

On the possibility of single-photon conduction in a nanocell with a colloidal quantum dot

N. D. Zhukov¹, M. V. Gavrikov^{1,2}, and A. G. Rokakh²

¹ NPP Volga Limited Liability Company
101 Prospekt im. 50 let Oktyabrya, office 31, Saratov, 410033, Russia

² Saratov State University
83 Astrakhanskaya st., Saratov, 410012, Russia

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In quantum-sized particles of semiconductors CdSe, PbS, HgSe, InSb, a high, up to two orders of magnitude, photoconductivity for interband transitions of nonequilibrium carriers is observed, due to the removal or weakening of the blocking by the Coulomb limitation and the single-electron current. Under the size quantization conditions, the observed resonant current peaks are nullified or shifted towards lower energies. The energy minimum of the quanta recorded in this case is approximately 100 meV. The results obtained can be used in uncooled IR detectors, including single-photon ones.

Keywords: colloidal quantum dot, quantum size particle, size quantization, one-electron current, one-photon process, interband and intraband transitions, photoconductivity, Coulomb limitation.

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REFERENCES

1. V. Yu. Panevin, A. N. Sofronov, and L. E. Vorobyov, Physics and Technology of Semiconductors **47** (12), 1599 (2013).
2. E. Finkman, S. Maimon, V. Immer et al., Physica E **7**, 139 (2000).
3. A. Iacovo, C. Venettacci, L. Colace, L. Scopa, and S. Foglia, Scientific Reports **6**, 37913 (2016).
4. A. Gorodetsky, I. T. Leite, E. U. Rafailov et al., Appl. Phys. Lett. **119**, 111102 (2021).
5. P. Senellart, G. Solomon, and A. White, Nature Nanotechnology **12**, 1026 (2017).
6. B. Sanguinetti, E. Amri, and F. Richou, Photonics **63** (3), 56 (2017).
7. N. D. Zhukov, M. V. Gavrikov, and D. V. Kryl'skii, Technical Physics Letters **46** (9), 881 (2020).
8. N. D. Zhukov and M. V. Gavrikov, Technical Physics Letters **48** (8), 18 (2022).
9. J. Cui, Y. E. Panfil, S. Koley et al., Acc. Chem. Res. **54**, 1178 (2021).
10. N. D. Zhukov, I. T. Yagudin, N. P. Abanshin, and D. S. Mosiyash. Technical Physics Letters **46** (11), 1088 (2020).
11. M. V. Gavrikov, E. G. Glukhovskoy, N. D. Zhukov, and I. T. Yagudin. Application for invention 2021123783. <https://new.fips.ru/registers-doc-iew/fips>
12. N. D. Zhukov, T. D. Smirnova, A. A. Khazanov, O. Yu. Tsvetkova, and S. N. Shtykov, Semiconductors **55** (12), 1203 (2021).
13. N. D. Zhukov, O. Yu. Tsvetkova, M. V. Gavrikov, A. G. Rokach, T. D. Smirnova, and S. N. Shtykov, Semiconductors **56** (4), 401 (2022).
14. N. D. Zhukov, M. V. Gavrikov, and S. N. Shtykov, Semiconductors **56** (4), 269 (2022).
15. I. A. Gorbachev, S. N. Shtykov, G. Brezesinski, and E. G. Glukhovskoy, Bionanoscience **7**, 686 (2017).
16. N. D. Zhukov and M. V. Gavrikov, International Research Journal, No. 8 (110), 19 (2021).
17. <http://xumuk.ru/encyklopedia>
18. A. N. Akimov, A. E. Klimov, S. V. Morozov, S. P. Suprun, V. S. Epov, A. V. Ikonnikov, M. A. Fadeev, and V. V. Rumyantsev, Semiconductors **50** (12), 1713 (2016).
19. L. E. Vorobyov, V. Yu. Panevin, N. K. Fedosov, D. A. Firsov, V. A. Shalygin, S. Hanna, A. Seilmeier, Kh. Moumanis, F. Julien, A. E. Zhukov, and V. M. Ustinov, Solid State Physics **46** (1), 119 (2004).