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Doping effect numerical comparison of band gap energy and active region range for GaN and GaAs based semiconductor

(2021) *Journal of Physics: Conference Series*, 1892 (1), art. no. 012031, .

DOI: 10.1088/1742-6596/1892/1/012031

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Abstract
This work reports the effect of doping concentration on the energy-band structure of semiconductor materials. The research focuses on the resultant values of bandgap energy and its depletion region (length/area), based on the initial concentrations of doping which are the donors and acceptors. The energy-band diagram is simulated by initializing the various materials' properties of Gallium Nitride (GaN) and Gallium Arsenide (GaAs), and solving the Poisson's equation derived from Maxwell's equation. The equation is solved by applying the finite difference method (FDM) and using the Newton-Raphson method. Both of these materials are compared with different doping concentrations (1 1013cm-3-1 1017cm-3). Taking the GaAs properties as the controlled variable, the band structure is validated with literature findings. The measured band gap energy of GaN changes from 1.5215eV to 7.6689eV, and GaAs, from 1.1330eV to 5.6431eV. It increases with the proportion to the doping concentration increments. However, when obtaining both of the spatial active regions for GaN and GaAs, it reduce from (1.9990μm-0.0790μm)x1μm2 and from (1.9990μm-0.0890μm)x1μm2 respectively. The findings show the effect of doping concentration on the semiconductor energy-band structure. Thus, the numerical system is expected to be used as the determination of the internal quantum efficiency, and the output spectrum of light-emitting diode (LED) chip. © Published under licence by IOP Publishing Ltd.

Funding details
International Islamic University MalaysiaIIUM
Kementerian Pendidikan MalaysiaKPMFRGS/1/2018/TK07/UIAM/02/1, FRGS 19-033-0641

This work was supported by the Department of Physics, International Islamic University Malaysia, and the Ministry of Education (Malaysia) through Fundamental Research Grant Scheme (Project No.: FRGS 19-033-0641) (References No.: FRGS/1/2018/TK07/UIAM/02/1).

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Publisher: IOP Publishing Ltd

Conference name: International Laser Technology and Optics Symposium in Conjunction with Photonics Meeting 2020, ILATOSPM 2020
Conference date: 22 October 2020 through 23 October 2020
Conference code: 168935

ISSN: 17426588
Language of Original Document: English
Abbreviated Source Title: J. Phys. Conf. Ser.
2-s2.0-85106063400
Document Type: Conference Paper
Publication Stage: Final
Source: Scopus

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