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Structural Properties and Energy Spectrum of Novel GaSb/AlP Self-Assembled Quantum Dots

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Abstract: In this work, the formation, structural properties, and energy spectrum of novel self-assembled GaSb/AlP quantum dots (SAQDs) were studied by experimental methods. The growth conditions for the SAQDs' formation by molecular beam epitaxy on both matched GaP and artificial GaP/Si substrates were determined. An almost complete plastic relaxation of the elastic strain in SAQDs was reached. The strain relaxation in the SAQDs on the GaP/Si substrates does not lead to a reduction in the SAQDs luminescence efficiency, while the introduction of dislocations into SAQDs on the GaP substrates induced a strong quenching of SAQDs luminescence. Probably, this difference is caused by the introduction of Lomer 90°-dislocations without uncompensated atomic bonds in GaP/Si-based SAQDs, while threading 60°-dislocations are introduced into GaP-based SAQDs. It was shown that GaP/Si-based SAQDs have an energy spectrum of type II with an indirect bandgap and the ground electronic state belonging to the X-valley of the AlP conduction band. The hole localization energy in these SAQDs was estimated equal to 1.65–1.70 eV. This fact allows us to predict the charge storage time in the SAQDs to be as long as >>10 years, and it makes GaSb/AlP SAQDs promising objects for creating universal memory cells.

Keywords: quantum dots; GaSb/AlP; molecular beam epitaxy; structural properties; energy spectrum; QD-Flash

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1. Introduction

The systems for long-term information storage with the possibility of fast access [1,2] are important for the development of computing technologies. The so-called universal memory cells combining the fast data access peculiar to the dynamic random-access memory (DRAM) and non-volatile long-term data storage will provide a significant increase in the performance and energy efficiency of memory elements that opens up prospects for a revolution in computer architecture. One of the promising methods in this research field is