

Estimation of Output Power Characteristics for Resonant-Tunneling Diode THz Oscillator with Cylindrical Cavity Resonator

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Terahertz (THz) radiation, in the range between the light waves and millimeter waves, has gained much attention because of its applications, such as imaging, spectroscopy, high resolution radars and high-capacity wireless communications [1]. Among the electron devices, resonant tunneling diodes (RTDs) are one of the major candidates for THz wave sources, because of their operation at room temperature, compactness, and undemanding system requirements. Recently, oscillation frequency was increased up to 1.98 THz [2]. To achieve oscillation frequencies more than 2 THz, new RTD THz oscillator structure based on low conduction loss cavity resonator was proposed [2]. However, in the first fabrication trial, oscillation frequencies were only up to 1.79 THz. To optimize structure parameters and reach higher frequencies, oscillation frequency limitations and structure dependences were analyzed [3]. However, for practical applications optimization of output power characteristics is also essential. In this work output power behavior of RTD oscillator with cylindrical cavity is analyzed.

The oscillator is composed of an RTD mesa structure, a circular cavity resonator and bow-tie antenna as shown in Fig. 1. The RTD mesa is located at the center of the cylindrical cavity. The oscillation occurs in the cavity, and output power is supplied to the bow-tie antenna and radiated into the substrate side. To achieve high output power, optimization of the oscillator structure parameters is essential. Similar calculation approach as in our previous work [3] was used to obtain dependences of output power on radius and height of the resonant cavity (Fig.2).

It is revealed that output power generally increases with decreasing cavity size at fixed frequency. Obviously, output power increases with decreasing frequency, since larger RTD mesa area is needed for lower frequencies. However, we found existence of low frequency oscillation limit, where output power rapidly decreases with increasing mesa area and with decreasing oscillation frequency. This effect could affect oscillation power even at frequencies around 1THz and hence, to reach highest output power, careful analysis of output power is required. Analysis of the calculation results has shown that for the RTD device considered in the present study, output power up to 40 μ W at 1.5 THz could be expected with cavity radius of 5 μ m and height of 4 μ m.

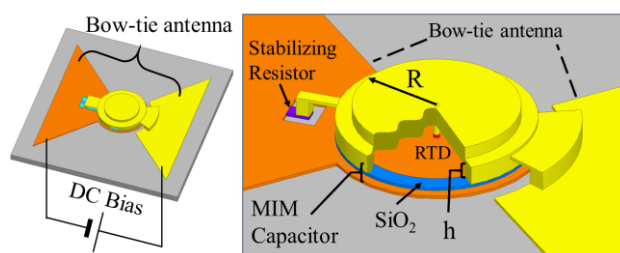


Fig. 1 Schematic structure of RTD oscillator with cavity

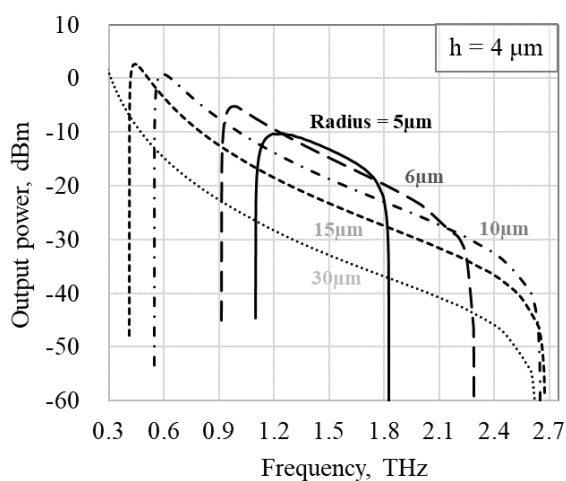


Fig. 2 Estimation of the RTD oscillator output power for various cavity radiuses at fixed cavity height of 4 μ m

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