【Grant-in-Aid for Specially Promoted Research】

Science and Engineering (Engineering)

Title of Project : High-performance semiconductor terahertz devices unifying quantum transition and traveling of electrons

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Research Project Number : 16H06292 Researcher Number : 30167887
Research Area : Engineering
Keyword : Electron devices, Quantum devices, Terahertz waves

【Purpose and Background of the Research】

High performance semiconductor terahertz sources, such as those with high output power, room-temperature operation and compactness, are key components for the unexplored terahertz frequency range. Up to now, we have succeeded a room-temperature oscillation of resonant tunneling diodes (RTDs) above 1 THz. This is the first-time achievement in electronic single devices. Because the terahertz range is located between radio waves and light waves, and also because its photon energy is non-negligible, it is necessary to establish a comprehensive base of terahertz device physics including electron travelling and quantum-mechanical transition in order to realize high performance terahertz sources.

Based on these background, we aim in this research at establishment of terahertz device physics and realization of high performance terahertz sources for various applications.

【Research Methods】

1. Terahertz device physics: By measuring temperature dependence of several oscillation characteristics including output power, frequency, and coherence of RTD oscillators, we intend to experimentally and theoretically figure out the transition of operation from those of electron to optical devices, and to establish the base of terahertz device physics.
2. High performance terahertz sources: We intend to realize RTD oscillators with high frequency and high output power by taking into account the optical device operation based on the results in 1 together with suitable structures for resonators and antennas. Wide frequency weep and narrow spectrum are also intended.
3. Application of high performance terahertz sources: Basic experiments toward terahertz applications, such as high-sensitivity real time imaging, high-resolution spectroscopy, and high-capacity wireless communication, will be done using high performance terahertz sources.

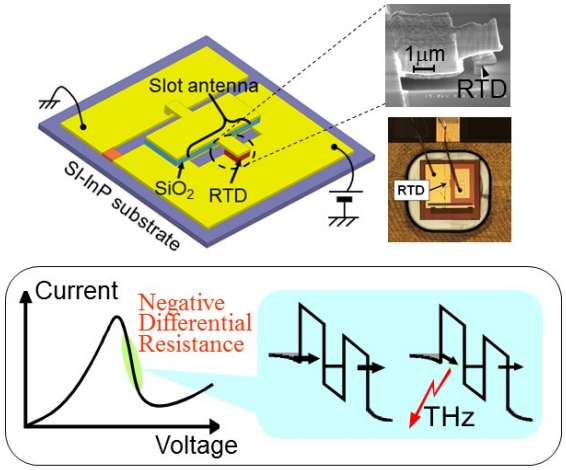

Figure 1 Terahertz oscillator using resonant tunneling diode (RTD) and negative differential resistance in the current-voltage characteristics

【Expected Research Achievements and Scientific Significance】

A comprehensive base of terahertz device physics bridging between optical and electronic devices, is expected to be established. Using this base, realization of high performance terahertz sources will become possible, which lead the research field of the terahertz waves as a break through.

【Publications Relevant to the Project】

T. Maekawa, H. Kanaya, S. Suzuki, and M. Asada, "Oscillation up to 1.92 THz in resonant tunneling diode by reduced conduction loss," Appl. Phys. Express **9**, 024101 (2016).

S. Kitagawa, S. Suzuki and M. Asada, "Wide frequency-tunable resonant tunnelling diode terahertz oscillators using varactor diodes," Electron. Lett. **52**, pp.479–481 (2016).

【Term of Project】 FY2016-2020
【Budget Allocation】 413,700 Thousand Yen

【Homepage Address and Other Contact Information】

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