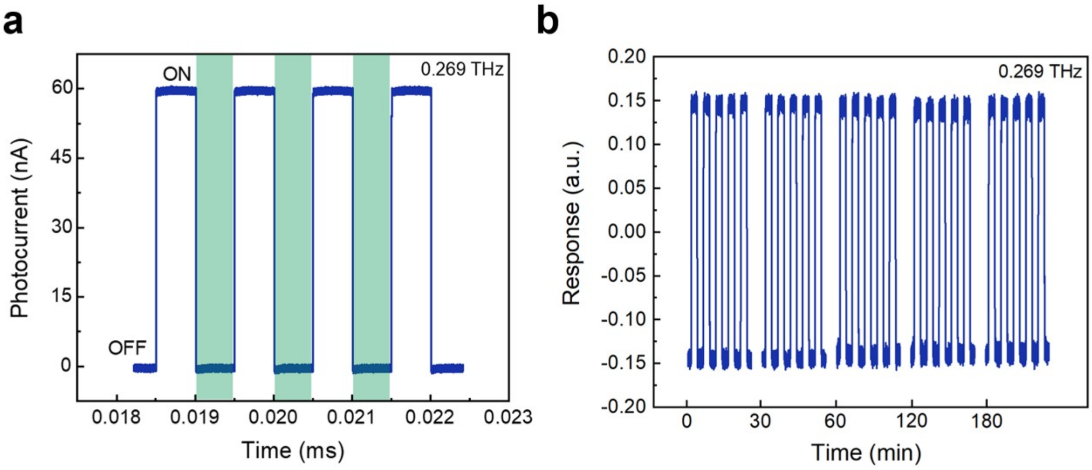

Figure S7. Waveform and stability of Si detector at 0.269 THz. a) The photocurrent waveform of Si detector at 0.269 THz at 0.5 V. b) The photoresponse stability measured on the Si detector under continuous irradiation at 0.269 THz at 0.5 V. As shown in the figure, 99% of the initial light response remained good during 3 hours of exposure.

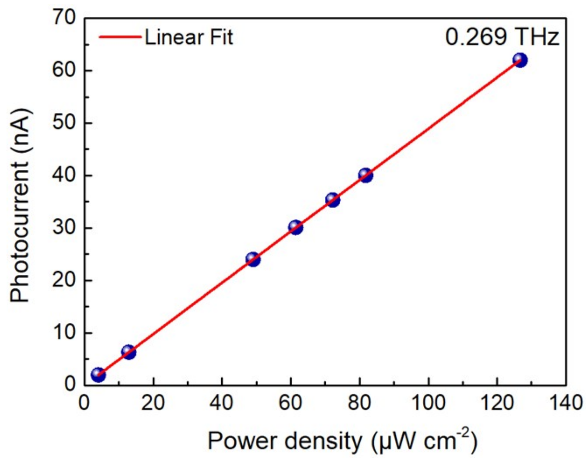

Figure S8. Photocurrent of Si detectors at 0.5 V at different 0.269 THz power densities. The photocurrent of the Si detector is linearly related to the power density at 0.269 THz.

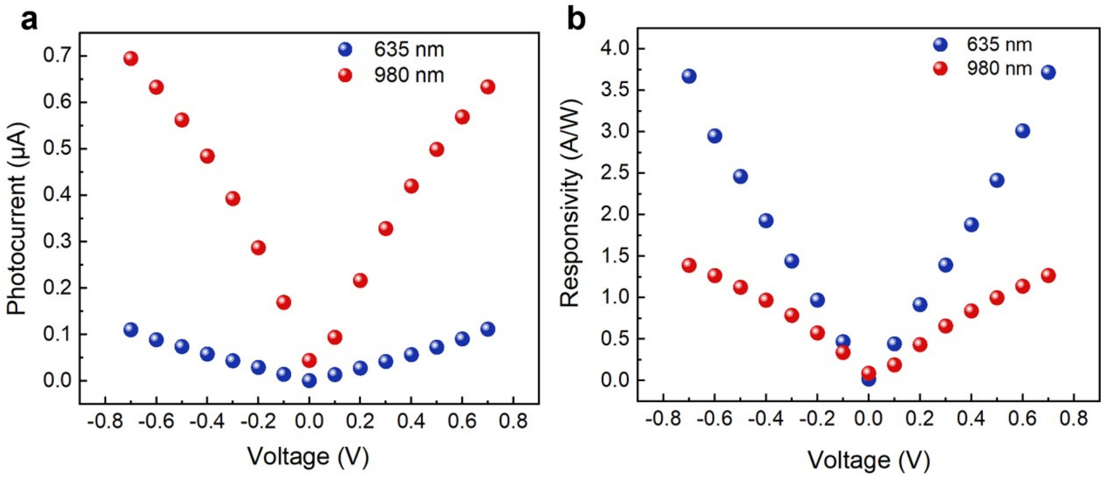

Figure S9. Response characteristics of a 3D MSM structured Si detector in the visible-NIR band (below 1100 nm). a) Response currents of Si detectors at 635 nm and 980 nm. The response currents of the Si devices at 0.7 V are 0.11 and 0.63 μA at 635 nm and 980 nm, respectively. b) Responsivity of Si detectors at 635 nm and 980 nm. The responsivity of Si detectors are 3.72 A/W and 1.27 A/W at 635 nm and 980 nm, respectively.