

【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering I)



Title of Project : Development of devices and systems toward realization of high-capacity wireless communications by terahertz waves

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Research Area : Electrical and electronic engineering, Electron device/Electronic equipment

Keyword : Electron device/Integrated circuits, Terahertz device

【Purpose and Background of the Research】

Short-distance very high-capacity wireless transmission is expected in the frequency range from 0.1 to a few terahertz (THz). For realization of such a transmission system, high performance THz oscillation devices and modulation method are required.

In this project, possibility of very high-capacity THz wireless communications are investigated through the research on (1) high-frequency and high-power operation and control of radiation directivity of the THz oscillators, (2) establishment of modulation method and devices for very high-capacity transmission, and (3) transmission measurements using these devices, based on our previous results of THz oscillators using resonant tunneling diodes (RTDs), small-size high-speed transistors, and demonstration of high-capacity optical transmission.

【Research Methods】

As the oscillator devices, RTDs integrated with slot resonators shown in Fig.1 are fabricated, and oscillation with high frequency (fundamental oscillation over 1THz) as well as high output power and electric control of radiation directivity are investigated.

For the high frequency oscillation, RTDs with high current density and low capacitance are designed. For the high output power, offset antennas for impedance matching and array configuration are used. By these structures, oscillation characteristics such as the coherence are measured. For the control of directivity, electrical beam steering of the phased array is studied theoretically and experimentally.

Direct frequency modulation of RTDs with bias voltage, phase modulation utilized the injection locking, modulation of THz waves with optical signal utilizing free carriers generated by optical absorption are investigated.

Hetero-junction bipolar transistors with high drivability for modulation of RTDs and

modulators are designed and fabricated. Suitable structures for integration of these devices are also discussed. Using transmitters with these devices and receivers with Schottky barrier diodes, wireless transmission characteristics are measured.

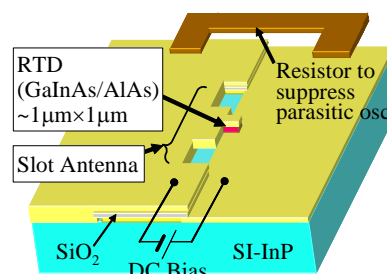


Fig.1 Resonant tunneling diode (RTD) oscillator

【Expected Research Achievements and Scientific Significance】

Development of ultra-high frequency electron devices is expected, and characteristics of the THz frequency range, such as ultra-broad band nature and efficient use by the locality, are expected to be clarified, through this project of a new field for THz communications. Based on the results from this project, many applications of very high-capacity wireless communications are expected.

【Publications Relevant to the Project】

- S. Suzuki, A. Teranishi, K. Hinata, M. Asada, H. Sugiyama, and H. Yokoyama, "Fundamental Oscillation of up to 831 GHz in GaInAs/AlAs Resonant Tunneling Diode", Appl. Phys. Express, vol.2, 054501 (2009).
- M. Asada, S. Suzuki, and N. Kishimoto, "Resonant Tunneling Diodes for Sub-Terahertz and Terahertz Oscillators", Jpn. J. Appl. Phys., vol.47, pp.4375-4384 (2008).

【Term of Project】 FY2009-2013

【Budget Allocation】 164,100 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.pe.titech.ac.jp/AsadaLab/Asada_Lab.html