Photoactive Terahertz Metasurfaces for Ultrafast Switchable Sensing of Colorectal Cells

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Supplementary Note 1

Coupling modulation between Lorentz and lattice modes

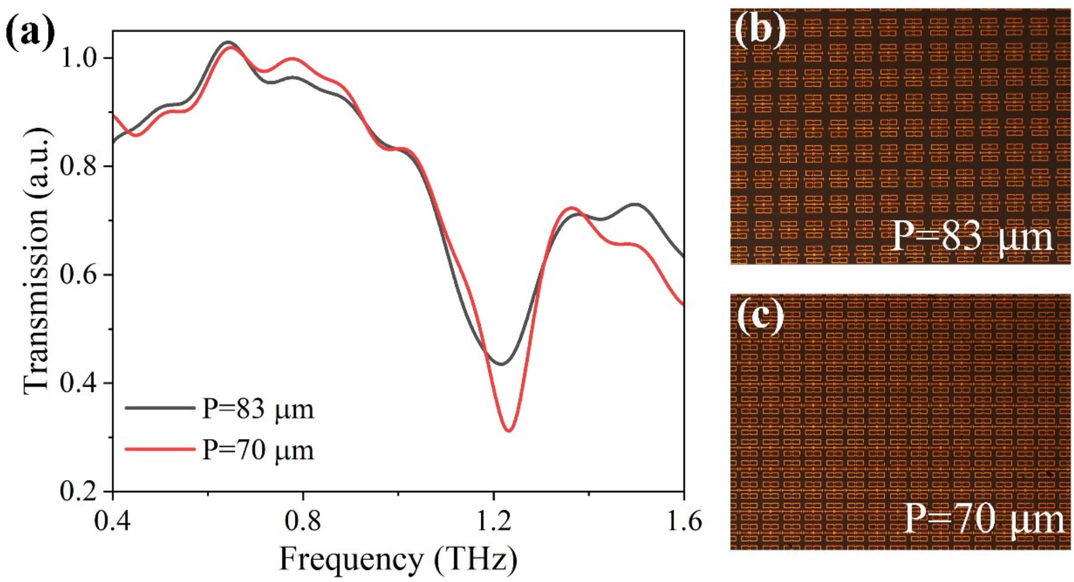

Figure S1. a) Experimental THz transmission spectra for varying lattice periods. Microscopic image of fabricated THz metasurfaces with b) *P*=83 μm and c) *P*=70 μm.

To further study the coupling effect between Lorentz and lattice modes, two samples with different lattice periods are fabricated, with measured THz transmission spectra shown in Figure S1a. It is noticed that the Lorentz mode of the sample with *P*=83 μm is coupled efficiently with lattice mode, accompanied by a weaker resonant profile (black line in Figure S1a). Besides, the microscopic images of fabricated THz metasurfaces with P=83 μm and P=70 μm can be seen in Figures S1b and S1c.

Supplementary Note 2

Extraction of silicon photoconductivity

Based on the OPTP systems, we have obtained the frequency-resolved conductivity of silicon film (600 nm) under different pump conditions, by recording transmission amplitude of SOS substrate. Supporting the photogenerated carriers are evenly distributed in silicon film, the variation of silicon photoconductivity relative to the static conductivity under no pump excitation can be retrieved, according to the following formula:[1, 2]

$$\Delta\sigma(\omega) = \frac{\varepsilon_0 c}{d}(n_a + n_s)\frac{-\Delta E(\omega)}{E_0(\omega)} \tag{S1}$$

where c is the light speed in the free space (3×10^8 m/s); d is the thickness of silicon film (600 nm); ε_0 is the free space permittivity ($8.854187817 \times 10^{-12}$ F/m); n_a and n_s are the refractive indexes of air and sapphire substrate (1 and 3.1), respectively; $E_0(\omega)$ is the THz frequency-resolved transmission amplitude of SOS without pump excitation; $\Delta E(\omega)$ is the amplitude variation of SOS under different pump conditions: $\Delta E(\omega) = E_0(\omega) - E_{pump}(\omega)$.

