Size distribution of quantum dots on the surface of artificially grown quantum crystals

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Owing to the progress of modern nanotechnologies, new artificial materials are developed that considerably expend functionality of electronic technology in physics and ad-hoc devices in chemistry and biology. In part, the use of pattern self-organization provides achieving precise positioning of QDs for construction of planar and volumetric arrays of QDs [1-2].

To obtain patterns with perfect periodicity, one uses the extreme ultraviolet interference lithography (EUV-IL) technique at wavelength λ=13,5nm [1]. For manufacturing two-dimensional arrays of dots by applying the reactive ion etching technique, gallium arsenide (GaAs) is often used as a subtrate, though silicon (Si) substrates are also in use. Artifical quantum dot crystals ordered in three dimensions grow at such substrates by applying the molecular beam epitaxy technique. X-ray diffractometry and atom-force microscopy (AFM) show high structural perfection of quantum dot crystals growing with the use of the mentioned techniques, as well as narrow size distribution of QDs.

In research [3] The size distribution function for nanodots in artificial three-dimensional quantum dot crystals (Si)Ge/Si and In(Ga)As/GaAs obtained using the patterns with perfect periodicity has been computed. Hut nanodots are modeled by cone-like clusters, for which the Thomson formula has been obtained that in necessary to find out the cluster growth (dissolution) rate under Ostwald's ripening. It follows from the comparison of the theoretical curve with experimentally obtained histograms that the size distribution function is formed under the Ostwald's ripening due to peculiarities of forming quantum dots Ge and InAs at previously patterned substrates Si and GaAs.

1. Grutzmacher D., Fromherz T., Dais Ch., Stangl Ju., Muller E., Ekinci Y., Solak H., Sigg H., Lechner R. T., Wimtersberger E., Birner S., Holy V., and Bauer G. Three-dimensional Si/Ge quantum dot crystals // *Nano Letters*. – 2007. – Vol.**7**. – P. 3150-3156.
2. Kiravittaya S., Rastelli A. and Schmidt O. G. // Rev. Prog. Phys. – 2009. – Vol.72. – P. 046502.
3. Vengrenovich R.D., Ivanskii B.V., Stasyk M.O., Panko I.I. On the size distribution in three-dimensional quantum-dot crystals // Semiconductor structures, low-dimensional systems, and quantum phenomena. – 2014. Vol. 48, №6. – P. 783-791.