# Si-Ge Heterojunction Bipolar Transistors

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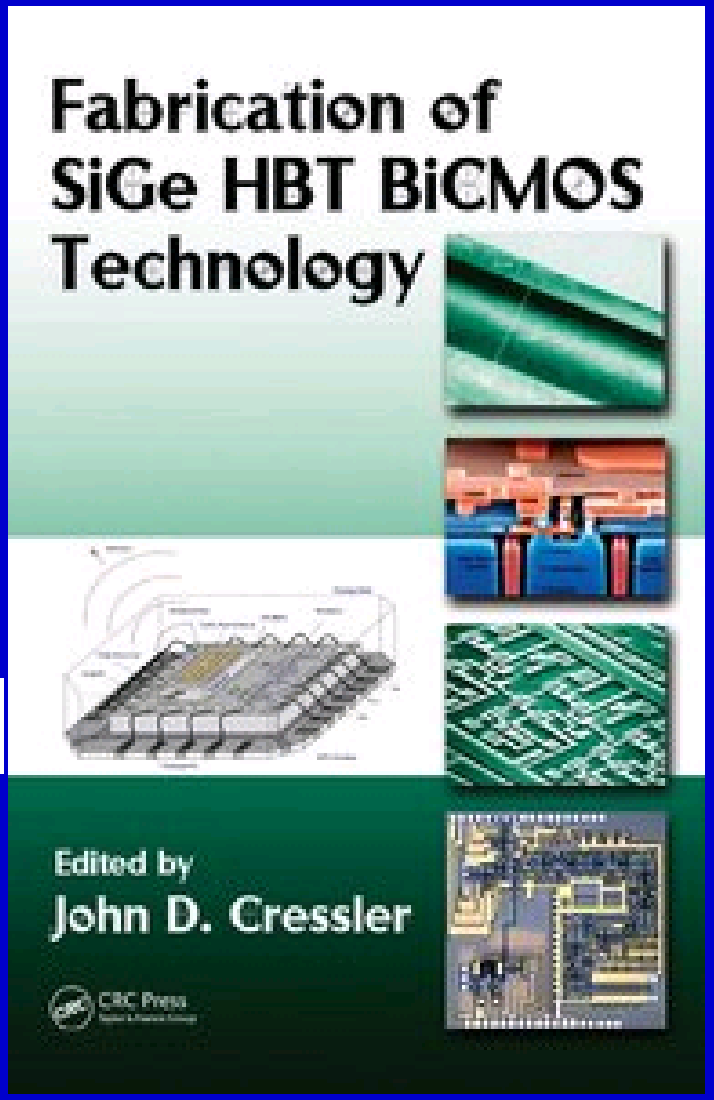
