innovations
for high
performance
microelectronics

Modeling a parasitic vertical bipolar transistor

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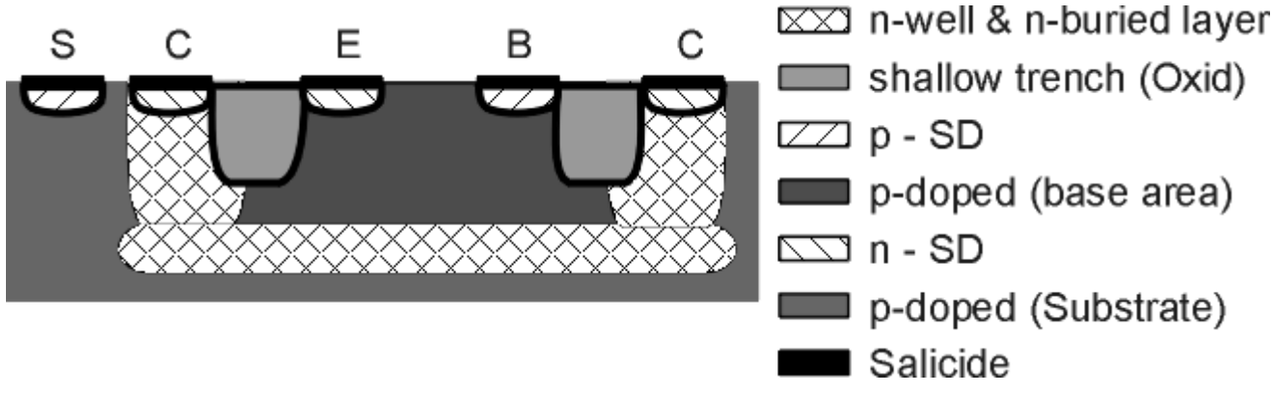
Overview

- **Technology**
- **Structure**
- **Measurement**
- **Plots**

Technology

- **SiGe:C – BiCMOS** (SGB25VD – des IHP)
  - **SiGe : Silicium Germanium** (not used)
  - **C : Carbon** (not used)
  - **Bi : Bipolar** (not used)
  - **CMOS : Complementary Metal Oxide Semiconductor**

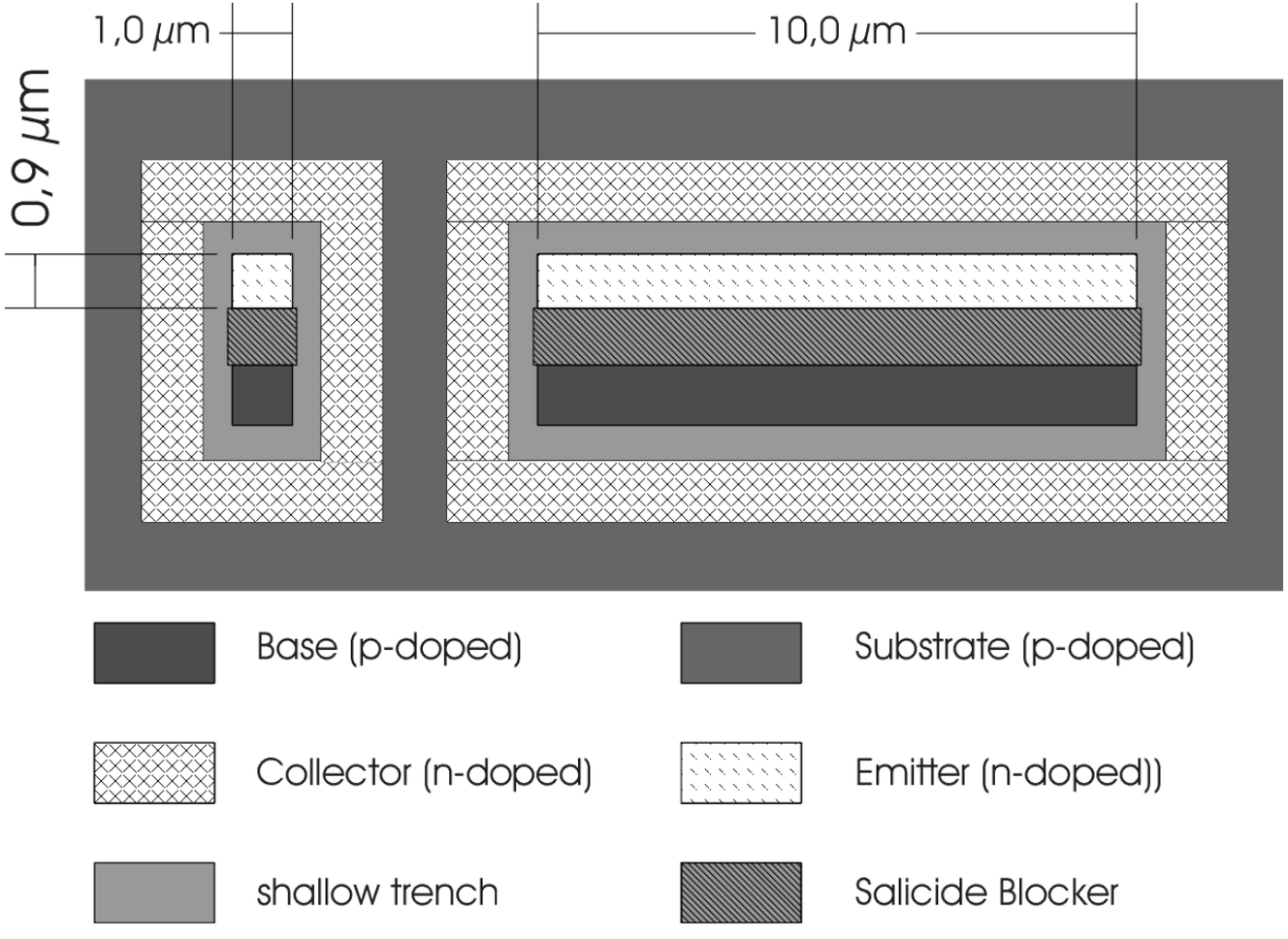
Transistor (side view)



