A Quasioptical Resonant-Tunneling-Diode Oscillator Operating Above 200 GHz

E. R. Brown*, C. D. Parker*, K. M. Molvar*, A. R. Calawa*, and M. J. Manfra*

We have fabricated and characterized a quasioptically stabilized resonant-tunneling-diode (RTD) oscillator having attractive performance characteristics for application as a radiometric local oscillator. The fundamental frequency of the oscillator is tunable from about 200 to 215 GHz, the instantaneous linewidth is between 10 and 20 kHz, and the output power across the tuning band is about 50 μW. The narrow linewidth and fine tuning of the frequency are made possible by a scanning semiconfocal open cavity which acts as the high-Q resonator for the oscillator. The cavity is compact, portable, and insensitive to vibration and temperature variation. The total dc power consumption (RTD plus bias supply) is only 10 mW.

The present oscillator provides the highest power obtained to date from an RTD above 200 GHz. We attribute this partly to the use of the quasioptical resonator, but primarily to the quality of the RTD. It is fabricated from the $In_{0.53}Ga_{0.47}As$/AlAs materials system, which historically has yielded the best overall resonant-tunneling characteristics of any material system. The RTD active area is 4 μm^2, and the room-temperature peak current density and peak-to-valley current ratio are 2.5×10^5 A cm^{-2} and 9, respectively. The RTD is mounted in a WR-3 standard-height rectangular waveguide and is contacted across the waveguide by a fine wire that protrudes through a via hole in a Si_3N_4 "honeycomb" overlayer. We estimate that the theoretical maximum frequency of oscillation of this RTD is approximately 1.1 THz, and that scaled-down versions of the same quasioptical oscillator design should operate in a fundamental mode up to frequencies of at least 500 GHz.

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*E. R. Brown, C. D. Parker, K. M. Molvar, A. R. Calawa, and M. J. Manfra are with Lincoln Laboratory, Massachusetts Institute of Technology.