DC and High Frequency Analysis of InGaAs/InP HBT

Yogesh Kumar Verma
Lovely Professional University, Jalandhar, Phagwara, Punjab, 144411

Abstract:

In this brief, the performance analysis of InGaAs/InP HBT is performed. DEVEDIT tool of Silvaco Atlas Device Simulator is utilized to construct the present structure. InP material comprises of higher energy bandgap than InGaAs, thus forming a heterojunction. This n-p-n HBT consists of InP emitter, base and collector of InGaAs materials. Accordingly, the ac current gain, gummel plot, and s parameters are calculated.

Keywords: InGaAs, InP, HBT, DEVEDIT.

1. Introduction:

The heterostructure devices have been utilized since past to enhance the performance of semiconductor devices [1]-[10]. The heterostructure devices including HBT, HEMT, heterostructure-tunnel field effect transistors (HTFETs) are extensively used presently in the semiconductor industry. The n-p-n HBT structure in the present work consists of InP emitter, base and collector of InGaAs materials. Accordingly, the ac current gain, gummel plot, and s parameters are calculated.

2. Model description:

The structure of the present device is constructed using DEVEDIT feature of TCAD (Atlas). The InGaAs/InP materials are utilized in the structure. The structure utilizes the feature of wide energy bandgap of InP and narrow energy bandgap of InGaAs. Fig. 1 represents the structure of the analysed device.

3. Methodology:

The structure of the present device is constructed using DEVEDIT feature of TCAD (Atlas). The inherent utilization of heterostructure property is performed. The different parameters including ac current gain, base current, collector current, and s-parameters are calculated.
4. Results and discussions:

Fig. 2 represents the ac current gain of the device. It is evident from Fig. 2 that AC current gain is constant at lower frequency and reduces with increase in frequency. Fig. 3 represents the gummel plot of the device. It is evident from Fig. 3 that base current and collector current increases with increase in base voltage. Fig. 4 and 5 represents the s parameters of the device. Fig. 4 represents the calculation of $S_{12}$ and $S_{21}$. Fig. 5 represents the calculation of $S_{11}$ and $S_{22}$.

![AC Current Gain](image1)

**Fig. 2:** AC current gain (Y-axis) Vs. Log frequency (X-axis, Hz)

![Gummel Plot](image2)

**Fig. 3:** Gummel Plot
5. Conclusion:

In this brief, the performance analysis of InGaAs/InP HBT is performed. InP material comprises of higher energy bandgap than InGaAs, thus forming a heterojunction. This n-p-n HBT consists of InP emitter, base and collector of InGaAs materials. Accordingly, the ac current gain, gummel plot, and s parameters are calculated. The s-parameters: $S_{11}$, $S_{12}$, $S_{21}$, and $S_{22}$ are also calculated and Smith chart is also derived.
References:


