Novel admittance spectroscopy for evaluating quantum transport parameters in resonant tunneling diodes

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1.Introduction

Resonant tunneling diodes (RTDs) are one of candidates for compound semiconductor THz devices. We perform a novel admittance spectroscopy for evaluating quantum transport parameters in fabricated RTDs.

2.Method

The fabricated triple-barrier RTDs (TBRTDs) basically consists of InAlAs tunnel barriers and InGaAs/InAs/InGaAs quantum wells and exhibit negative differential conductance (Fig.1). The admittance Y_exp was experimentally estimated up to 67 GHz. Also bias voltage dependance of the admittance was evaluated in including a certain voltage range of negative differential conductance. Besides that, our original definition of admittance function Y_theory for the TBRTD is theoretically derived with important quantum transport parameters such as tunneling time, phase breaking time, and relaxation time in reservoirs.

3. Results

By regarding the admittance Y_exp = Y_theory, we can evaluate values of quantum transport parameters as functions of bias voltage. Then by refereeing these values, we can calculate the admittance beyond the limitation of 67 GHz. Fig.2 shows the experimental results and theoretical calculation of the magnitude of negative differential conductance of the TBRTD, and we can predict the gain towards THz range. In fact, by employ the same epi-wafer of the TBRTD, we fabricated the antenna-integrated THz source, and we observed oscillation performance in 300 GHz range as shown in the inset of the Fig.2.

4. Conclusion

A novel admittance spectroscopy for evaluating quantum transport parameters in RTDs is established and performed to discuss the device performance of 300 GHz range of the for InP-based TBRTDs.