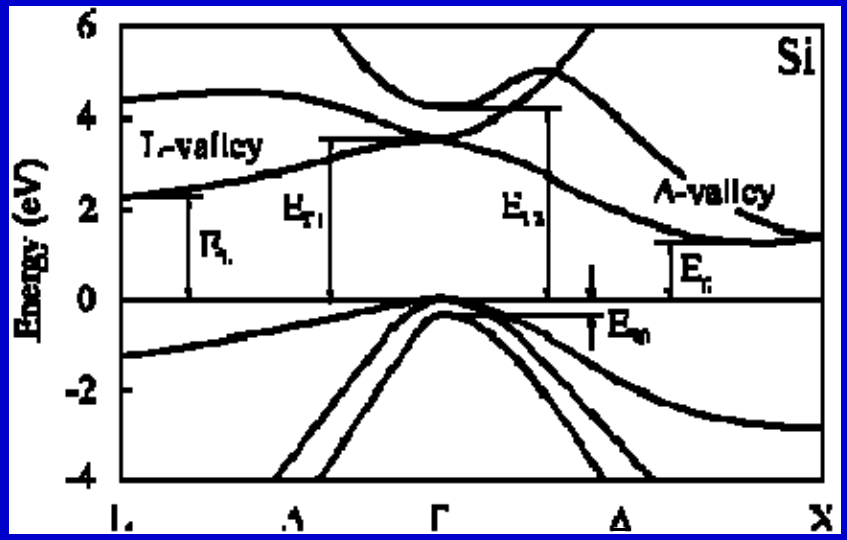
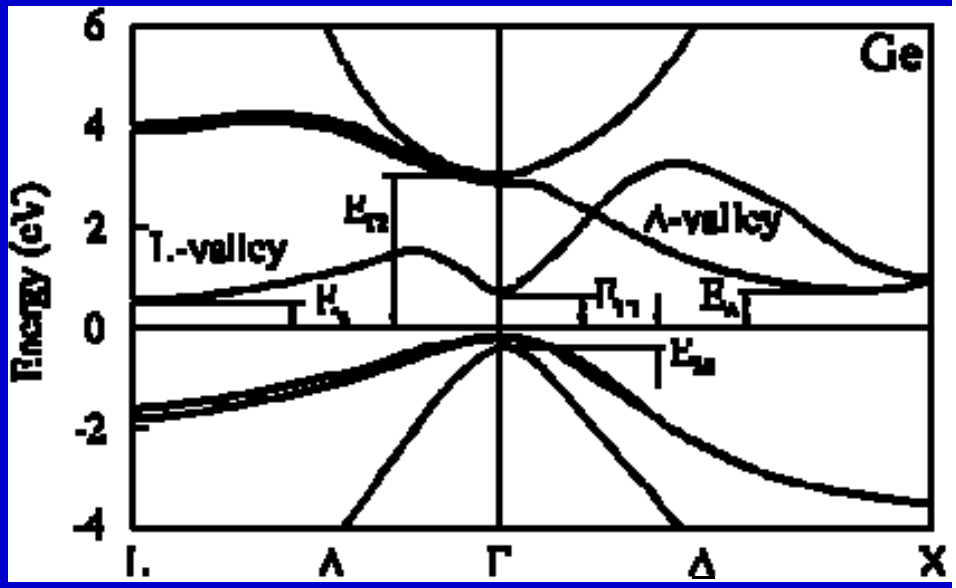
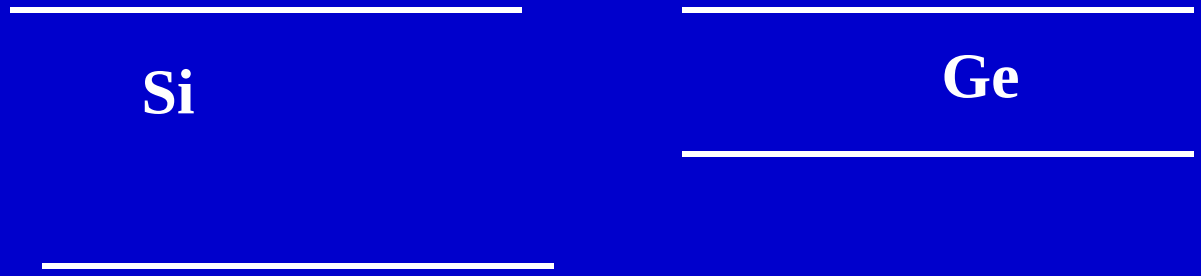


