Review Report for a Ph.D. Thesis submitted to
St. Petersburg State University

Title: Nuclear spin effects in self-assembled quantum dots
Author: Maria Kuznetsova

The review report provides 1) general comments, 2) specific comments followed by 3) final evaluation statement.

I. General Comments:

The research issue of the reviewed thesis is as a part of a rapidly developing scientific area called as “spintronics”, which assumes to use electron spin manipulations as a physical basics for new generation of active elements of microelectronic devices. The thesis presents the results of the investigations of the spin-related properties of quantum dots. Due to a tight localization of electrons in quantum dot their hyperfine interaction with nuclear spins is significantly stronger than in bulk semiconductors or in quantum wells. This makes easier to observe diverse physical effects. On the other side, the interpretation of the experimental results obtained on the quantum dot structures prepared by the state-of-the-art technology is not straightforward due to dispersion of the individual parameters of quantum dots in their array. One of the main results of the thesis is the development of a new model that allows one to retrieve unambiguous data on spin dynamics of nonhomogeneous array of quantum dots.

The thesis consists of an introduction and three chapters where the original experimental results are described and discussed. The detection of polarized luminescence in transverse magnetic field was used as the experimental technique to study spin dynamics (Hanle effect). In addition to the classical variant of study this effect, the author used another kind of excitation protocol as well as succeeded to register the processes with the relaxation times of the order of microseconds. Such new experimental technique developments gave the possibility not only to spread out the investigated temporal ranges but also for the first time to realize resonant pumping of nuclear spin polarization.

II. Specific Comments:

1. In Introduction and experimental details description, the author used the term “optical axis” giving no comments about the meaning of this term for heterostructure based on optically isotropic sphalerite type of crystals.

2. Page16, result 8, introduced the term “strong excitation of QD”.
2.1 What is the quantitative measure of the excitation level that was used in this work?

3. Page 17 contains information about the samples under study as follows: “The original structure was grown by molecular-beam epitaxy on a (100) GaAs substrate. Then it was separated into several pieces which were then thermally annealed at different temperatures.”
3.1. Have been found and analyzed any differences in properties of different pieces? (Areal homogenity of initial wafer?)

4. Pages 23, 25, Fig. 7, 9 depict experimental data points as well as solid lines.
What do represent solid lines?

III. Evaluation:

New experimental and theoretical results reported in PhD thesis of Maria Kuznetsova reflect a high level of professionalism of the author in the field of solid state physics and physics of semiconductors. The results were presented and discussed at numerous international scientific conferences and published in high-level peer-reviewed journals.

If all addressed and answered appropriately to the issues and comments raised and provided above, I would say the Ph.D. thesis written and submitted by Maria Kuznetsova can be accepted and doctoral degree can be awarded to author after successful defense.

Reviewer

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