As mentioned in the main text, the pump-probe delay time of 32 ps is characterized as the maximum carrier excitation of silicon carriers. Thus, every THz measurement is fixed at delay time of 32 ps to acquire the transmission results. The measured frequency-resolved $\Delta\sigma(\omega)$ of silicon film is illustrated in Figure S2a, from which it is noticed that silicon conductivity increases with pump fluences. By extracting the $\Delta\sigma(\omega)$ against pump fluence at specific frequencies (Figure. S2b), we can see that $\Delta\sigma(\omega)$ exhibits a distinct exponential growth trend with pump fluence, and the maximum variation of conductivity at 0.777 THz and 1.215 THz can be up to 17550 and 15197 S/m, respectively.

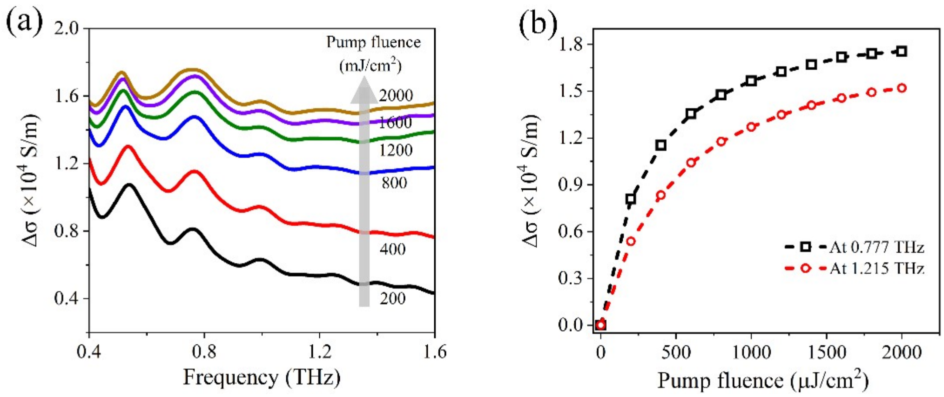

Figure S2. a) Measured frequency-resolved photoconductivity of silicon film under different pump fluences. b) Extracted silicon conductivity against pump fluences, at 0.777 THz and 1.215 THz.

Supplementary Note 3

Time-dependent growth curves of the three colorectal cells

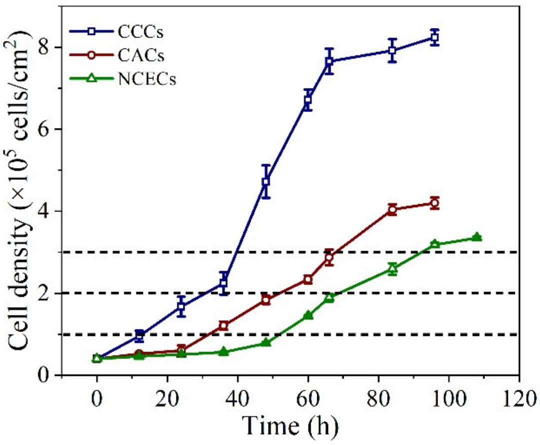

Figure S3. Time-dependent growth curves of CCCs, CACs and NCECs cultivated onto the surface of THz metasurfaces. The error bar represents standard deviations calculated from three measurements.

