

Many Body and Nonparabolicity Effects in the Intersubband Transitions of Conduction and Valence Bands of Quantum Well Media

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Many-body effects are required for a microscopic description of conduction intersubband absorption of quantum wells (QW's), as demonstrated by comparing and contrasting theory and experiments. Typical inter conduction subband transitions can be described with parabolic dispersion relations and constant dipole moments. [1] In contrast, intervalence-band transitions are non parabolic, and the intervalence dipole moments are strongly k -dependent.

In this paper, we highlight the following issues: (i) The strong band coupling and resulting non parabolicity and k -dependence of the dipole moments combined with Coulomb corrections lead to double features in some of the multiple transitions, which can be measured by comparing and contrasting the evolution of the TE and TM modes with increasing excitation. (ii) The combined contributions from both types of sub bands to the inter subband transitions including many body effects and non parabolicity in all subbands are discussed by means of a strong pump pulse generating electrons in the conduction band and holes in the valence bands, and a weak probe pulse in the infrared. (iii) The conduction band states are a mix of electrons and holes. Consequently conduction band signatures are predicted in the TE mode. The overall spectral shape, number of peaks and the relative oscillator strengths of the multiple transitions calculated with and without Coulomb effects are radically different, further highlighting the relevance of our theory [2].

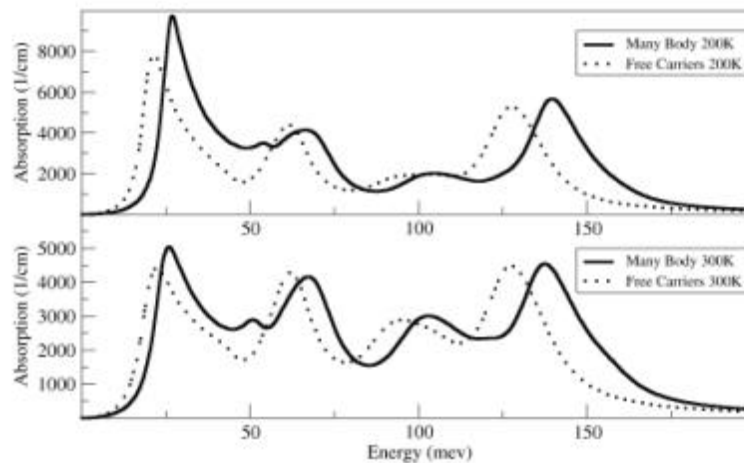


Fig.1. Valence band (dominant) contribution to the TE optical absorption of a 5 nm GaAs/AlGaAs, and $N=3 \times 10^{12} \text{ cm}^{-2}$.

The extra features that appear in the optical spectra around 50 meV for different temperatures (compare many body and free carriers curves) are a consequence of an interesting coupling of many body and bandstructure effects, as pointed out in (i) above: The k -space region where the dipole moments are appreciable is restricted, and there is consequently not enough k -space available to let the Coulomb interaction redistribute the oscillator strength to a single peak.

Similar features apply to other samples and temperatures and also for the refractive index change.

References:

[1] J. Li and C.Z. Ning, Phys. Rev. Lett. **91**, 097401 (2003).

[2] M.F. Pereira Jr., and H. Wenzel, Phys. Rev B **70**, 205331 (2004).