Terahertz Spectroscopy of Double CdTe/CdMgTe Quantum Wells

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Modulation doped heterostructures with a two-dimensional electron gas (2DEG) have been intensively studied with THz spectroscopy techniques in the presence of magnetic field. Two main reasons are motivating this research: an interest in basic studies of low-energy excitations of a 2DEG and possible applications of such heterostructures as THz optical devices. In most cases, both directions of research are related to the cyclotron resonance and magnetoplasmon excitations observed at low temperatures and high magnetic fields on as-grown samples or samples with grid-like lithographically processed surface. Up to now, most of reseach has been devoted to GaAs/AlGaAs systems and much less abundant data exists for CdTe-, GaN- or graphene-based structures. Recently, we have presented results of THz spectroscopy studies on single modulation doped CdTe/CdMgTe quantum wells [1]. In particular, we have determined dispersion of magnetoplasmons and we shown an influence of the polaron effect on cyclotron resonance spectra.

In the present studies we deal with double CdTe/CdMgTe quantum wells modulation doped with Iodine donors. The idea of the studies was to compare THz excitations in three types of samples: A - as grown, B - with a gold grid produced on the sample's surface and C - with the surface etched in such a way that a grid was formed with trenches cutting one quantum well only. A large separation of the wells (equal to about 100 nm) allows to stop etching between the wells. The period of both grids and their geometrical aspect ratio was equal to 8 μm and 50%, respectively. Magnetotransport studies showed that a 2DEG was present in both quantum wells. We measured transmission of THz radiation through the samples at 2 K and in magnetic fields up to 12 T. The radiation was generated by a molecular laser or electronic sources. A transmitted signal was registered as a function of magnetic field with a carbon bolometer.

In samples A and B we observed a cyclotron resonance signal only with an effective mass of $0.101m_0$. Surprisingly, no evidence of magnetoplasmon excitations was found in sample B with the gold grid, although they were observed on such samples with single quantum wells [1]. On the other hand, in sample C we observed only magnetoplasmon excitations with a dispersion relation similar to that observed in [1] and with a high amplitude, comparable to that fo the cyclotron resonance, not observed before.

In conclusion, we propose that samples with double quantum wells and with etched grid surface are possibly optimally adapted to observe magnetoplasmon excitations which are not there perturbed by the presence of the cyclotron resonance.

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