- **Parasitic bipolar transistor of an isolated NMOS – transistor**
- **Bipolarmodul is not necessary → cheap** (CMOS + LDMOS)
- **Can be used in bandgap circuits**

Transistor (top view)

1 µm and 10µm emitterlength

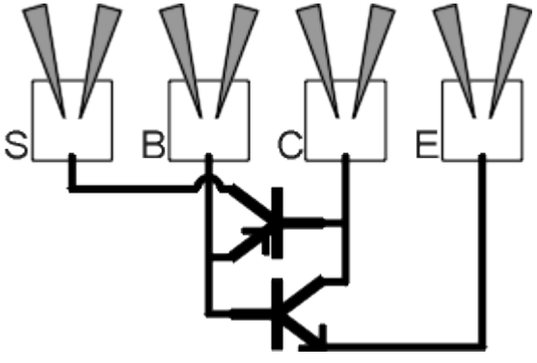


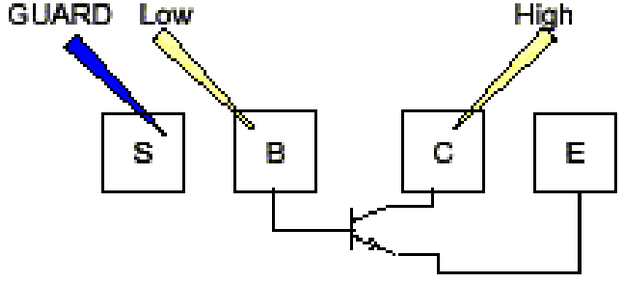
measurement

- **IC-CAP was used**
- **DC- Characteristics**
  (- 40, -10, 27, 70, 125) °C
  (1, 3, 10, 50) µm Emitterlength
- **CV- Characteristics**
  (- 40, 27, 125) °C
  (1, 3, 10, 50) µm Emitterlength

measurement

- **DC- behaviour**
  - **Source Measurement Unit** (SMU HP 4142)
  - **Triaxialwire**
  - **Kelvin-Probes**
- **Capacitance**
  - **LCR-Meter** (HP 4284 A)
  - **'Auto Balanced Bridge'** (additional guard)





Temperaturedependent parameter (GP – Model)

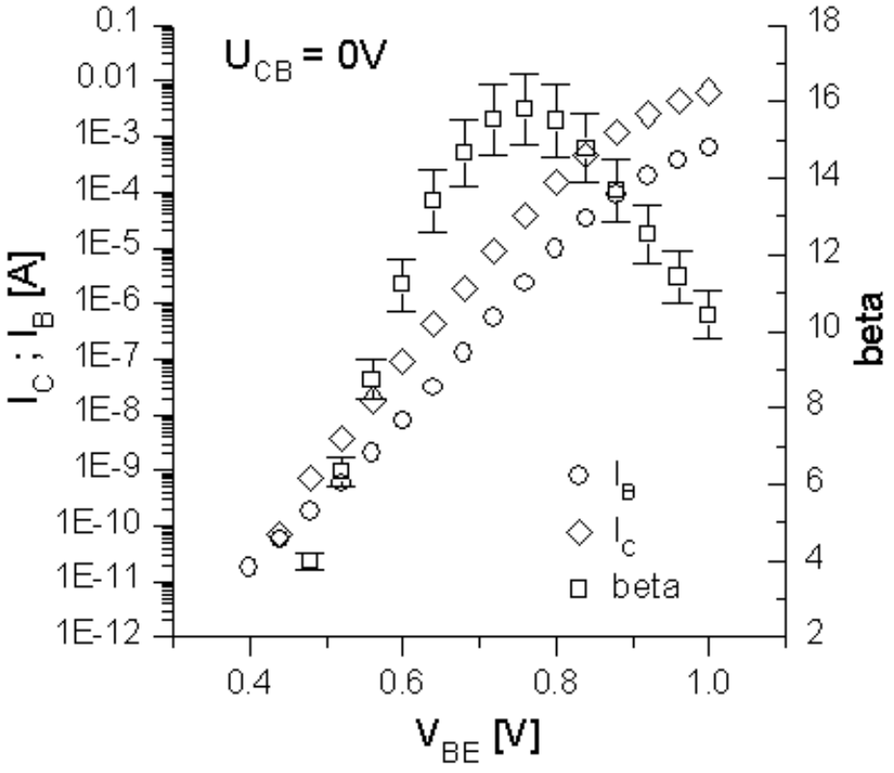
• **Activation energy**	*EG*
• **Built – in potentials**	*VJE, VJC, VJS*
• **Zero bias capacitances**	*CJE, CJC, CJS*
• **Saturation current**	*IS, ISE, ISC*
• **Current gain**	*BF, BR*

