Raman Scattering in Superlattices with SiGe Quantum Dots

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In the last two decades under active theoretical and experimental studies of electronic and optical properties of quantum-dimensional crystal structures that create conditions for their practical application as promising materials of modern nano- and opto-electronics [1]. The physical processes occurring in QD and SL, have been studied both experimentally and theoretically in works [1-4].

In our work, a description of the experimental Raman spectra from SL to QD will be held at the microscopic level, which will be considered a real atomic structure of atomic QD and environment. Note that in the theoretical description of Raman spectra and absorption in these structures should be taken into account the convolution dispersion branches phonon modes. Since SL with QD implemented new frequency different from the lattice constant of raw materials, it leads to dispersion branches rolls phonons and manifestation of the spectrum in the range typical of optical phonons.

The theoretical model presented in this study allows analysis of the Raman features for all types of phonons within a microscopic approach using only general parameters of real crystals (phonons of frequency, atomic mass and steel grating). We study superlattices (SL) with layers of SiGe quantum dots (QDs) by Raman (Raman) and proposes a theoretical model that describes the experimental spectra. The model takes into account the real crystal structure of QD and the surrounding matrix, and electron-phonon interaction matrix QD. The intensities of Raman spectra were calculated using the procedure of secondary quantization and Green's function method. The results showed that the crystal structure of the superlattice consisting of Si layers and layers of SiGe quantum dots can be described as a mixed crystal with a certain distribution of "impurities" (SiGe- "atoms"). Qualitative correlation in the position and intensity of bands in the theoretically calculated and experimentally obtained Raman spectra with layers of SiGe quantum dots is observed and the nature of the doublet bands, is explained.

1. K.L. Wang, D. Cha, J. Liu, and C.Chen, Proceedings of the IEEE 95, (2007) 1866.

2. Sung-kit Yip, Yia-Chung Chang, Phys. Rev. B **30** (1984) 7037.

3. M.Cazayous, J. Groenen, A. Zwick, A. Mlayah, R. Carles, J.L. Bischoff, D. Dentel, Phys. Rev. B 66 (2002) 195320.

4. V.O. Yukhymchuk, V.M. Dzhagan, A.M. Yaremko, and M. Ya. Valakh, Eur. Phys. J. B 74, (2010) 10.