Supplementary Information

Electrically tunable terahertz metamaterials with embedded large-area transparent thin-film transistor arrays

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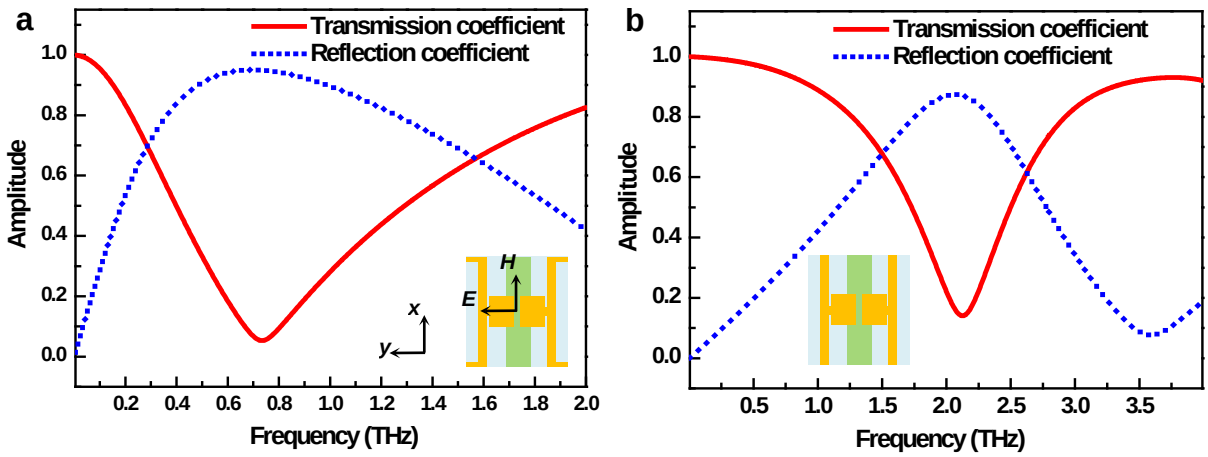

Figure S1. Transmission/reflection coefficient of *a*-IGZO TFT-based metamaterials with (a) connected or (b) unconnected metamaterial design. The resonance frequency red-shifts from 2.1 to 0.75 THz due to the connecting design along *y*-direction in our structure.

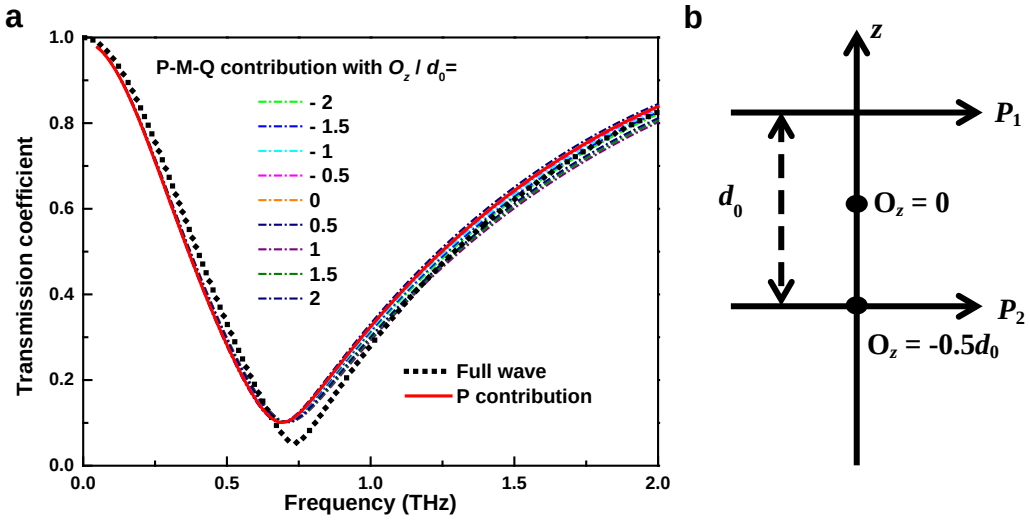

Figure S2. The choice of coordinate origin for calculating magnetic dipole (*M*) and electric quadruple (*Q*) moments. (a) The transmission coefficient (amplitude) calculated by fitting the multipolar expansion model with different choice of coordinate origin O_z. (b) Schematic of the coordinate origin. Here P_1 and P_2 represent the electric dipole moments of source/drain layer and gate layer, respectively. The distance between these two layers is indicated as d_0. We found that the different choice of coordinate origin O_z for calculating *M* and *Q* results only in a small difference to the transmitted field, while the electric dipole moment (*P*) unambiguously remains dominant to the scattered radiation. Therefore, we simply show the results in Figs. 2c-2e by choosing the origin at the middle of these two metal layers.

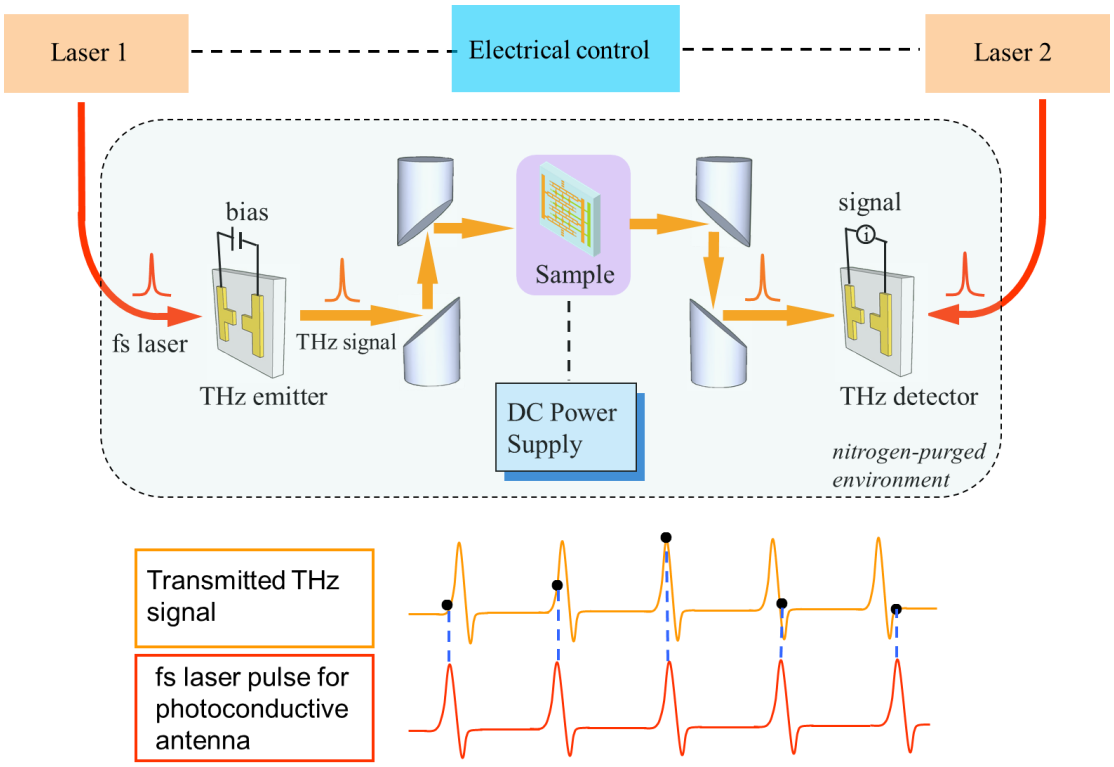

Figure S3. Experimental setup for characterizing the tunable THz metamaterial.