Temperaturedependent parameter (VBIC – Model)

- **Built – in potentials** *PE, PC, PS*
- **Zero bias capacitances** *CJE, CJC, CJCP, CJEP*
- **Saturation currents** *IS, IBEI, IBEN, IBCI, IBCN, etc.*
- **Emission coefficients** *NF, NR*
- **resistors** *RE, RB, RC, RS, RBP*
- **Avalanche parameter** *AVC2*
- **Self – heating**

Forward Gummel

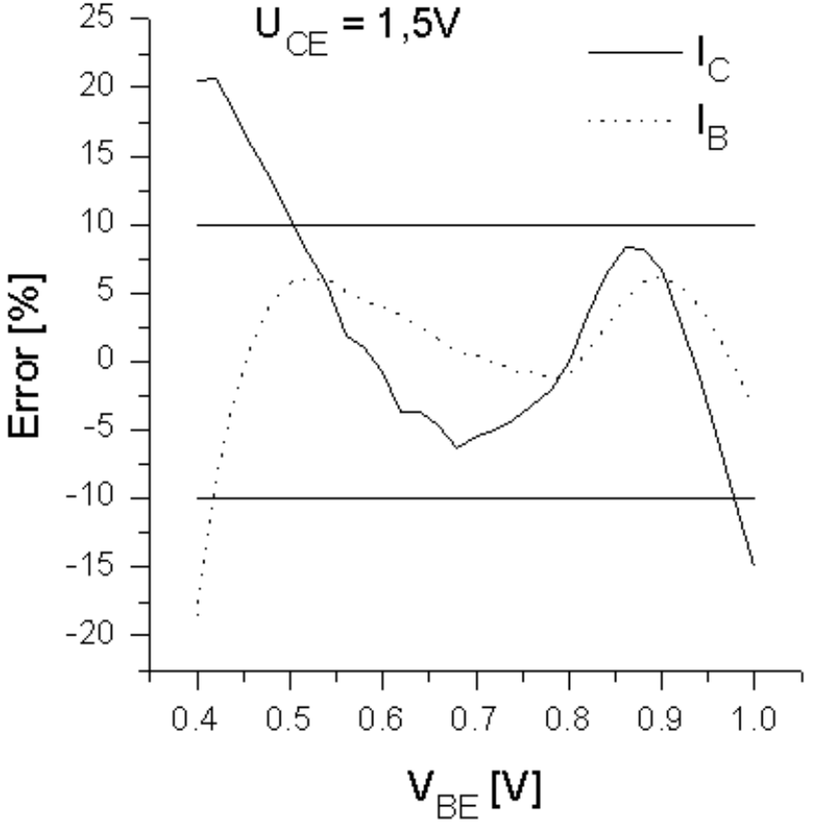
Temperature: 27 °C ; emitterlength: 10 µm