Supplementary Note 4

Optical micrographs of THz metasurfaces cultivated with colorectal cells

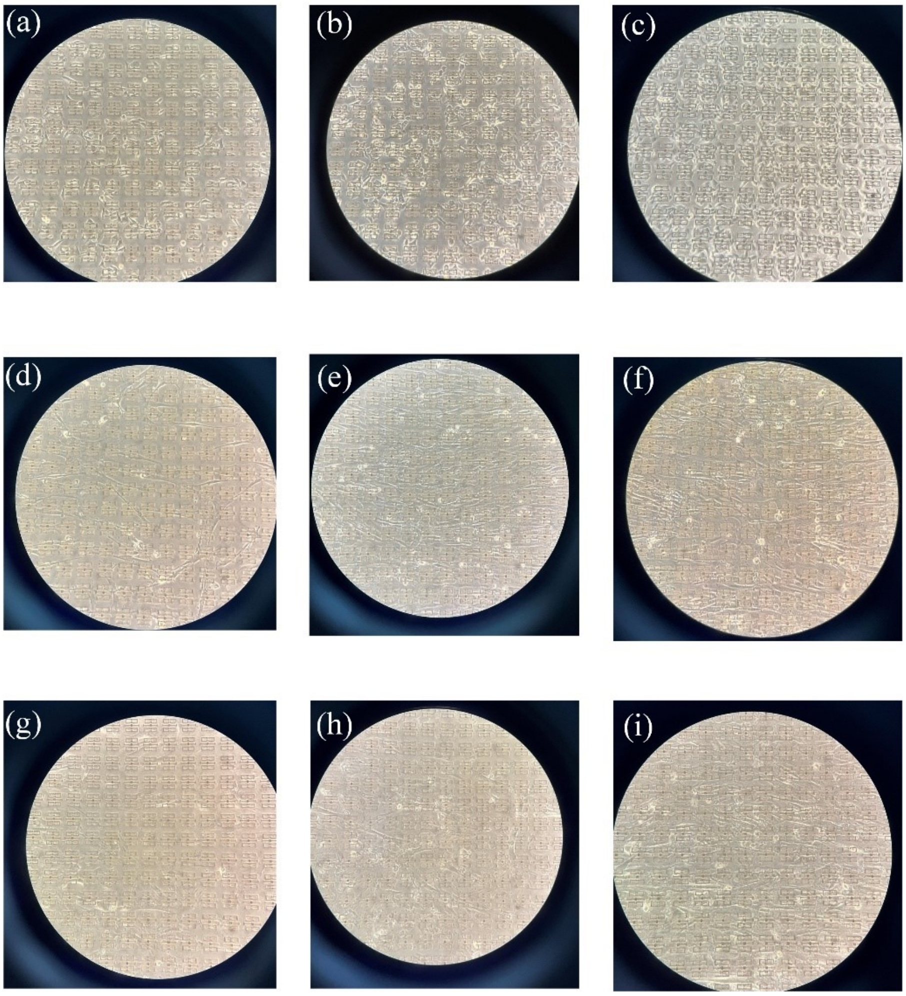

Figure S4. Optical micrographs of a-c) CCCs, d-f) CACs, and g-i) NCECs adhered onto the surface of THz metasurfaces with varying densities of 1×10^5, 2×10^5 and 3×10^5 cells/cm^2.

Supplementary Note 5

Cell staining experiment

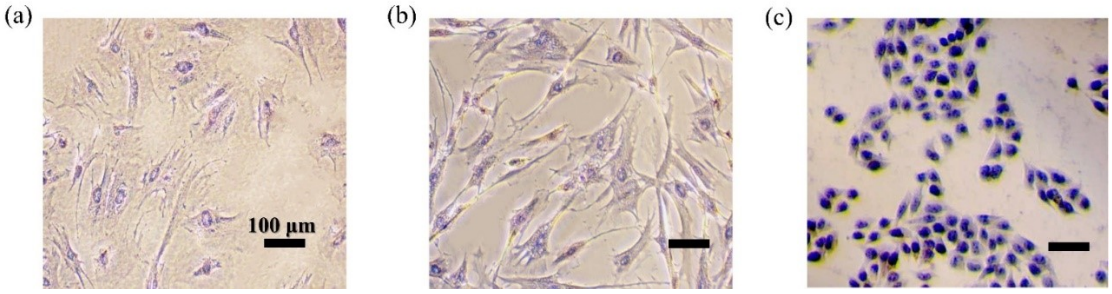

Figure S5. Cell staining results for (a) NCECs, (b) CACs, and (c) CCCs.

Reference

[1] L. Cong, Y. K. Srivastava, H. Zhang, X. Zhang, J. Han and R. Singh, *Light: Sci. Appl.*, 2018, **7**, 28.

[2] L. Cong, J. Han, W. Zhang and R. Singh *Nat. Commun.*, 2021, **12**, 6940.