**Coherent Coupling in a Two-Dimensional Arrayed Resonant-Tunneling-Diode Terahertz Oscillator**

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The potential of resonant-tunneling-diodes (RTDs) as compact, room-temperature terahertz (THz) sources has been acknowledged, whereas mode-locking in large-scale RTD arrays remains a challenge. While the utilization of common resistors has enabled coherent coupling in RTD arrays, all reported configurations are restricted to one-dimensional (1D) arrangement due to difficulties in expanding slot antenna structures to a two-dimensional (2D) configuration. In this study, we introduce a novel 2D RTD arrayed THz oscillator composed of vertically intersected slot antennas, issuing the potential of large-scale RTD arrays with enhanced THz output power and improved directivity.

The device structure is illustrated in the figure, featuring vertically intersected slot antennas with four RTDs located at the intersects. Common resistors are intentionally placed between adjacent RTDs to lock them in anti-phase mode. This mode-locking enables coherent global coupling, facilitated by the accumulated mutual anti-phased coupling between adjacent RTD pairs. Fabrication involves the formation of Ti/Pd/Au ohmic contacts, $CH_4/H_2$ reactive ion etching (RIE) for common resistors, air-bridge evaporation using a two-step E-beam exposure method, and wet etching to define RTD mesas. Scanning electron microscope (SEM) imaging verifies well-defined air-bridge morphologies, as shown in the figure inset.

A frequency test utilizing a lock-in strategy reveals coherent, single-peak oscillation at 484 GHz, indicating successful global coupling among all RTDs. Further expansion of the proposed array configuration is expected to result in high-power, high-directivity THz radiation.