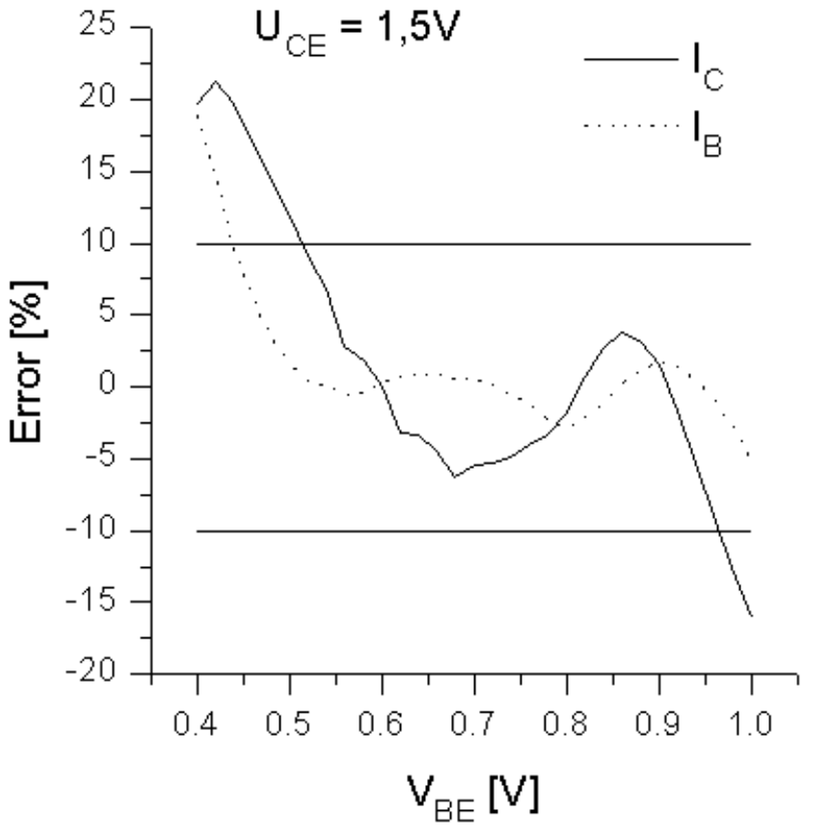
Simulation error

Temperature: 27 °C ; emitterlength: 10 µm
Error = 100 % · (Simulation – Measurement) / Measurement

GP – model

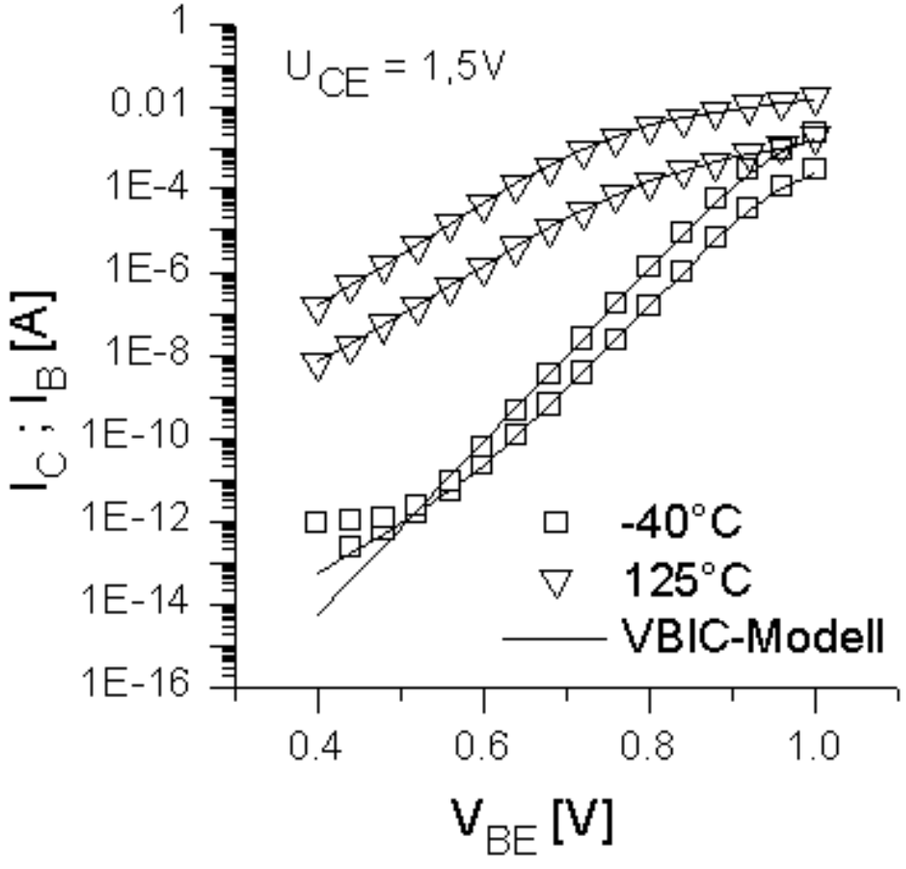


VBIC – model



Forward Gummel (Temperature)

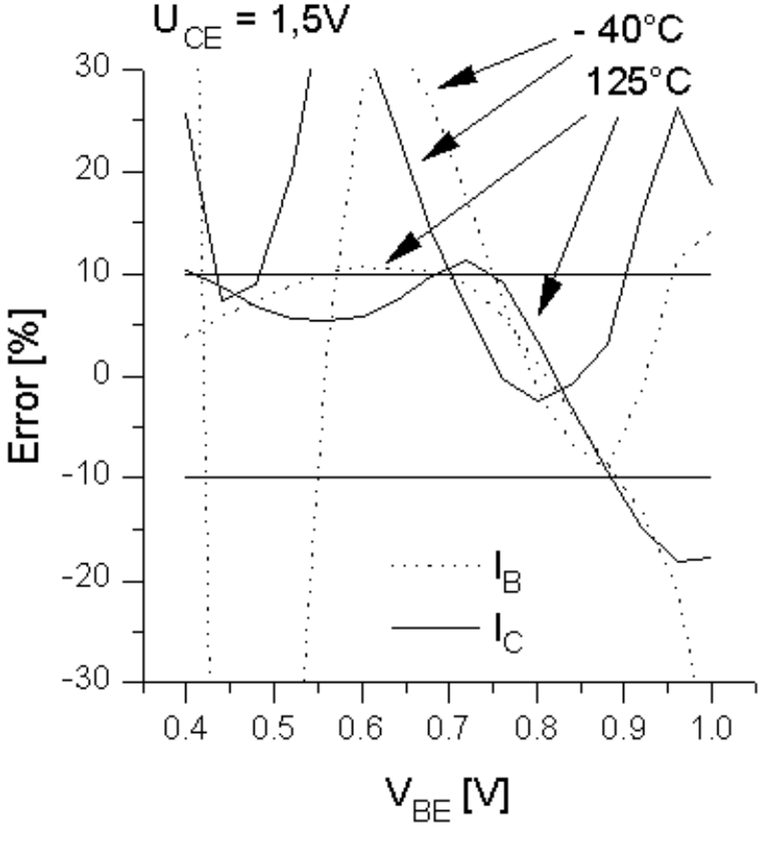
Temperature: - 40 °C, 125 °C ; emitterlength: 10 µm



