Terahertz Emission from CdTe-based Multiple Quantum Wells

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Terahertz radiation is a natural candidate to be a game changer in the future electronics and communication systems. The roads towards creation of 6G and 7G systems begun to be explored and it is only the matter of time before full-scale THz systems become a reality. One of the directions leading to these advanced ways of exploring the THz part of the electromagnetic spectrum is defined by the need to construct compact detector - emitter systems that should fulfill challenging requirements of a low-energy consumption, tunability, high spectral resolution and sensitivity. Despite a tremendous progress in THz science and technology over the last two dacades, there are still many open problems to be solved. In particular, new solutions of low-energy consumption emission – detection semiconductor systems are required to fullfil market demands. While the detection part of future systems is well developed, the efficiency of semiconductor emitters is low. That is why, research that can lead to proposing new types of emitter designs is so imprtant.

We have recently shown that low-photon-energy emission, with a maximum at about 1.2 meV was obtained from electrically pumped modulation-doped single GaAs/AlGaAs heterostructure at zero magnetic field. In the present paper, we address the problem of THz emission using electrically pumped semiconductor quantum system at low temperatures and in magnetic fields. The systems under study are multiple CdTe quantum wells modulation-doped with Ioidne. The structures were grown by molecular beam epitaxy on semi-insulating GaAs substrates. Each sample contained ten quantum wells that were 20 nm wide. A series of samples was grown with different doping levels and different width of barriers separating the wells. The presence of free electrons with a total concentration of about 10^{12} cm^{-2} was verified by the cyclotron resonance and magnetotransport (classical and quantum) studies. For emission experiments, the samples were placed at the magnetic field and biased with pulses of the electric power. The emitted radiation was coupled to a Michelson interferometer with a Golay cell as a detector. We show that the emission of THz radiation appears only at a certain magnetic field strongly suggesting that the mechanism responsible for the emission is so called Landau emission, a process of a radiative recombination of electrons from upper to lower Landau levels which can be thought of as an inverse of cyclotron resonance. The magnetic field at which the emission appears is around 1 T, and the spectrum is peaked at energy close to the cyclotron resonance of electrons with the effective mass of CdTe ($0.102m_0$). The present study allows us to determine the design of the multiple CdTe-based quantum structure (doping, spacer and barrier width) to maximize the power of emitted radiation.

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