Cyclotron Resonance above the Quantum Limit in the Double and Multiple Quantum Wells Structures

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Introduction

The object of the study are structures containing double and multiple quantum wells (DQW and MQW) interacting with each other. The structures are based on GaAs / AlGaAs, InGaAs / InAlAs and GaAs / AlAs obtained by MBE and MOCVD. The main objective of this experiment is to carry out Cyclotron Resonance (CR) measurements for DQW and MQW structures at different (especially low – about 4.2 K) temperatures and magnetic fields higher than 90 T. This allows us to reach the quantum limits for such investigated structures at about 90T. The CR experiments give an information about the existing the screening of the energy interaction as well as it was confirmed by MPR resonance [1] and SdH oscillations in the DQW [2] and MQW [3] structures.

Experimental

Magneto-optical experiments in the IR region and pulsed megagauss magnetic field were performed at the National High Magnetic Field Laboratory, Pulsed Field Facility (11-23 August 2014). Magnetic field up to 150 *T* was generated in a single-turn coil discharging a capacity of 250 *kJ*, 17,5 nH during 6 *ms* approximately. To excite the CR of electrons in the MQW the CO_2 was applied a laser at *9.6 µm 10.1 µm 10.6 µm wave length*, while the MCT detector was used to detect radiation transmitted through the sample within the single-turn coil.

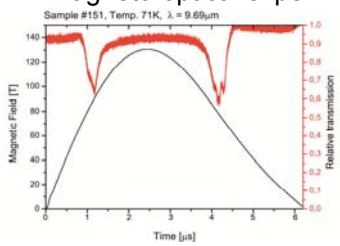

Fig.1 CR measurments for sample #151 - MQW.

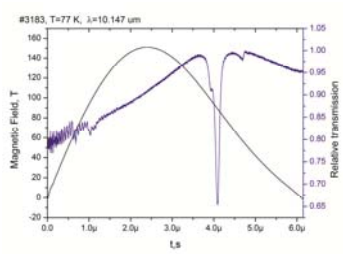

Fig.2 CR measurments for sample #3183 - DQW.

Results and Discussion

For sample #151 (MQW) we received characteristics for the three different temperatures (6 *K*, 70 *K* and 300 *K)* and a two-wavelength (*9.6 µm and 10.6 µm)*, while for sample # 3183, three wavelength were used (*9.6 µm, 10.1 µm and 10.6 µm) for* three different temperatures (6 *K*, 70 *K* and 300 *K)*. Strong resonance peak is clearly distinguished on each transmission spectrum shown: at the magnetic field of 75*T* for T=6*K and 10.6 µm* wavelength, at about 80 *T* (splitted on two ones: at 74 *T* and 82 *T*) for *9.6 µm.* For temperature 70 K we can observe splitted resonance peaks at 75 *T* for *10.6 µm and* 82 *T for 9.6 µm*. Measurements at 300 K showed resonances in a magnetic field of 80 T and 85 T, respectively at a wavelength of 10.6 *µm* and 9.6 *µm.*

For the #3183 at 7.2K the two main peaks is observed (at about 85 T and 92,5T) – there are not splitted. For higher temperatures (77K and about 300 K) the position of the peaks are similar but for higher temperatures both peaks are splitted into two (e.g fig 2) as wells as the CR peaks below 60 T which are observed only at higher temperatures.

Conclusions

Calculation of the energy spectra for investigated structures shows that the peaks at magnetic field beetwen 80 and 90 T are beetwen landau levels above quantum limits. Peaks between 55 and 65 T are caused by electron transmission between n=0 landau levels at first subband (symmetric and antisymmetric states) and n=0 of the second subband (symmetric and antisymmetric states) – this transmission is below quantum limits.

Acknowledgements

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References

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