Nanoscale physics

The role of bulk and surface diffusion in the process of nucleation, evolution, and growth of the GeSi/Si nanoislands

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Accumulated experimental data of self-assembled GeSi quantum dots (QDs) composition distribution are divided into two alternative groups. The first group based on Si-core and Ge-shell. The second one based on Ge-core and Si-shell.

Two types of theoretical models of QDs formation exist. Thermodynamic models are based on the inhomogeneity of stress distribution in QDs bulk. The core is more stressed than the shell. Penetration of the atoms with the smaller radius into the core leads to decreasing of stress in the cluster. This process is followed by Si-core formation. Models with kinetic limitations take into consideration the kinetic abilities and the geometry of the transport ways of the matter.

We used the high-local and direct technique (Scanning Auger Microscopy) for QDs composition determination in the present study [1].

Objects of investigation are GeSi QDs which were obtained by Ge deposition on Si substrate under the Stranski-Krastanov growth mode by the MBE technique.

Lateral distribution of Ge on the sample surface reveals a Ge-core in the center of QDs surrounded with a Si-shell.

There is a high-stress region in the center of the cluster. Penetration of the Si into the cluster core is thermodynamically favorable. But the bulk diffusion is negligible small under the growth conditions. Therefore, kinetic abilities of the bulk diffusion are not enough for stress relaxation and Si-core formation under QDs growth conditions.

Surface and sub-surface diffusion course extremely intensely under the growth conditions. Specified processes provide the formation of Ge-core and Si-shell. Thus, Ge-core formation is caused by high kinetic abilities of surface and sub-surface transport ways of the matter, but not by high-stress relaxation factor.

1. *Ponomaryov S. S., Yukhymchuk V. O., Lytvyn P. M., Valakh M. Ya.* Direct Determination of 3D Distribution of Elemental Composition in Single Semiconductor Nanoislands by Scanning Auger Microscopy // Nanoscale Research Letters-2016-**11**-103.-P. 1-13.