

On the Possibility of the Development of Vicinal Superlattices in Quantum Wires on Semiconductor Low - Index Surfaces

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As is well known, vicinal superlattices (VSLs) are realized in 2D electron systems on semiconductor high-index Miller surfaces. The possibility of existence of such VSLs was predicted theoretically [1]; simultaneously and independently they were realized [3]. The existence of SL effects in VSLs is due to the appearance in these systems of a new crystallographic translation period in the plane of quantum wells $A \gg a$ (a is the lattice constant). A new translation period A produces minigaps (MGs) in the energetic spectrum of the particles in these systems and, as a result, different SL effects. At the present time, all these VSLs are developed only in 2D systems. In this work we suggest a new method of development of the VSL in the quantum wires (QWRs). The special feature of this method is the combination of the main properties of the VSL - the separation in the system by some way of the long translation period A - with the possibility of developing this situation in the QWR on semiconductor low - index surfaces. It is easy to see that this situation is possible when the axis of the QWR which lies on the low - index surface will be oriented at the necessary angles to the basic translation vectors along the surface. In this case the translation symmetry of the QWR will be determined by its orientation on the crystal surface since the possibility of a free motion only along the axis of the wire selects in the initial two - dimensional translation group along the surface a one - dimensional translation subgroup along the wire with the basic period A . Thus, in the one-dimensional VSL the period A is selected by the orientation of the wire on the surface. For example, if the QWR is realized in the MOS system with the use of a narrow gate [4] then the orientation of the wire will be determined simply by the appropriate orientation of the gate. The analytic expressions of the new periods A were obtained as a function of the angles which determine orientation of the QWR for the different low-index surfaces GaAs and Si. The positions of MGs in the one-dimensional k -space were determined. It should be noted that in the region of the particle wave function localization in the QWR there are many crystallographic planes which form a SL energetic spectrum of the particle. Illustrative estimates of the magnitude of the MGs for the QWR of the rectangular cross-section made in the weak coupling approximation demonstrate their dependence on the geometric parameters of the cross-section, on the period A as well as on the crystal potential.

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