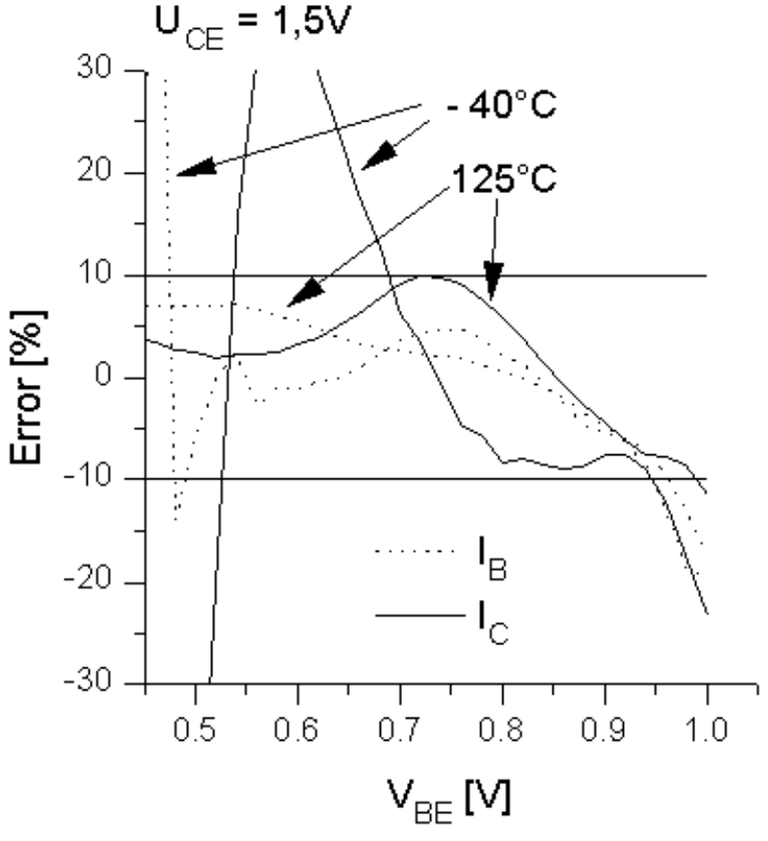
Forward Gummel

Temperature: - 40 °C, 125°C ; emitterlength: 10 µm
Error = 100 % · (Simulation – Measurement) / Measurement

