SUMMARY AND CONCLUSIONS

In this thesis we have made an attempt to study two important optical properties of quasi-two-dimensional electron gas in quantum well. They are: (i) one- and two-photon interband magneto-optical absorption in an indirect band gap semiconductor quantum well and (ii) photon drag effect due to phonon scattering in quantum wells. Besides, we have studied the effect of polar optical phonon confinement on energy loss rate of a quasi-two-dimensional electron gas in quantum well in a quantizing magnetic field.

Phonon assisted magneto-optical interband absorption due to free electron-hole transitions is calculated in quantum wells of indirect band gap semiconductors neglecting excitonic effects. First, one-photon magneto-optical interband absorption coefficient assisted by phonons is calculated. We have considered electron scattering due to acoustic phonons and non-polar optical phonons. In this case optical matrix element is independent of polarization. It is found that all transitions are possible between Landau levels. One-photon absorption coefficient is evaluated for SiGe/Si QW. Absorption coefficient reflects the joint density of states in magnetic
We have also calculated two-photon magneto absorption coefficient assisted by phonon scattering for polarizations in the plane and perpendicular to the plane of the layer. For inplane polarization, absorption coefficient is calculated for left and right circular polarizations of the radiation. In this case the intraband optical matrix element, due to one of the two-photons, is polarization dependent. However, due to phonon involvement allowed transitions between Landau levels are governed by $\Delta n = 0, \pm 1, \pm 2, \ldots$, except for $n = 0$ for right circular polarization. The threshold energy of two-photon absorption for left and right circular polarizations are different. In case of non-polar optical phonon scattering the threshold for absorption coefficient is shifted to lower energy side by an amount of energy of non-polar optical phonons.

We have studied the photon drag effect, assisted by phonons, in a quantum well for polarization in the plane of the layer. Phonons are assumed to be bulk type. Expressions for photon drag current density are derived when electron scattering is due to acoustic phonons, non-polar optical phonons and polar optical phonons.
We have calculated the phonon-assisted photon drag current density, first, for a GaAs/GaAlAs QW. It is found to decrease with increasing frequency of the radiation. In the case acoustic phonon scattering photon drag current density shows a discontinuity when photon energy matches with the energy separation of the sub bands. In the case of non-polar and polar optical phonon scatterings two discontinuities, corresponding to phonon absorption and emission, are found in the photon drag current density. The current density due to polar optical phonon scattering is found to be larger than that due to acoustic and non-polar optical scattering. It is to be noted that no change in the sign of photon drag current density is observed due to intersubband transitions. However, its sign is decided by sign of charge carrier and direction of propagation of the radiation. It is found that photon drag current density increases with the temperature and carrier concentration and it decreases with increase of well width. It is also found to be greater than the corresponding value in the bulk.

Photon drag current density in SiGe/Si QWs due to acoustic deformation potential and non-polar optical phonon scattering behaves similar to that in case of GaAs/GaAlAs QWs.
However, its magnitude is two to three orders of magnitude smaller than that of GaAs/GaAlAs QW.

Another important property we have studied is the energy loss rate of a Q2D electron gas in a GaAs/AlAs QW in a quantizing magnetic field. The main purpose of this study is to see the effect of LO phonon confinement on electron energy loss rate. The models of phonon confinement considered are Haung-Zhu model, slab mode and guided mode models. Energy loss rate is studied as a function of magnetic field, at a constant temperature and carrier concentration. Resonance peaks are found at $\hbar \omega_{LO} = n \hbar \omega_c$, where $n = 1,2,3,...$, in all the cases. It is found that energy loss rate due to phonon confinement is reduced nearly by an order of magnitude compared to that due to bulk phonons. This can be due to loss in degree of freedom of phonons in z-direction and number of confined modes involved in the scattering being reduced. Energy loss rate evaluated at different electron temperatures is found to increase with increase of electron temperature. At higher temperatures electrons can emit more number of LO phonons and may lead to larger energy loss rate. Energy loss rate is found to increase with increasing well width. Larger the well width lesser the phonon confinement and hence there can be larger energy loss.
rate. It is also found that larger the width of Landau level smaller is the energy loss rate. Since LO phonon energy is very much greater than the Landau level width only inter Landau level transitions are possible and peak value of electron loss rate is inversely proportional to the Landau level width. This may cause reduction of energy loss rate.

Energy loss rate due to interface modes is calculated. Only symmetric modes contribute for intra subband scattering. Their peak positions are found to be at resonant frequencies corresponding to symmetric interface modes of well and barrier materials. These are different from confined and bulk phonons. Energy loss rate due to interface modes also increases with increase of electron temperature. In view of the reduction in energy loss rate due to confinement we feel that confined phonons have to be considered in the study of this transport property.