# Si and Ge Band Structures



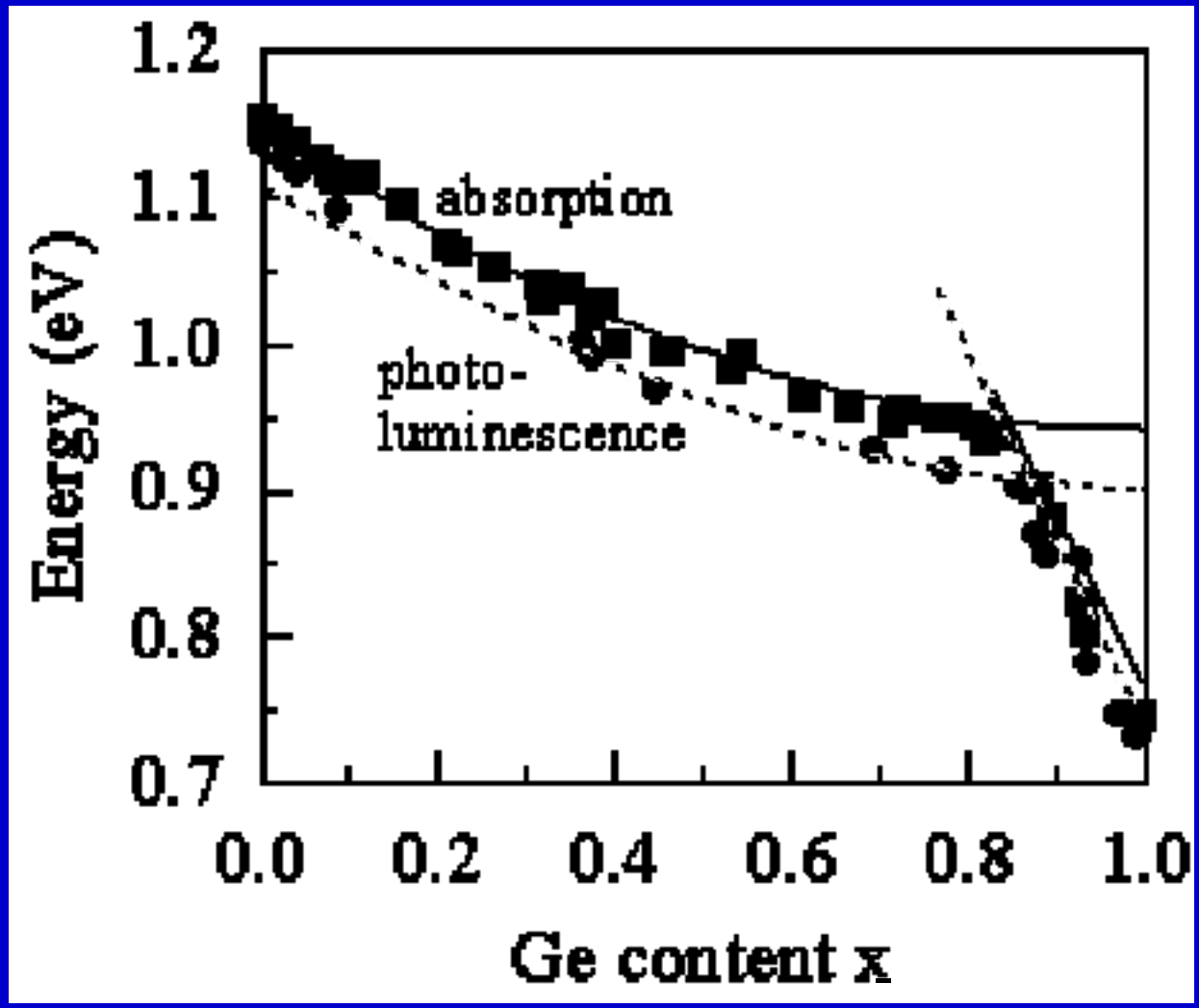



# Si-Ge band alignment




| | Eg (eV) |
|---|---|
| Si | 1.12 |
| Ge | 0.66 |

# Energy Gap versus Ge content



# Si-Ge Technology in a Nutshell

Started in 1987 (IBM)