GP – model



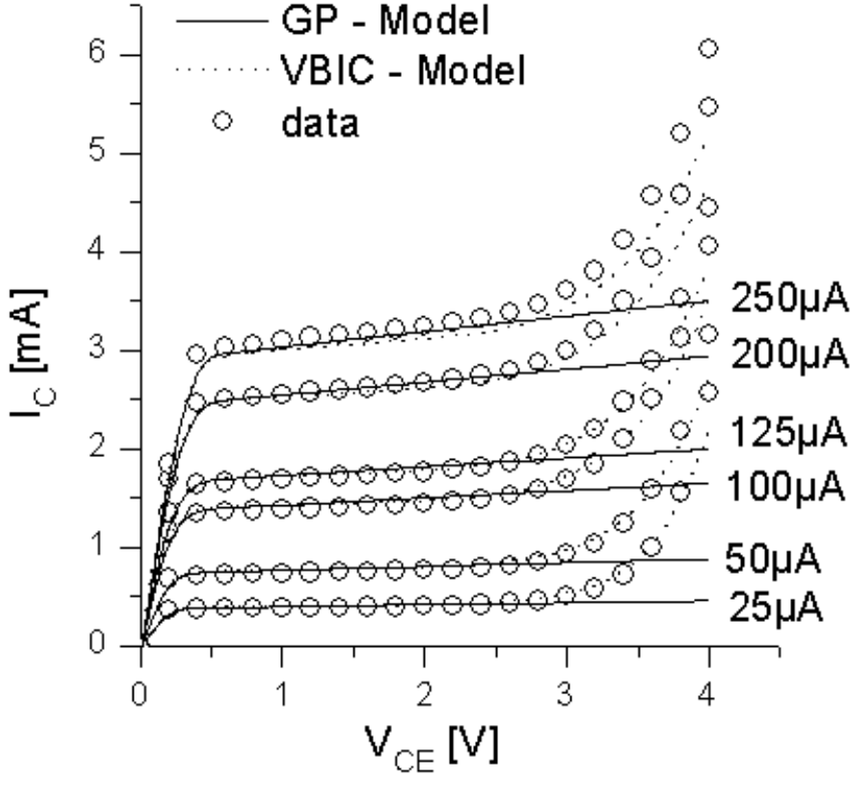
VBIC – model



Forward Output

Temperature: 27 °C ; emitterlength: 10 µm

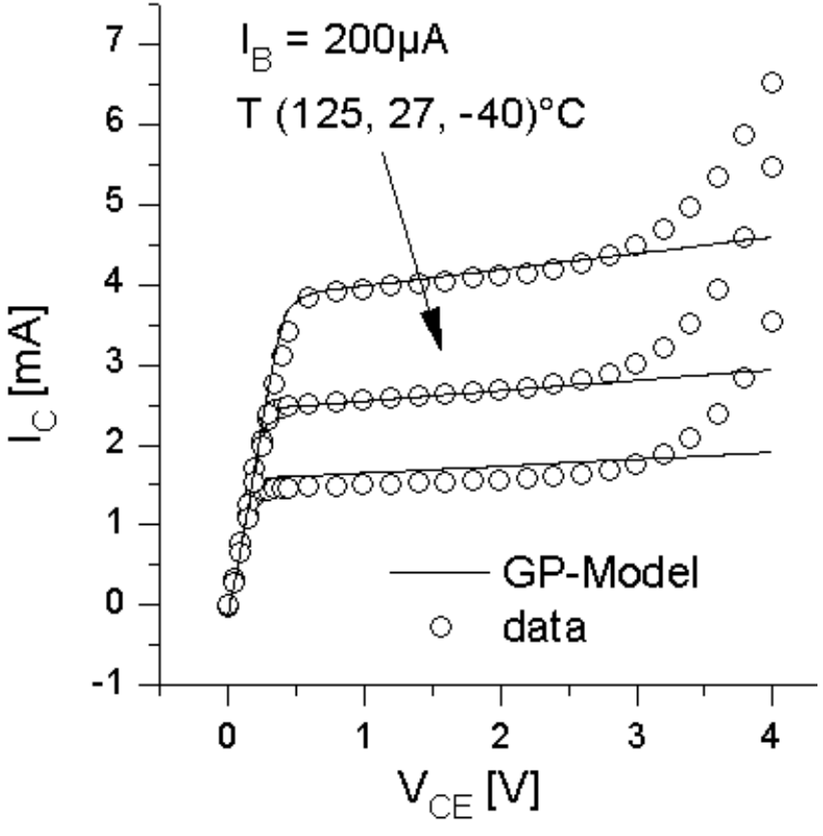
