Title	半導体シングルヘテロ接合における集団的サブバンド間電子励起による共鳴光散乱の理論
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Theory of Resonant Light Scattering by Intersubband Electro
Excitations in Semiconductor Single Heterojunctions

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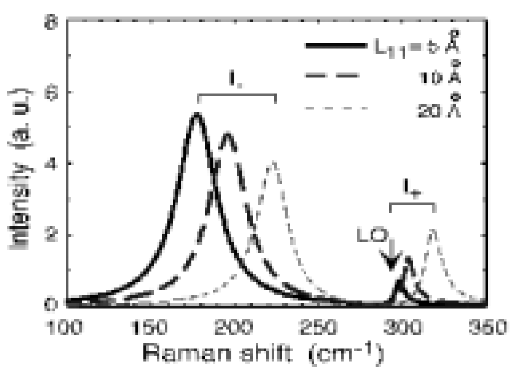
Light scattering spectra by coupled intersubband plasmon-longitudinal optica excitations (I$_+$ and I$_-$) have been studied in semiconductor heterostructures such as modulation d quantum-well (MQW) structures and single heterojunctions. In a recent work, the absence due to the upper branch of the coupled intersubband plasmon-LO phonon modes from quasi- electron gas (2DEG) in Si δ-doped Al$_{0.3}$Ga$_{0.7}$As/GaAs single heterojunction was reported [1]. The I$_+$ mode peak was also not seen in the earlier data by Pinczuk and Worlock [2] in single heteroj

In this thesis we have developed a theory of resonant light scattering by int excitations in semiconductor single heterojunctions. Our theory involves the dynamical of 2DEG taking into account electron-electron and electron-phonon interactions. We co density excitations in 2DEG coupled with LO phonons via the depolarized electric fiel time Green`s function technique, general expressions for light scattering intensity by obtained. To explore the origins of the absence of the I$_+$ peak, we have carried out numerical calculation spectral intensity based on the self-consistent subband energies and wave functions, 0→1 intersubband transition with energy splitting E$_{01}$=E$_1$-E$_0$.

We found that the Coulomb length L$_{11}$ plays the important role to determine the depolarizati from the intersubband transitions, and the dynamical electron-electron Coulomb interac ionic dielectric function is enhanced as the frequency approaches the LO phonon frequen role of L$_{11}$, we have depicted the intensities of the I$_\pm$ modes assuming L$_{11}$=5, 10, 20 Å and damping constants for electrons and phonons, Γ$_e$=2 meV and Γ$_{ph}$=1 meV in Fig.1. As L$_{11}$ decreases from 20 to 5 Å, the I$_+$ peak approaches the LO phonon frequency and the intensity diminishes strongly, while the I$_-$ peak shifts to lower frequency side and its intensity increases. Figures 2(a) and (b) show the experimental Our calculated values of E$_{01}$ and L$_{11}$ are 19.2 meV and 5.12 Å, assuming 2DEG concentration N$_s$ = 5.3x10^{11}cm^{-2} at T = 9 K. Our calculated I$_+$ peak is extremely weak compared to that of I$_-$ peak. Therefore, it can be concluded that the absence of the I$_+$ mode is due to the small L$_{11}$ in comparison with that (L$_{11}$~15 Å) of MQW [2] so that the strong anti-screening by the ionic dielectric function occu rise to the decrease of scattering intensity by the I$_+$ mode.



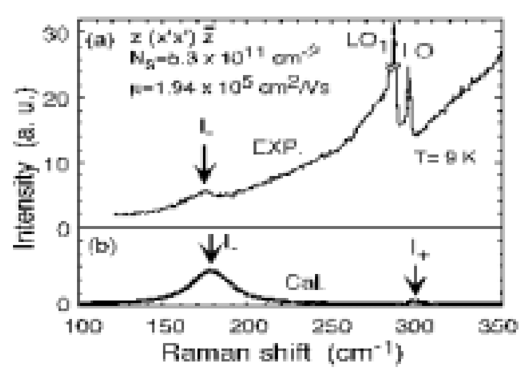


Fig.1: Calculated light scattering intensities I$_-$ and I$_+$ lines for L$_{11}$=5, 15, and 20 Å

Fig.2: Comparis ing intensity (a) with calcu

References
[1] S. Katayama, M. Koyano and S. Yamada, phys. stat. sol. (b) 215, 359 (1999).
[2] A. Pinczuk and J.M. Worlock, Surf. Sci. 113, 69 (1982).

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