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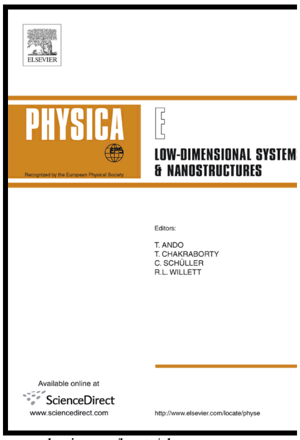

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On intersubband absorption of radiation in delta-doped QWs.

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Abstract

The results of calculation of intersubband absorption coefficients for either center-, or edge-delta-doped with Phosphorus 10 nm and 20 nm-wide $Si_{0.8}Ge_{0.2}/Si/Si_{0.8}Ge_{0.2}$ quantum wells are presented. It is shown, that the absorption for delta-doped structures differs substantially from that of a pure rectangular or uniformly doped ones. There are two main features for delta-doped quantum wells. The first one is the blue shift for optical transitions between first and others (more pronounced), and second and others (less pronounced) space quantized energy levels. The second one is that edge doping changes the symmetry of the quantum well and forbidden optical transitions for the rectangular structure become now allowed. The influences of temperature, quantum well width, and impurity concentration on the optical absorption are studied. It is shown that the most dramatic changes in comparison with rectangular quantum wells are for wider investigated edge-doped structures with bigger number of ionized impurities.

Keywords: semiconductors; optical properties; heterostructures; quantum wells.

1. Introduction

The topic of intersubband optical transitions in quantum wells (QWs) is very important in the nanostructure physics for many reasons. In particular, the combination of experimental and theoretical (calculation of the intersubband absorption) researches is a powerful tool for scientific purposes, as it allows one to clear up the main parameters of the QWs, such as their symmetry, energy structure, population of subbands with the charge carriers, etc [1-3]. On the other hand, intersubband optical transitions in rectangular quantum wells are the base for different kind of optoelectronic devices, such as photodetectors [4], modulators [5], quantum cascade lasers [6,7], and so on. One of the main parameters for such devices is the operating frequency, which is determined by the energy difference between space quantized subbands. It is known that for some purposes stabilization of the working frequency of the device is an absolute imperative, but for other tasks it is very desirable to have similar devices with a tunable operating frequency. Therefore if a new possibility of changing the frequency appears, it has to be carefully studied, and that is what this article is devoted to. The possibility of changing the separation between space quantized energy subbands is shown in our recent studies about the influence of the degree of impurity ionization on the shallow impurity binding energy for delta-doped QWs [8-10]. As to authors' knowledge, the history about hydrogen-like impurities in QWs began with the pioneering Bastard's article [11], which was published more than 30 years ago. In that work he had shown that shallow impurity