THz spectroscopy of GaInAs/GaAs quantum wells

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A THz response of a microcavity in which quantum well excitons are strongly coupled to cavity photons is one of intensively investigated subjects in the field of exciton polaritons. Our aim is to study an influence of THz radiation on photon-exciton coupling in the case of GaInAs/GaAs quantum wells (QWs) incorporated in a microcavity, in the presence of a two-dimensional electron gas (2DEG), at low temperatures and high magnetic fields. To this goal, a number of preliminary studies have to be carried out. One of these is related to characterization of GaInAs/GaAs QWs by transport and THz spectroscopy.

A series of samples was grown by the Molecular Beam Epitaxy. This included epitaxial layers of GaInAs with different silicon donor concentration, single and multiple QWs with different spacer thickness and barrier doping. These technological steps aimed at finding the most favorable conditions to grow high quality QWs with a 2DEG of possibly high electron mobility.

Transport measurements were carried out at 1.8 K by sweeping the magnetic field (B). This allowed to calculate both the Hall mobility and concentration and to compare the latter with the concentration obtained from the period of Shubnikov - de Haas oscillations. In all cases we obtained an agreement within a few per cent.

THz spectroscopy experiments were carried out on samples with a 2DEG concentration on the level of 10^{11} cm^{-2}. Radiation from a molecular laser was directed through an oversized steel tube to a sample cooled to 1.8 K and subjected to magnetic fields up to 12 T. A photovoltage induced by a THz radiation was registered as a function of B with a lock-in technique. Both the magnetotransport and magnetospectroscopy measurements were carried out before and after illumination of the samples with visible light from a halogen lamp. The illumination increased a 2DEG concentration and reduced the signal-to-noise ratio in THz photocurrent spectra.

The spectra are dominated by a cyclotron resonance peak which allows to determine the effective mass of electrons in the QWs equal to $0.042m_0$. In some samples, Shubnikov - de Haas oscillations induced by THz radiation were excited which allowed to measure the electron concentration during a spectroscopic experiment.

In conclusion, magnetotransport and THz spectroscopy measurements were carried out on a series of GaInAs/GaAs QWs with systematically changed technological parameters. The results allowed us to define basic characteristics of a THz response of a 2DEG in the QWs which is indispensable in further investigation of QWs coupled to a microcavity and to define technological conditions for a growth of QWs of the highest quality.

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