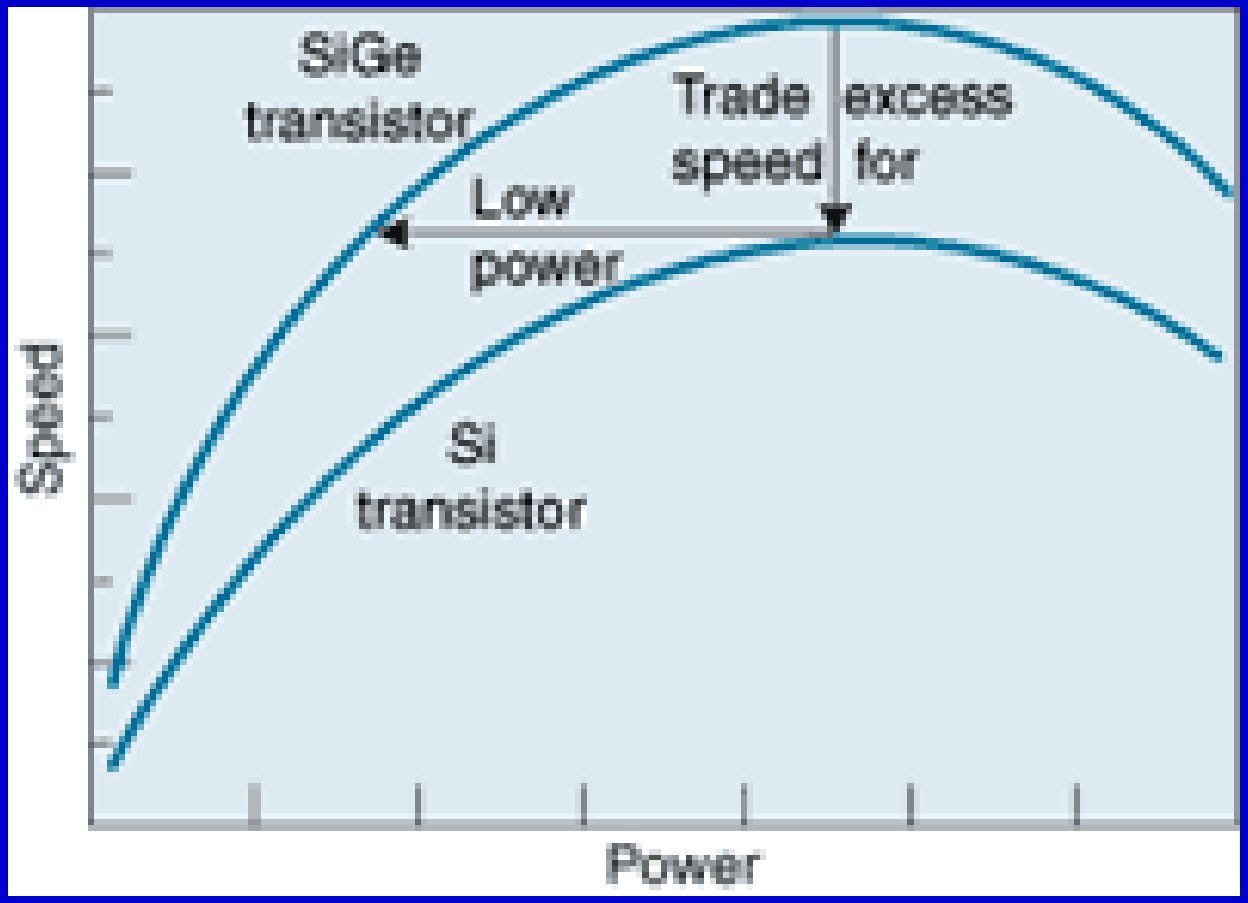
Companies involved in the beginning

- IBM (US)
- Analog Devices (US)
- NEC (Japan)
- Daimler Benz (Germany)
- Nortel (Canada)

