

The Impact of Base Current or Voltage Biasing On Characterization and Modeling of HBTs

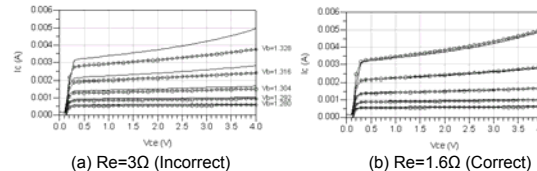
B. Lee, L. P. Dunleavy, W. Clausen, D. P. Markell
Modelithics Inc.



Introduction

- Influences of measurements with constant base voltage sources (vs. constant base current sources) are identified using modeled and measured performances of an example (1.6 x 30 um) InGaP/GaAs HBT.
- Extraction of some parameters (R_e , emitter resistance and E_g , Energy gap for forward saturation current) is more accurately done using DV-IV with constant base voltages.
- Modified (Curtice) Gummel-Poon Models are used to show the variation of model performances with extractions based on constant current source measurements alone with improvements achieved through adding constant base voltage source measurements.

- The comparison of the model performance for the IV curves with base voltages with the incorrect and correct R_e value.

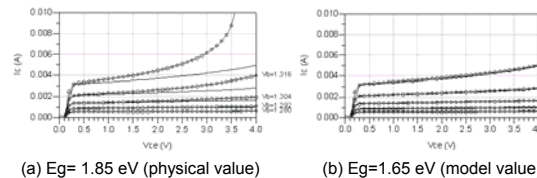


- Higher R_e value can be extracted by using "flyback" measurement due to self-heating effect.
- R_e value can be corrected by using The base voltage source IV measurement.

Motivation

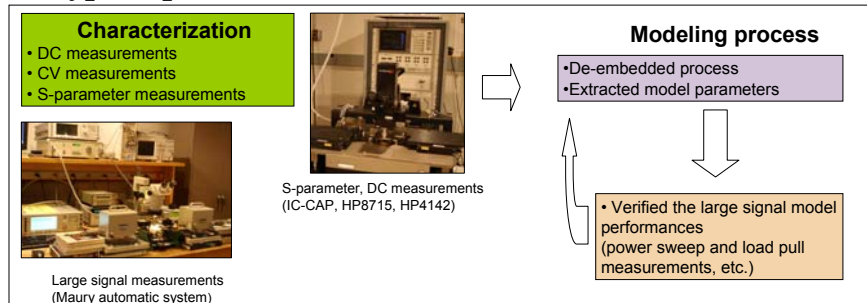
Hetero-junction Bipolar Transistors (HBTs) is actually current controlled active device. However, DC measurements with current sources on the base is not enough for a corrected modeling. Different type of source on the base to help correcting model parameters.

- The comparison of the model performance for the IV curves with base voltages with the incorrect and correct E_g value

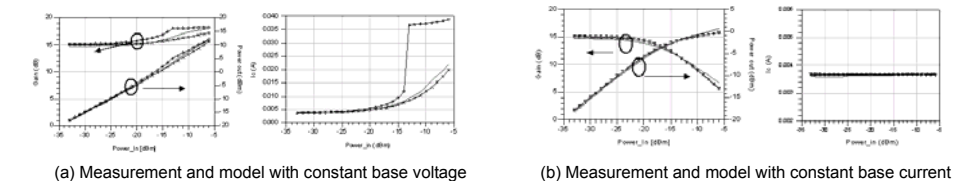


- the physical value of E_g may need to be modified for model fitting.
- the physical value of the energy gap of the base is 1.85 eV for the InGaP/GaAs HBT.

The typical process of Transistor characterization and modeling

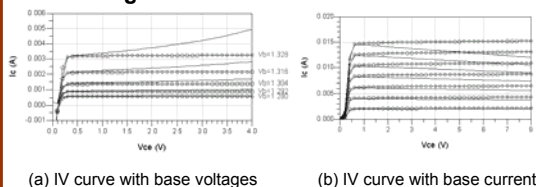


- Verification of model performance using a 50Ω power sweep measurement with the incorrect and correct E_g value



Discussion Results and Issues

- the comparison of modeled (-o- line) and measured (solid line) without considering self-heating effects



- Self-heating effects differently on the IV behavior with different sources on the base.
- R_{th} can be directly extracted by using several methods.

Conclusion and Future work

- Correct electro-thermal modeling of HBTs is a critical issue.
- One of the most important parameters is the thermal related energy gap of the base, E_g .
- Simple IV measurements with base voltage sources can be used to correct the parameter values of R_e and E_g .
- More reliable extraction method of thermal related parameters for HBTs will result from using base voltage source IV measurements instead of relying solely on IV measurements with base current sources.