HBT

Summary

❖ Basic of operation:

The principal difference between the BJT and HBT is in the use of different semiconductor materials for the emitter-base junction and the base-collector junction, creating a heterojunction

❖ Structure:

The fundamental benefit of the HBT structure, namely the use of wide-gap emitters, permits higher current gain since small carrier injection from the base into the emitter is much reduced. This is due to a larger energy barrier in the valence band of emitters (for NPN HBTs) when compared to homojunction transistors. As a result, it becomes unnecessary to apply a doping structure to maintain a specific current gain. The bipolar transistor function of HBTs derives from this latitude,which is one of their most significan characteristics.In HBT architectures, it is possible to achieve lower base resistance and lower base-emitter capacitance, both of which significantly enhance high-speed performance.

❖ Characteristics:

- The output current control mechanism of an HBT is similar to that of a homojunction bipolar transistor except for the use of a wide-gap emitter. Namely, electron injection current is primarily controlled by the base conduction-band potential.
- The band diagram for a typical npn HBT is shown in the figure. Because of the difference in band-gap energies between the emitter and base regions, the barrier for holes is higher than the barrier for electrons.
- A lower hole population on the valence band of the emitter layer produces a lower hole injection current.
- This results in higher emitter injection efficiency, leading to higher current gain.
- In the diagram shown in the Figure, the band-gap energy around the emitter-base
- junction varies continuously, which is called a graded emitter.

❖ Application:

- Power Amplifier, Microwave and Millimeter-Wave Amplifiers and oscillators, High-Speed Digital ICs and in many high-speed applications. Because of HBTs made with 111-V semiconductors typically with AlGaAs-GaAs material system have several benefits over Si BTs and GaAs FETs. Bipolar transistors with wide-gap emitters have lower base resistance,

reduced emitter capacitance, and higher early voltage. Due to GaAs superior electron transport characteristics, AlGaAs-GaAs HBTs have significantly higher cutoff frequencies than Si BTS. HBTs provide additional advantages over FETs, such as good threshold control, high transconductance, and low 1/f noise, because they perform like bipolar transistors. The different AlGaAs-GaAs HBT device designs incorporate a nonequilibrium electron transport that increases electron velocity above an equilibrium transport.