I_B : (25, 50, 100, 125, 200, 250) µA

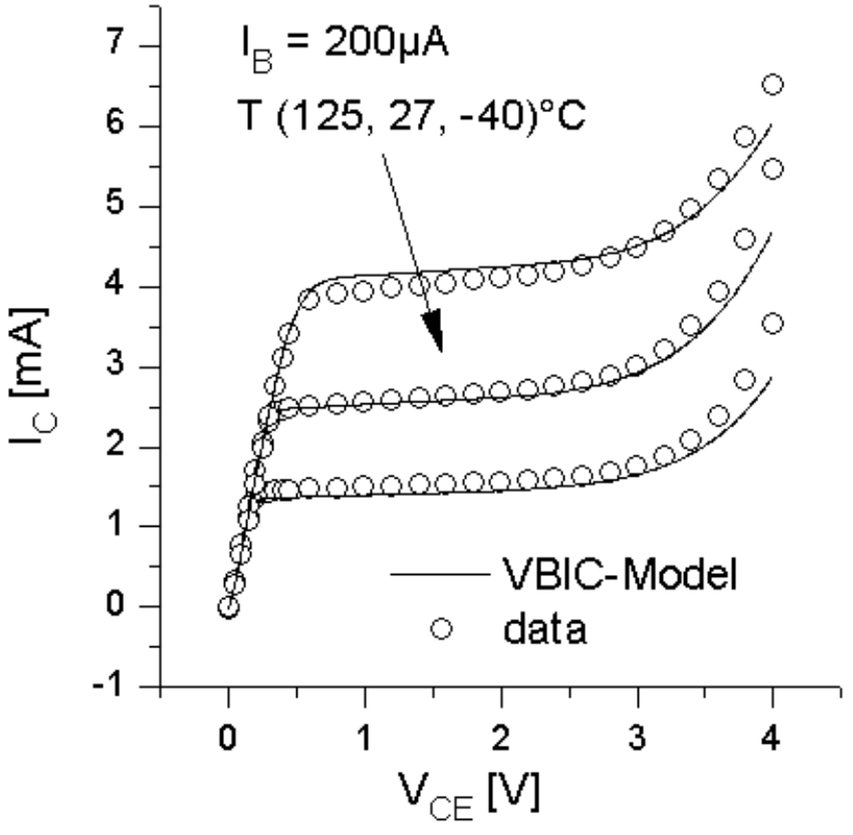


Forward Output

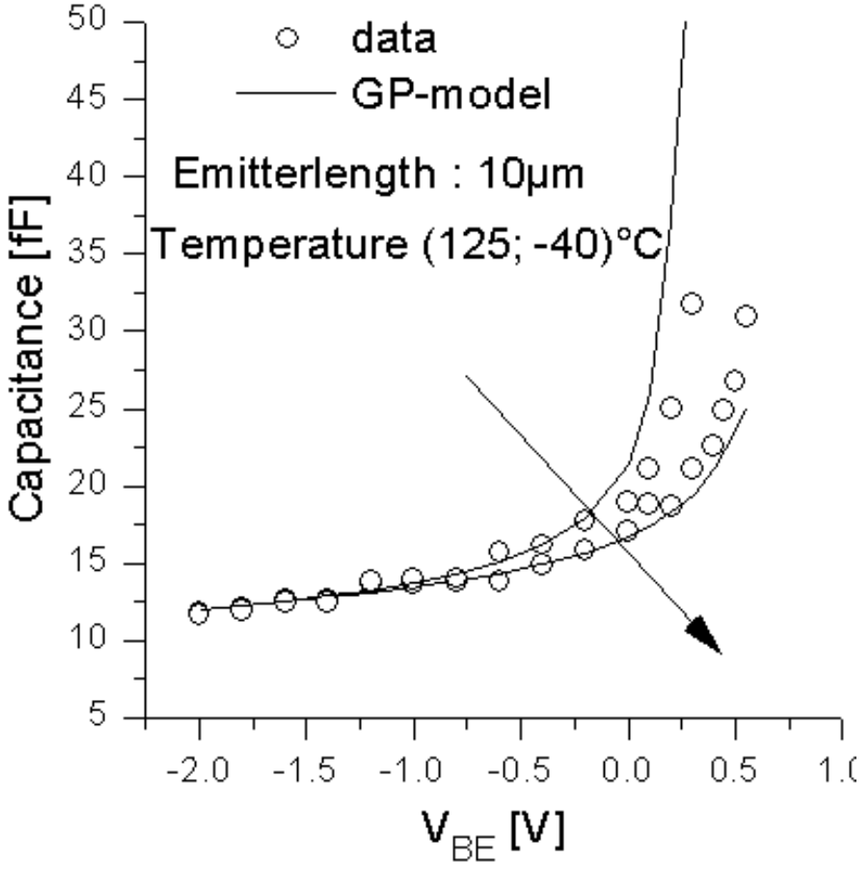
Temperature: (- 40, 27, 125) °C ; emitterlength: 10 µm

