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Functional Capabilities of Two-Barrier Semiconductor Structures

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Abstract

Two-barrier semiconductor structures with a high-resistance sublayer and longitudinal illumination, using certain design and technological parameters, have several unique functionalities, such as injection amplification of the photocurrent, and spectral selective sensitivity. This investigation considers the possibility of creating highly sensitive devices in the optical (CdTe, Si) and X-ray (CdTe) ranges of electromagnetic waves. The process of mutual compensation of photocurrents arising in opposite potential barriers overlapping the sublayer, with longitudinal absorption of radiation, leads to pronounced short-wavelength and long-wavelength maxima in the spectral distribution of intensity or photocurrent. Using structures based on cadmium and silicon telluride, as examples, the phenomenon of the sign reversal of the spectral photocurrent and the possibilities of measuring wavelengths are demonstrated. To study the photoelectronic processes occurring in these structures, the obtained mathematical expressions are used, which relate the parameters of the structure and optical radiation. The algorithm developed using these expressions is based on a new spectral analysis mechanism, which makes it possible to implement it as affordable, small-sized, low-material, and low-power devices. All this is considered in the context of solving urgent problems of quantitative remote identification of the components of an optically transparent medium suitable for solving environmental issues.

Keywords: photodetectors, highly sensitive devices, spectral analysis, injection amplifications, semiconductor structures

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References

1. Khudaverdyan, S., Vaseashta, A., Ayvazyan, G., Khachatryan, M., Atvars, A., Lapkis, M., Rudenko, S.: On the semiconductor spectroscopy for identification of emergent contaminants in transparent mediums. In: Vaseashta, A., Maftei, C. (eds.) Water Safety, Security and Sustainability. ASTSA, pp. 663–689. Springer, Cham (2021). https://doi.org/10.1007/978-3-030-76008-3_29
2. Khudaverdyan, S., et al.: On the selective spectral sensitivity of oppositely placed double-barrier structures. Photonics **9**, 558–568 (2022). https://doi.org/10.3390/photonics9080558
3. Fang, Y., Armin, A., Meredith, P.: Accurate characterization of next-generation thin-film photodetectors. Nat. Photon. **13**, 1–4 (2019). https://doi.org/10.1038/s41566-018-0288-z
4. Wu, Q., Cen, G., Liu, Y., Ji, Z., Mai,W.: A simple-structured silicon photodetector possessing asymmetric Schottky junction for NIR imaging. Phys. Lett. **412**, 127586 (2021). https://doi.org/10.1016/j.physleta.2021.127586
5. Ayvazyan, G., Vaseashta, A., Gasparyan, F., Khudaverdyan, S.: Effect of thermal annealing on the structural and optical properties of black silicon. J. Mater Sci: Mater. Electron. **33**, 17001–17010 (2022). https://doi.org/10.1007/s10854-022-08578-y
6. Vaseashta, A., Ayvazyan, G., Khudaverdyan, S.,Matevosyan, L.: Structural and optical properties of vacuum-evaporated mixed-halide perovskite layers on nanotextured black silicon. Phys. Stat. Sol. RRL **17**, 2200482 (2023). https://doi.org/10.1002/pssr.202200482
7. Sordo, S.D., Abbene, L., Caroli, E., Mancini, A.M., Zappettini, A., Ubertini, P.: Progress in the development of CdTe and CdZnTe semiconductor radiation detectors for astrophysical and medical applications. Sensors (Basel) **9**, 3491–3526 (2009). https://doi.org/10.3390/s90503491
8. Yang, G.,Kim,D., Kim, J.: Photosensitive cadmium telluride thin-film field-effect transistors. Opt. Express **24**, 3607–3612 (2016). https://doi.org/10.1364/OE.24.003607
9. Valmik, B.G., et al.: Investigation and fabrication of Cadmium Telluride (CdTe) single crystal as a photodetector. J. Phys. B: Cond. Matter. **614**, 4130271 (2021). https://doi.org/10.1016/j.physb.2021.413027
10. Sze, S.M.: Physics of Semiconductor Devices, 2nd edn. John Wiley & Sons, NY (1981)