Sub-THz RTD Oscillators Integrated with Planar Horn Antennas for Horizontal Radiation

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***Abstract*—Fabrication and oscillation characteristics of sub-THz RTD oscillators integrated with planar horn antennas for horizontal radiation are reported. The device consists of a GaInAs/AlAs RTD, a resonator, a waveguide, and a horn antenna on a semi-insulating InP substrate. Oscillation frequency of 455GHz and horizontal output power of ~0.6µW were observed. The output power is small at present because of small values of the peak-to-valley current ratio and the voltage width of the negative differential resistance region of the RTD.**

I. Introduction

The THz frequency range is receiving considerable attention recently because of its many applications, such as ultrahigh speed wireless communications and imaging. Compact and coherent solid-state light sources are important key components in these applications. Resonant tunneling diode (RTD) oscillators have been considered as one of the candidates for THz oscillators at room temperature. 712 GHz fundamental oscillation [1] and 1 THz harmonic oscillation [2] have been reported.

Planar structures, in which RTDs and antennas are integrated within the same substrate, are suitable for compact oscillators. In the reported RTD oscillators with planar structures [2] [3], output power is radiated in the substrate direction, and extracted through a hemispherical lens. If the output power is obtained in the horizontal direction, it is useful for many applications, such as interchip wireless transmission. In this paper, fabrication and oscillation characteristics of sub-THz RTD oscillators integrated with planar horn antennas for horizontal radiation are reported.

II. Experimental Results

The schematic structure of the oscillator is shown in Fig. 1. The device consists of a resonator, a waveguide, and a horn antenna. The resonator is formed with the slot line. The metal-insulator-metal (MIM) reflector [2] is formed at one of the edges of the resonator to achieve the shorted end for high frequency and the DC bias separation. The other edge is open and connected to the waveguide which width is wider than that of the resonator. RTD has a GaInAs/AlAs double-barrier structure on a semi-insulating InP substrate.The details of the RTD layer structure are described in [2]. The RTD area is approximately 1.4µm^2. The peak current density is approximately 7mA/µm^2, and the peak-to-valley (P/V) current ratio is around 1.5. The fabrication process is almost the same as that in [2].

Fig. 2 shows the measured oscillation spectra. The oscillation at 455GHz was obtained at room temperature. The output power emitted in the horizontal direction is ~0.6µW. The output power is small in the present sample due to the small values of the P/V ratio and the voltage width ΔV(~0.2V) at the negative differential resistance region. In addition to the horizontal radiation, output power of ~0.3 µ W into the substrate was also observed. This is probably due to radiation from the slot line resonator, and is expected to be suppressed by optimizing the structures of the resonator and antenna.

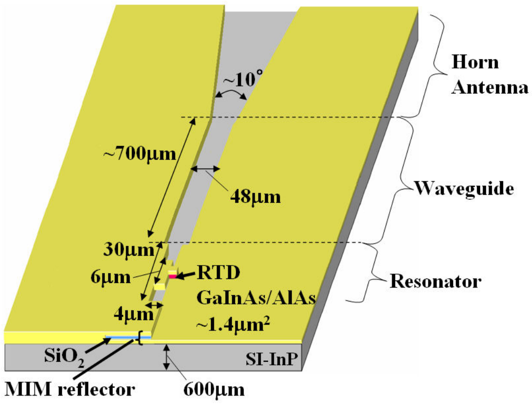

Fig. 1 Schematic structure of fabricated device.

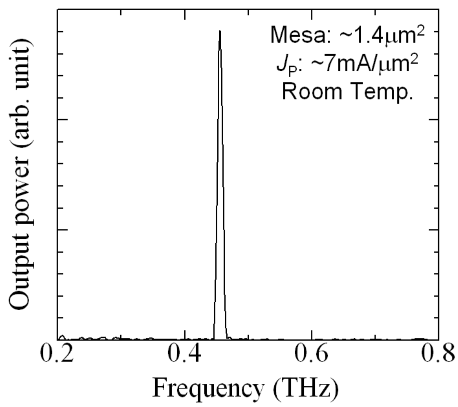

Fig. 2 Measured oscillation spectra of fabricated device.

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