Terahertz Induced Magnetoresistance Oscillations of a High_Density and High_Mobility Two_Dimensional Electron Gas

Z. D. Kvon [1,2], D. A. Kozlov [1,2] S. N. Danilov [3], C. Zoth [3], P. Vierling[3], S. Stachel[3], V. V. Bel'kov [3], and S.D.Ganichev [3]

[1] *Institute of Semiconductor Physics, Siberian Branch, Russian Academy of Sciences, pr. Akademika Lavrent'eva 13, Novosibirsk, 630090 Russia*

[2] *Novosibirsk State University, ul. Pirogova 2, Novosibirsk, 630090 Russia*

[3]*Terahertz Center, University of Regensburg, D 93040 Regensburg, Germany*

One of the remarkable phenomena discovered in two dimensional electron systems in the past decade is the phenomenon of microwave induced magnetoresistance oscillations which under certain conditions exhibit zero-resistance states [1]. Until recently, the great majority of works in this direction have been devoted to experiments in the microwave range (1–250 GHz), although the question of existence of these oscillations in the terahertz range is of undoubted interest. It is noteworthy that such investigations are hindered by a drastic decrease in the oscillation amplitude with an increase in the radiation frequency. Thus, investigation of the terahertz response of a 2DEG, especially at frequencies of about 1 THz, remains currently topical. In this work, we present the results of studying the terahertz response of a 2DEG to irradiation at a frequency of 0.7 and 1.63 THz. We measured the terahertz response (photoresistance and photovoltage) of the above structures at wavelengths of 432 and 184 μm in magnetic fields of up to 3 T. The experimental samples were Hall bars with a width of 50 μm and a distance between the voltage contacts of 350 μm fabricated on the basis of GaAs 13 nm quantum well with a high density (N_s = (0.8–1.0) × 10^{12} cm^{-2}) and high mobility (μ = (1.5–2) × 10^6 cm^2/Vs) two-dimensional electron gas (2DEG). The side barriers of the well were formed by an AlAs/GaAs superlattice, which made it possible to produce a high mobility 2DEG with a high electron density in the well. A molecular laser with an optical pumping by a CO_2 laser was used as a terahertz source. The terahertz radiation power was about 80 and 5 mW at the 184 and 432 μm lines, respectively. Photoresistance was measured with the use of a standard Lock-in detection at a modulation frequency of 200–270 Hz and the dc bias current across the sample I = (10–40) μA. The current source was disconnected to measure photovoltage. The main results are as follows:

1. The most interesting result is the observation of terahertz induced magnetoresistance oscillations (TIRO) of a high mobility 2DEG with the period corresponding cyclotron resonance harmonics These oscillations are observed only under of 0.7 THz radiation and its amplitude strongly growth as the temperature decreases from 10 K to 1.9 K. At 1.9 K oscillations with harmonics number up to 9 were clearly observed.

2. Study of the influence of random potential character on TIRO manifests the strong influence of its microscopic structure of this potential: screening of its long range part leads to the significant increasing of TIRO amplitude.

3. Under 1.63 THz radiation only the second and third harmonics were observed in photovoltage signal and there was no observable photoresistance oscillations.

[1]. I. A. Dmitriev, A. D. Mirlin, D. G. Polyakov, and M. A. Zudov, Rev. Mod. Phys. **84**, 1709 (2012).