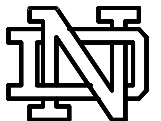




Modeling of High Current Effect in Staggered Lineup InP/GaAsSb/InP DHBT

Xiu Xing



Motivation



- **InP/InGaAs/InP: Positive CB discontinuity between base and collector**
Current blocking effect \rightarrow reduced f_T and β
- **InP/GaAsSb/InP DHBT: new alternative for InP-based DHBT**

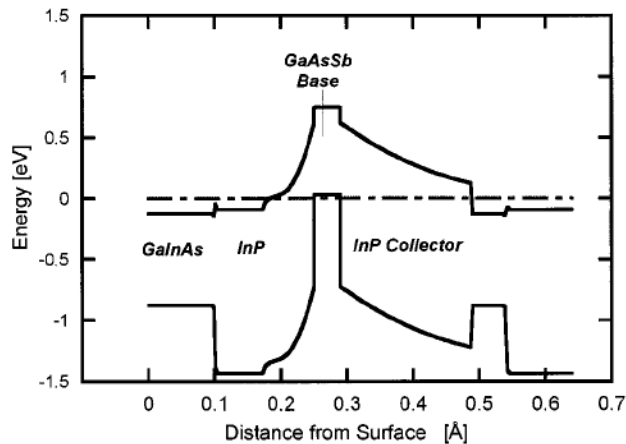


Fig. 1. Equilibrium band diagram for an InP/GaAs_{0.51}Sb_{0.49}/InP DHBT.

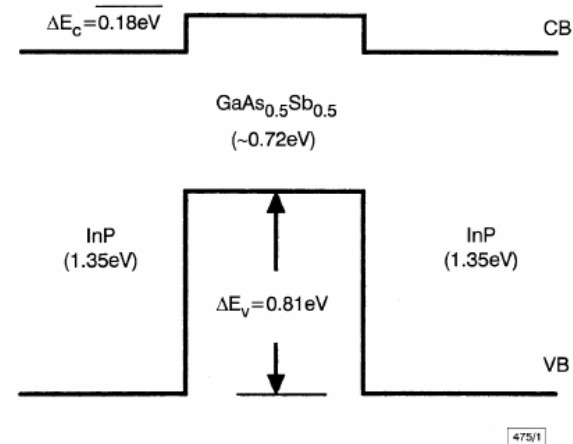
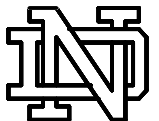


Fig. 1 Measured band lineup for InP/GaAs_{0.5}Sb_{0.5} system

- Launch electrons into collector with high initial electron velocity (effect of this not clarified);
- Current work mainly in experimental investigation.



Modeling



- **Current HBT models no longer applicable:**

-Ex. Lundstrom's HBT model:

Boltzman approximation; No recommendation currents; Low-level injection...

- **New model should take into account:**
- Fermi-Dirac statistics, arbitrary injection level, recombination currents ...
- **A reported framework (general):**

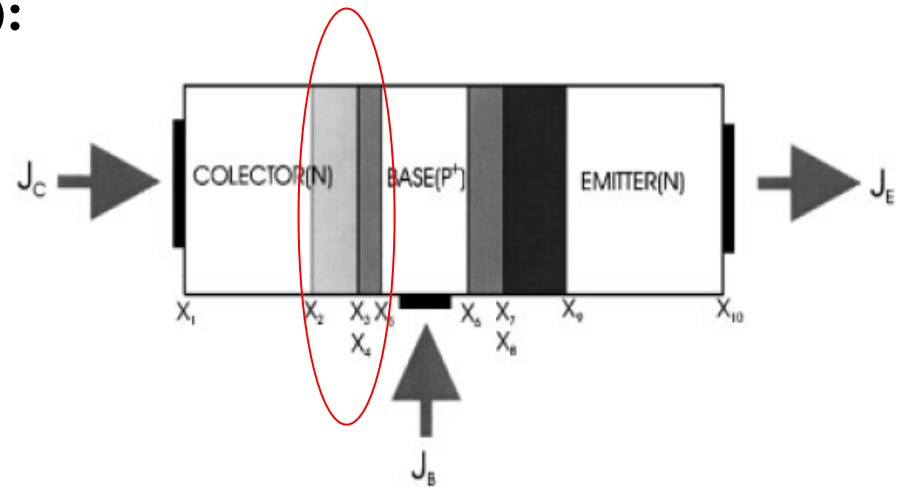
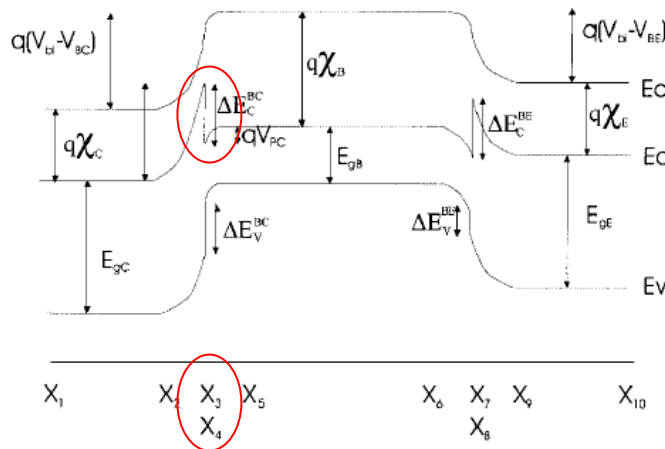


