

Terahertz Transverse Magnetism in 1-dimensional Plasmonic system

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As per general perceptions, transverse magnetism cannot exist in one dimensional plasmonic systems because of the fundamental limitations imposed by basic electromagnetic theory [1]. Contrary to this general belief, we have recently demonstrated transverse magnetism in a plasmonic wire constituting a cut-wire pair-based metasurface (Fig. 1) operating at the terahertz frequencies [2]. We have validated our experimental findings through theoretical approaches too (Fig. 1). We attribute the observation of transverse magnetism to appropriate interplay of resonance eigen mode, lattice mode and near-field Coulomb interactions between the cut-wire pair constituting the unit cell. Such demonstration of transverse magnetism in 1-dimensional plasmonic systems can help in realizing compact photonic or electrical integrated circuits besides other futuristic applications, such as, cloaking, magnetic storage etc.

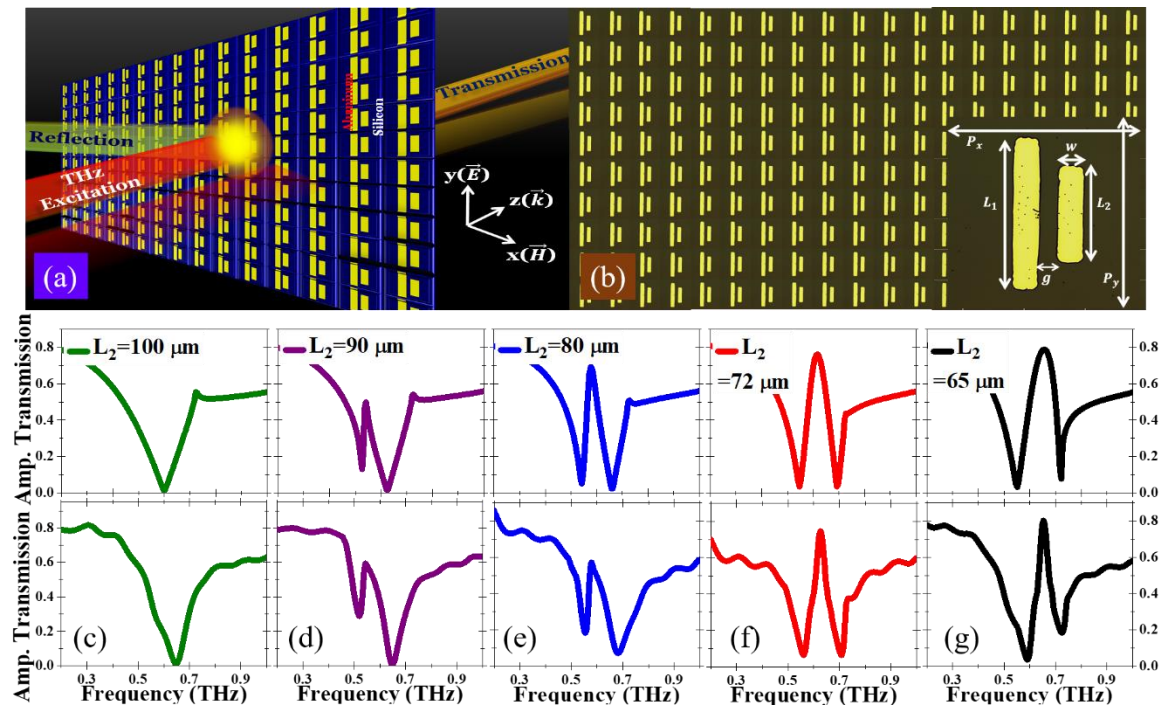


Figure 1: (a) Schematic of double cut-wire based metasurface under THz probe. (b) Microscope picture of metasurface sample including unit cell (inset) of one fabricated sample. Structural parameters, lattice periodicity (P_x, P_y): (120, 120) μm , length of the resonators $L_1 = 100 \mu\text{m}$, $L_2 = 65$ to $100 \mu\text{m}$ (variable), resonator width $w = 20 \mu\text{m}$, and gap between the resonators $g = 8 \mu\text{m}$. Here, intrinsic silicon and aluminum are used as substrate and resonator respectively. Figures, c, d, e, f and g represent theoretical calculations (top row) and THz measurements (bottom row) of transmission spectra. Induced current and magnetic field distribution for $L_2 = 65 \mu\text{m}$ reveal transverse magnetism in 1-dimensional plasmonic system [2].

Reference:

[1] D J Griffiths, "Introduction to Electrodynamics", Prentice Hall 3rd edition (1999)

[2] S. Karmakar, D Kumar, B. P. Pal, R. K. Varshney, and D Roy Chowdhury, "Magnetic wire: Transverse magnetism in a one-dimensional plasmonic system"