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Two-element array of resonant-tunneling-diode terahertz oscillator integrated with offset-fed slot antenna

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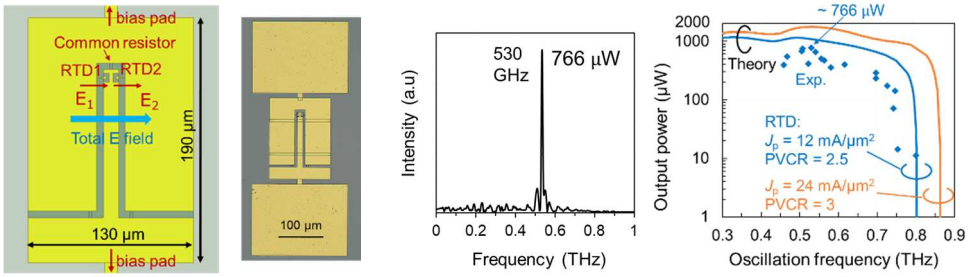
Resonant tunneling diodes (RTDs) are promising candidate as a compact and room temperature terahertz (THz) source [1]. However, the output power of conventional single RTD oscillators is small of ~10 μW, and increasing the output power is strongly required. Arrayed oscillators are effective for high-power oscillation, and coherent high-power oscillation has already been reported [2]. We proposed an oscillator array structure using strong coupling through a resistor in a simple oscillator structure without a capacitor for separating the DC circuit and the THz circuit, and demonstrated its operation [3]. This structure has an advantage of a wide synchronization frequency range due to the strong coupling. In this work, we proposed and fabricated an arrayed RTD oscillator with offset-fed slot antennas and a 180-degree bending coupling structure for high-efficient power coupling, and achieved a high output oscillation of ~0.77 mW at 530 GHz.

Fig. 1 shows the schematic structure of the proposed arrayed RTD oscillator. Two RTD mesas are integrated into two slot antennas, respectively, at positions shifted from the center, and each antenna is coupled through a common resistor. RTDs have a negative differential conductance (NDC) in their IV characteristics, which becomes a gain for THz oscillation. The oscillation frequency is determined by the LC parallel resonance of RTD capacitance and antenna inductance. Two resistors are placed at the end opposite the coupling part to form an antenna and to suppress parasitic oscillations at low frequencies. In operation in this resistor-coupled structure, the anti-phase mode (odd mode) in which the oscillation voltages of the two RTDs are in opposite phases is stable because the current in the common resistor is small. Therefore, the two antennas are connected by bending 180 degrees so that the power is combined in the substrate direction. We fabricated the device while fixing the antenna structure and changing the area of the RTD (Fig. 1(a), right). As a result, as shown in Fig. 1(b), a high-power oscillation of 0.766 mW was obtained at 530 GHz. Fig. 1(c) shows the output power versus oscillation frequency. The oscillation frequency increases as the mesa area shrinks, but the output power decreases. As shown in Fig. 1(c), the experiment and theory show good agreement, and in the future, higher output power is expected by using an RTD with high current density and good peak-to-valley current ratio (PVCR).



(a) (b) (c)

Figure 1. (a) Schematic structure of proposed two-element arrayed RTD oscillator and fabricated device. (b) Oscillation spectrum. (c) frequency dependence of output power.

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