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Dilute-P GaNP Semiconductor Alloy for Visible Light Emitter

CHEE-KEONG TAN, NELSON TANSU, Center for Photonics and Nanoelectronics, Department of Electrical and Computer Engineering, Lehigh University — Group III-Nitride semiconductor alloy in particular InGaN alloy is widely employed as the active media for the solid state lighting applications. In addition to the InGaN alloy, dilute-As GaNAs alloy has recently been suggested as the potential material for high efficiency solid state lighting devices. In conjunction with dilute-As GaNAs alloy, dilute-P GaNP alloy has the potential for its use in light emitting applications. The literature on dilute-P GaNP alloy is severely limited, thus the understanding of electronic properties of the material is of great importance in establishing the first step towards the device implementation. In this work we present the analysis of the electronic properties of dilute-P GaNP alloys through First-Principle Density Functional Theory (DFT). Our analysis shows that the replacement of N atoms with Phosphorus (P) atoms in the GaN alloy leads to significant changes in the band structure including the band gap and effective mass. In addition, our finding indicates minimal interband Auger recombination in the dilute-P GaNP alloys as compared to InGaN alloy, suggesting the potential of GaNP alloys as high efficiency visible light emitter. The electronic properties of the dilute-P GaNP alloys will be discussed in depth.

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