偏壓和幾何結構對矽鍺異質接面雙載子電晶體等效電路參數萃取的影響

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摘要

近年來隨著生活水準的提高,無線通訊(wireless communication)市場快速成長,無論是學術界或是工業界皆無不極力地發展無線通訊這高科技。而微波元件則是通訊系統中最重要的骨架。以矽為基底的矽鍺異質接面雙載子電晶體(SiGe HBT),除了比傳統的矽電晶體(Si BJT)有較高的效能外,也比三五族(III-V)複合材料的微波元件有較佳的低成本效益。

本篇論文之重點是在研究以矽為基底的矽鍺異質接面雙載子電晶體的小訊號等效電路模型,以及分析元件參數特性在不同偏壓條件以及幾何結構下的變

異。論文中使用的小訊號等效模型除了改善電晶體基底部分萃取的方式, 更近一步地簡化了萃取本質參數的公式。此外探討如何有效利用和準確預測電晶體因偏壓的改變產生的非理想現象以及尺寸縮小的情形下, 元件參數變化情形。最後的部份討論在不同的結構中, 對於電晶體特性的改善。利用既定的製程中, 如何利用幾何結構的分析, 使元件得到最佳化的效果。

Bias Dependence and Geometry Effect of SiGe HBTs Equivalent Circuit Elements Using Direct Parameter-Extraction Method

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Abstract

In recent years, with the improvement of living standard, the development of wireless communication has become the most important technology, not only in academic circles but also in the industries. Microwave transistors are backbone of these modern wireless communication systems. The Si-based SiGe HBTs (hetero-junction bipolar transistors) have the better transistor performance than Si-BJT and have the lower cost beneficial results than III-V compound materials.

The purpose of thesis is to investigate the characteristic of equivalent

small-signal model and analyze the bias dependence and geometry effect for parameters of SiGe HBTs. The small-signal model in this thesis not only improves substrate parameters extracted but also simplifies the formulas of intrinsic element extraction. On the other hand, we investigate how to predict these non-linear effects and the parameters variation with device scaling down. Finally, we research the characteristics improvement for different structures. We can optimize the efficacy of SiGe HBT by way of analyzing the device's construction.