Devices researched

- HBT
- HCMOS (CMOS)
- Si-Ge optoelectronic devices

# SiGe Advantage

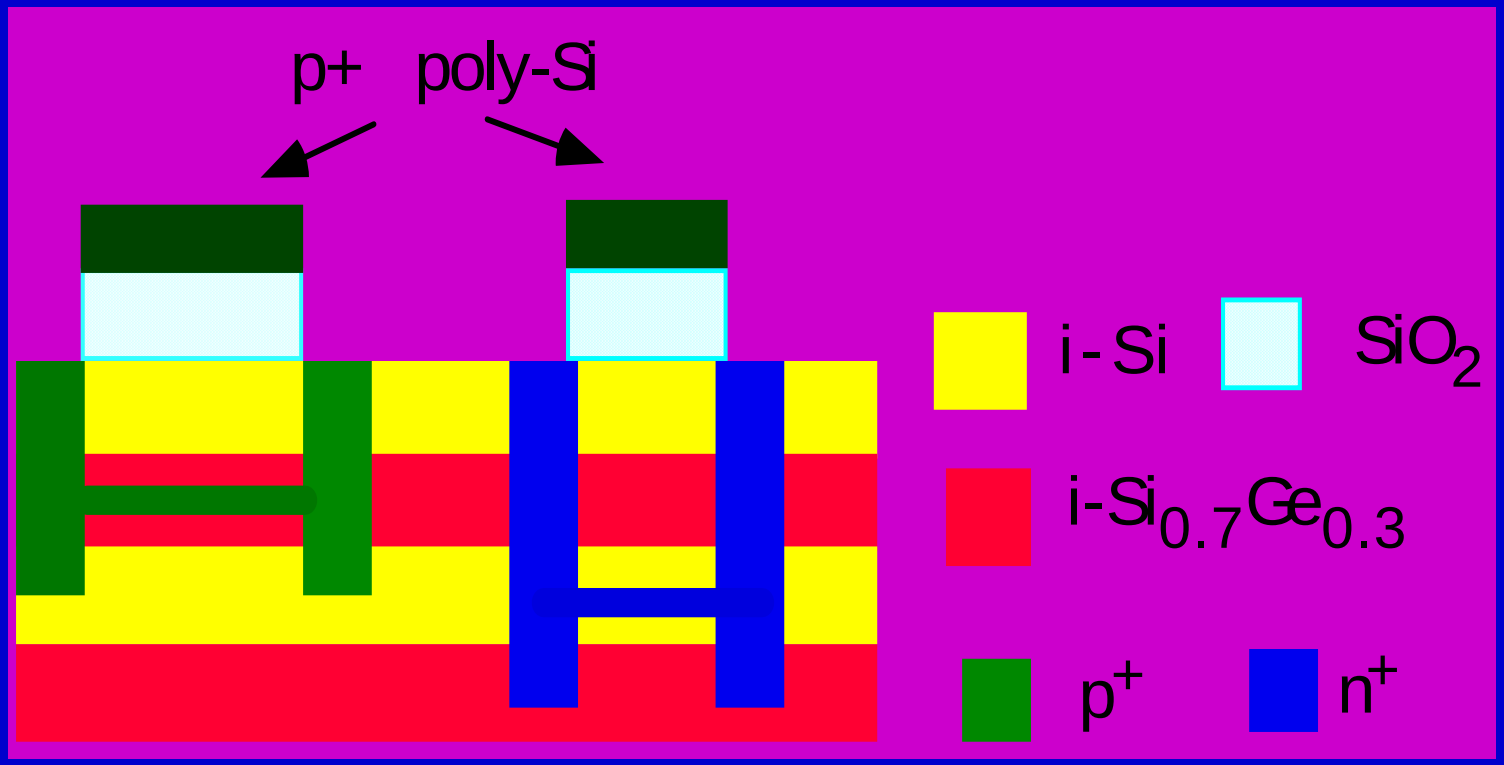



From http://www-3.ibm.com/chips/micronews/vol6_no1/ahlgren.html

# Technical Challenge

- Si substrate is NOT semi-insulating - problem for microwave circuit applications
- IBM Proposed Solution
  - Build passive elements on top of a thick polyimide layer