Figure 2. Structure of an abrupt DHBT using seven different regions.

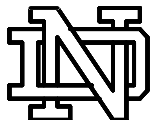
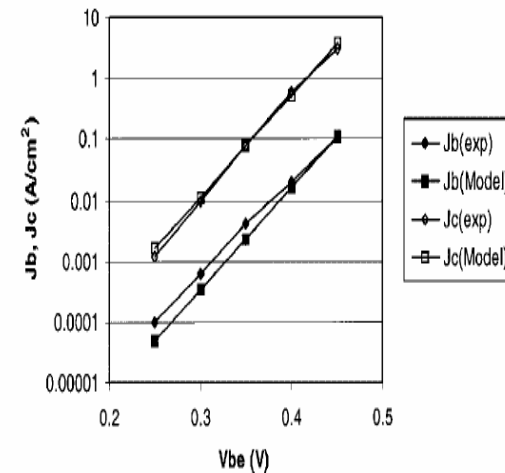


Modeling



- 8 equations from **F-D statistics for carrier (p, n) densities in SCR (4)**;
- 4 equations from **charge neutrality in bulk region (4 edges of SCR)**;
- 4 equations from **current balance: (n, p, 2 junctions)**;
- **Other complementing equations, 36 in all.**
- **Apply these in Matlab plus some simplifications...**

- **Potential improvements of this reported model:**
 - **-Too general, difficult to get close-form solutions;**
 - **-Expressions for current terms not well investigated;**
especially recombination currents
 - **-transition frequency f_T not modeled;**
 - **-Influence of Device size and geometry ?**

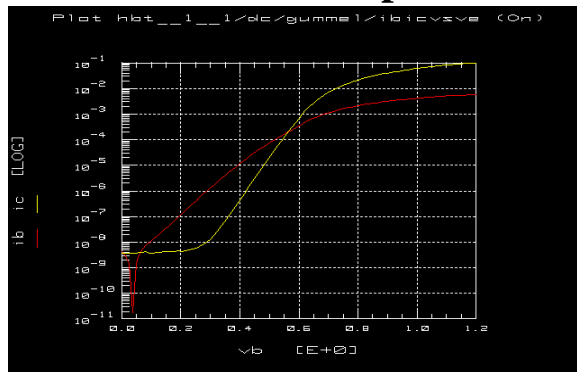


My work

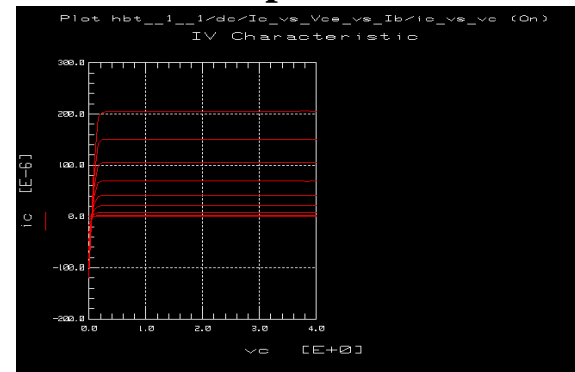


- Already got some experimental data: InP/GaAsSb/InP large area DHBT

Gummel-plot



I/V output curves



- Follow the previous principles, relate to band-diagram;
- Look into physics and find the expressions for current terms;
- Adjust boundary spatial points if necessary and corresponding equations;
- Make reasonable simplifications...
- Finally, get a bunch of applicable equations and expressions as a model to fit my experimental data well.

