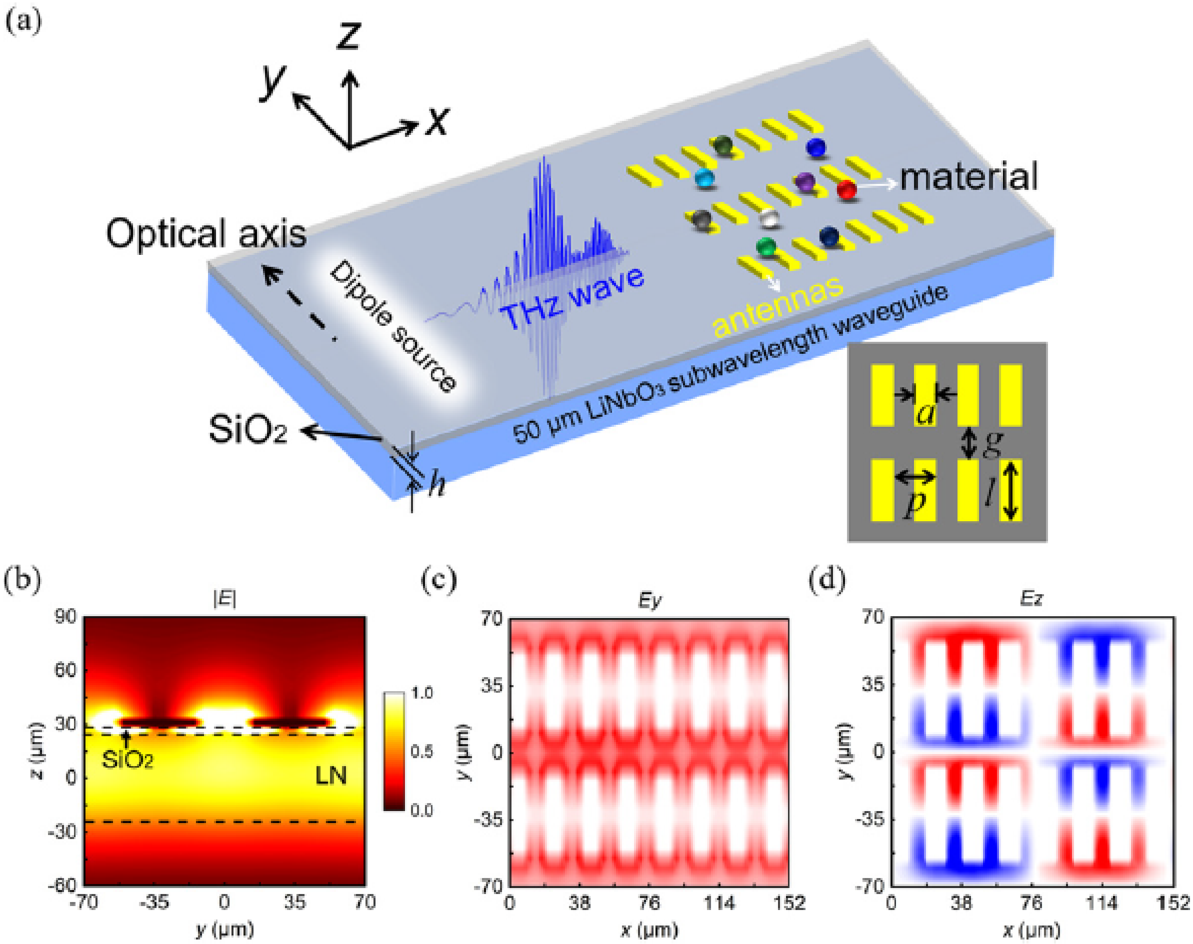
# Enhanced on-chip terahertz sensing with hybrid metasurface/lithium niobate structures

Recognizing special molecules is crucial in many biochemical processes, and thus, highly enhanced sensing methods are in high demand. In this work, we designed a microrod array metasurface with a SiO2-loaded subwavelength lithium niobate waveguide as a unique platform for enhanced experimental fingerprint detection of lactose. The metasurface could lead to strong surface wave modes due to the near-field coupling of the spoof localized surface plasmon, which also could provide a stronger interaction length between light and matter. The selectivity was remarkable in the transmission spectrum at an intrinsic characteristic frequency of 0.529 THz with a thin layer of lactose, while it was faint while transmitting terahertz (THz) waves normally through a lactose layer of the same thickness. Together with the ability to freely design the shape of the metasurface and the electromagnetic properties, we believe that this platform can function as an elegant on-chip-scale enhanced THz sensing platform.




(a) Schematic of THz detection of an analyte using a microrod array metasurface
as an on-chip sensor. A column of y-polarized dipoles located inside the LN
waveguide is used to excite THz waves (blue oscillation signal). The thickness of
the SiO2 layer is h¼2 lm. The inset shows the detailed design parameters: p, a,
l and g are 20, 10, 55, and 15 lm, respectively. (b) Enhanced field confined to the
surface of the composite structure. (c) and (d) Distribution of the field components
Ey and Ez at f¼0.529 THz.

In summary, we show the potential of a platform relying on a microrod array metasurface with a SiO2-loaded LN subwavelength waveguide as a generic design for THz sensing. Remarkable selectivity can be seen from the experimental and simulated transmission spectra with a minute amount of the analyte. The stronger confinement of surface wave modes owing to near-field SLSP coupling and the longer interaction length along the waveguide would effectively increase the molecular absorption, thereby enabling detection of a thin lactose layer. Meanwhile, the results agree well with each other. This is difficult to distinguish with normally incident THz waves transmitting through a lactose of the same thickness without a metasurface. The myriad of geometries for the composite structure provides engineers with enormous flexibility to design sensing platforms that operate over a broad range of frequencies. We believe that this platform is truly simple and efficient while providing a versatile method for enhanced fingerprint detection in the THz regime. This would bring THz sensing benefits to mainstream applications.

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