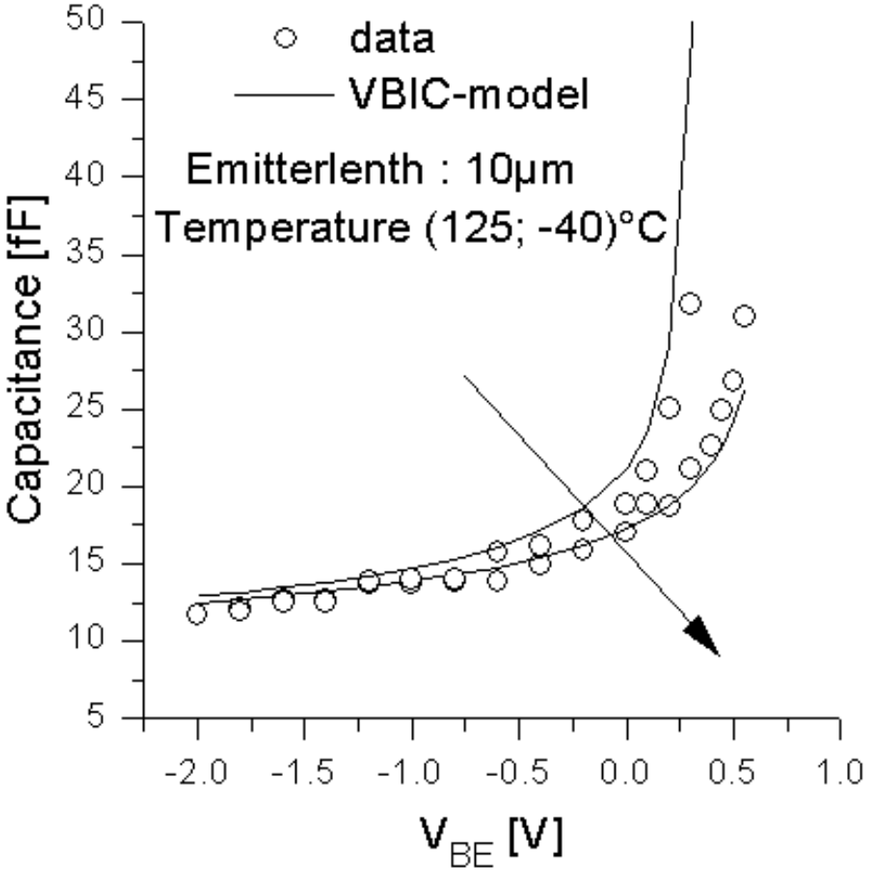
I_B : 200 µA



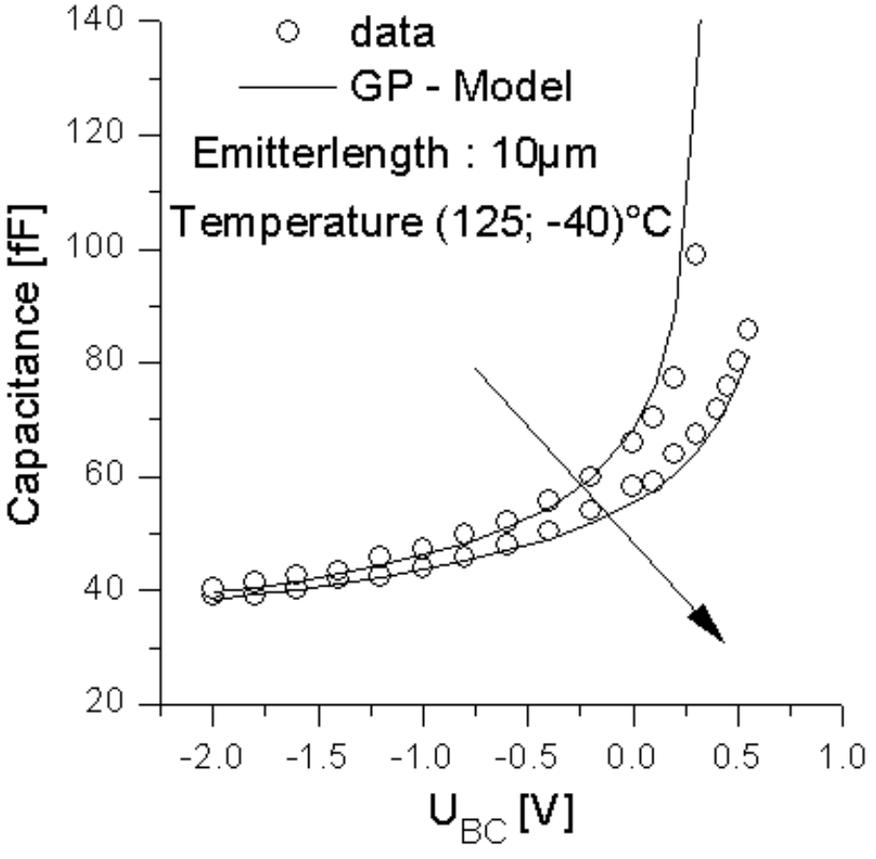


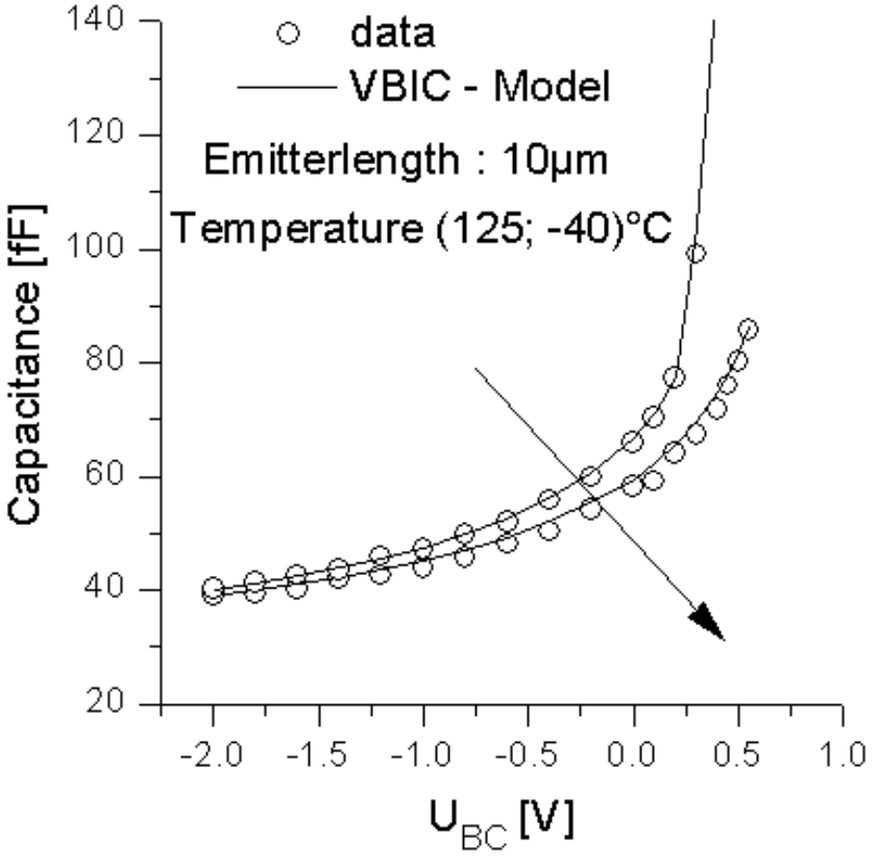
Base – Emitter – Capacitance





Base – Collector – Capacitance





Thank you for your attention