Electrical Properties of MIS Structures Based on *n*(*p*)-HgCdTe with Quantum Wells

A. V. Voitsekhovskii,[1*] S. N. Nesmelov,[1]
S. M. Dzyadukh,[1] V. S. Varavin,[2] S. A. Dvoretsky,[2]
N. N. Mikhailov,[2] M. V. Yakushev,[2] G. Y. Sidorov[2]
[1]*National Research Tomsk State University, 36 Lenin ave., Tomsk, 634050, Russia,* [2]*Rzhanov Institute of Semiconductor Physics of the Siberian Branch of the RAS, 13 Ac. Lavrentieva ave., Novosibirsk, 630090, Russia*

In recent years, admittance measurements are widely used to study electrical properties of semiconductor heterostructures with quantum dots and quantum wells [1, 2], particularly with using of MIS structures based on this material [3]. It should be noted that investigations of the properties of MIS structures based on HgCdTe with non-uniform composition distribution are still extremely rare [4, 5]. This work presents the results of experimental investigation of the impact of a single quantum well based on HgTe induced into *n*(*p*)-HgCdTe on the admittance of the MIS structures in wide range of measurement conditions.

The studied HgCdTe heterostructures were grown by molecular beam epitaxy (MBE) method on GaAs (013) substrates with ZnTe/CdTe buffer layers at Rzhanov Institute of Semiconductor Physics SB RAS. In a typical nanostructure, a HgTe single quantum well (SQWs) with the width of (5.6-6.5) nm was sandwiched between two $Hg_{1-x}Cd_xTe$ (x = 0.65-0.71) barrier layers with the thickness of (30-35) nm. Then the 40 nm thick CdTe layer was grown upon the upper barrier layer. A double-layer low-temperature insulator SiO_2/Si_3N_4 was deposited over the top CdTe layer. Measurements were carried out with the use of an automated admittance spectroscopy setup based on non-optical Janis cryostat and Agilent E4980A immittance meter.

For structures based on *p*-HgCdTe in the strong inversion mode at frequencies of (1-150) kHz, non-monotonic changes in capacitance and conductance are observed. For structures based on *n*-HgCdTe at frequencies of (50-500) kHz at low temperatures, the capacitive maxima in the strong inversion mode are also clearly visible (Fig. 1). Capacitance and conductance maxima are observed at the same bias voltages. At lower frequencies capacitance-voltage (CV) curve have a low-frequency behavior and maxima become less pronounced. At higher frequencies, CV characteristic is close to high-frequency behavior and capacitance maxima also appear less clearly. We will briefly describe the most likely mechanism for the CV characteristics maxima appearance. When the Fermi level in the SQW region approaches to the level of quantisation, quantisation level recharges following a change of the test signal. Capacitance of dimensional quantisation level in the SQW contributes to the full capacity of the structure and appears at intermediate frequencies in the strong inversion. For MIS-structures based on *p*-HgCdTe, a more complex picture of the maxima is observed [3], which is associated with effects of degeneracy and conduction band non-parabolicity.

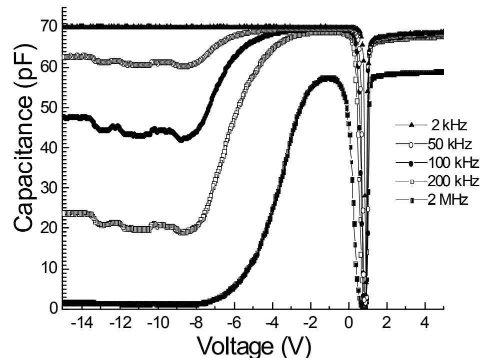

Fig. 1 Capacitance-voltage characteristics of MIS structures based on *n*-HgCdTe with HgTe SQW measured at various frequencies at temperature of 8 K.

It is shown that for MIS structures based on MBE *n*(*p*)-HgCdTe the presence of a SQW thickness of (5.6-6.5) nm can lead to the appearance of peaks on CV curve. An approximate method for determining the energy levels of quantum wells is proposed. The study was performed at financial support by RFBR and the Administration of Tomsk region as part of a research project № 16-42-700759.

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* Email: vav43@mail.tsu.ru