AIP Conference Proceedings

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Cite as: AIP Conference Proceedings **2369**, 020139 (2021); https://doi.org/10.1063/5.0060872

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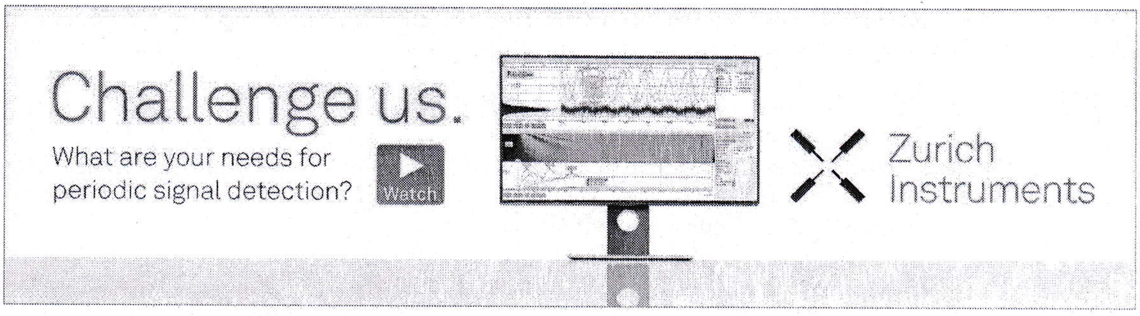

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A Theoretical Model to Study the Performance of a GaN HEMT Under Electron Velocity Saturation

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Abstract. This work represents a theoretical study of a GaN HEMT under the condition of electron velocity saturation. A simple current model is developed in order to find out the drain current of the device. The performance of the device has been studied with respect to mole fraction of AlGaN. It is observed that the choice of mole fraction of AlGaN has a significant role in controlling the drain current of the device. The device performance is also studied with doping concentration and thickness of the doped AlGaN layer. In addition, the impact of ambient thermal variation on the device performance has been studied and results are presented.

INTRODUCTION

GaN based semiconductor devices become very popular for high power and high frequency applications. This is because some inherent properties of GaN, such as wide energy band gap, high electron mobility, high saturation electron velocity, high thermal conductivity etc. [1]. Besides, the minimum lattice mismatch of GaN with its related alloys enables it to produce good heterojunction structures [2]. The field effect devices based on AlGaN/GaN heterojunction, such as high electron mobility transistors (HEMT) are very attractive in high power and high temperature application [3]. A number of works are carried out earlier on GaN HEMT to model its characteristics and study its performances [4-10]. Various issues such as development of current models, impact of thermal variation, self heating effects etc are considered earlier to study a GaN/AlGaN HEMT. In high power application, the device is subjected to high drain bias. So, it is very likely that the electric field between source and drain is very high and velocity of electrons is near to its saturation value. In such situation, velocity saturation model can be used to find out device current. In the earlier works developed so far this issue of electron velocity saturation is missed. The present work develops a current model considering electron velocity saturation under high drain field. This model is simple, attractive and best suited for high power devices. The performance of the device is also studied with the choice of mole fraction of AlGaN layer. In addition, the impact of thermal variation on device characteristics is presented.

DRAIN CURRENT

Let us consider a schematic diagram of a GaN HEMT as shown in Figure 1(a). The thickness of the N –AlGaN, undoped AlGaN and 2DEG layer are considered to be d_1, d_0 and Δd respectively. Figure 1(b) shows the corresponding energy band diagram of a GaN HEMT.

National Conference on Physics and Chemistry of Materials
AIP Conf. Proc. 2369, 020139-1–020139-5; https://doi.org/10.1063/5.0060872
Published by AIP Publishing. 978-0-7354-4121-7/$30.00