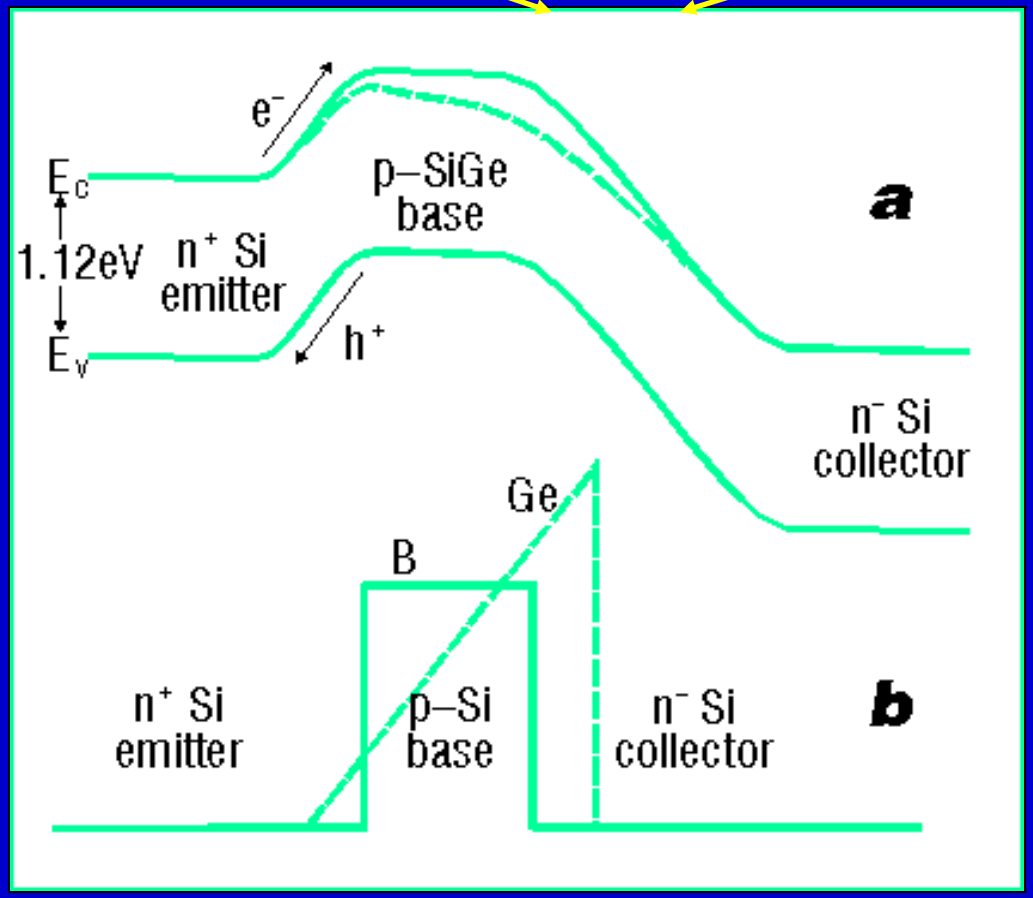
# Si-Ge CMOS



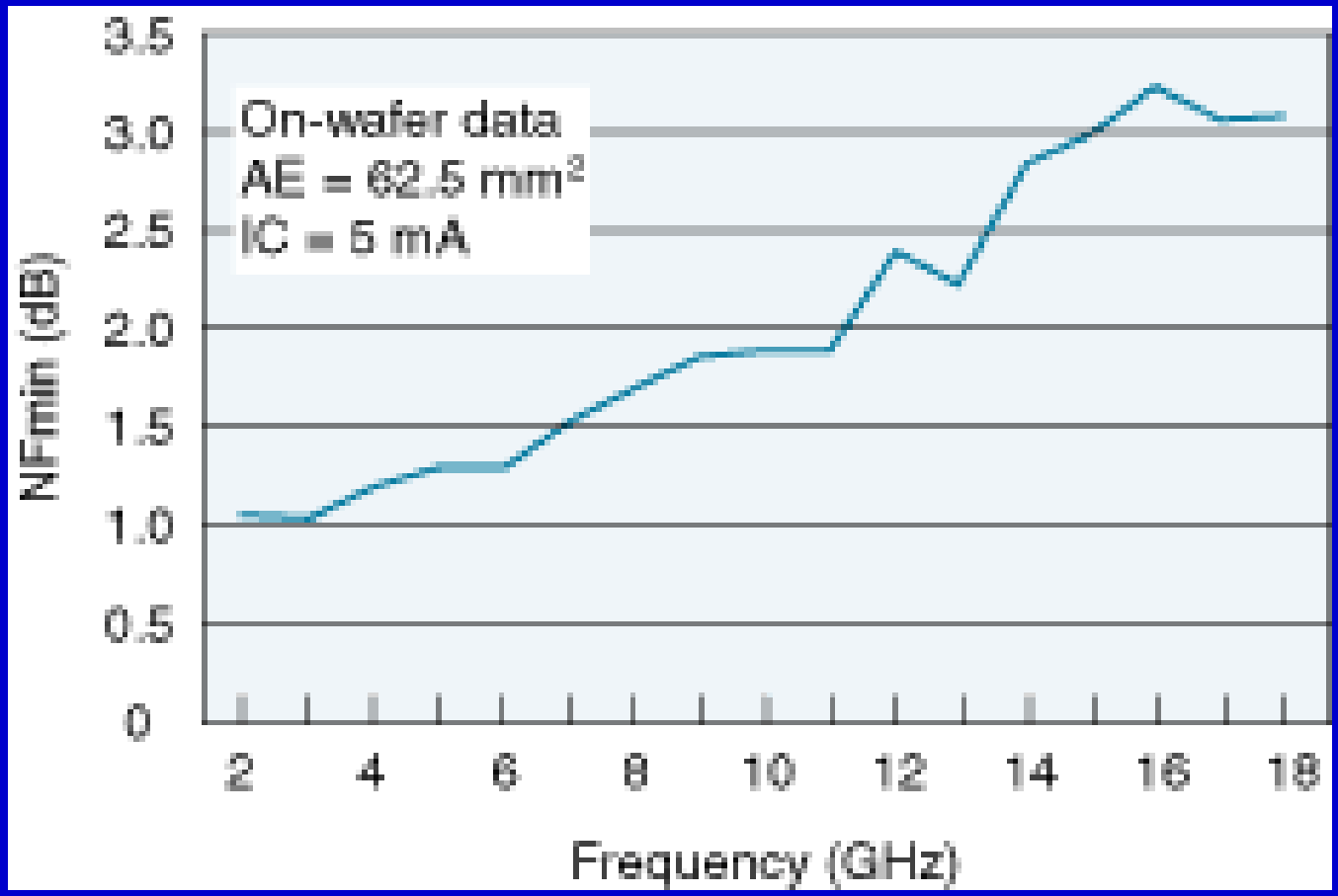
# Band diagram, doping, and Ge profile for Si-Ge HBT

Si-Ge HJT

Silicon BJT



# Noise Figure for SiGe HBTs



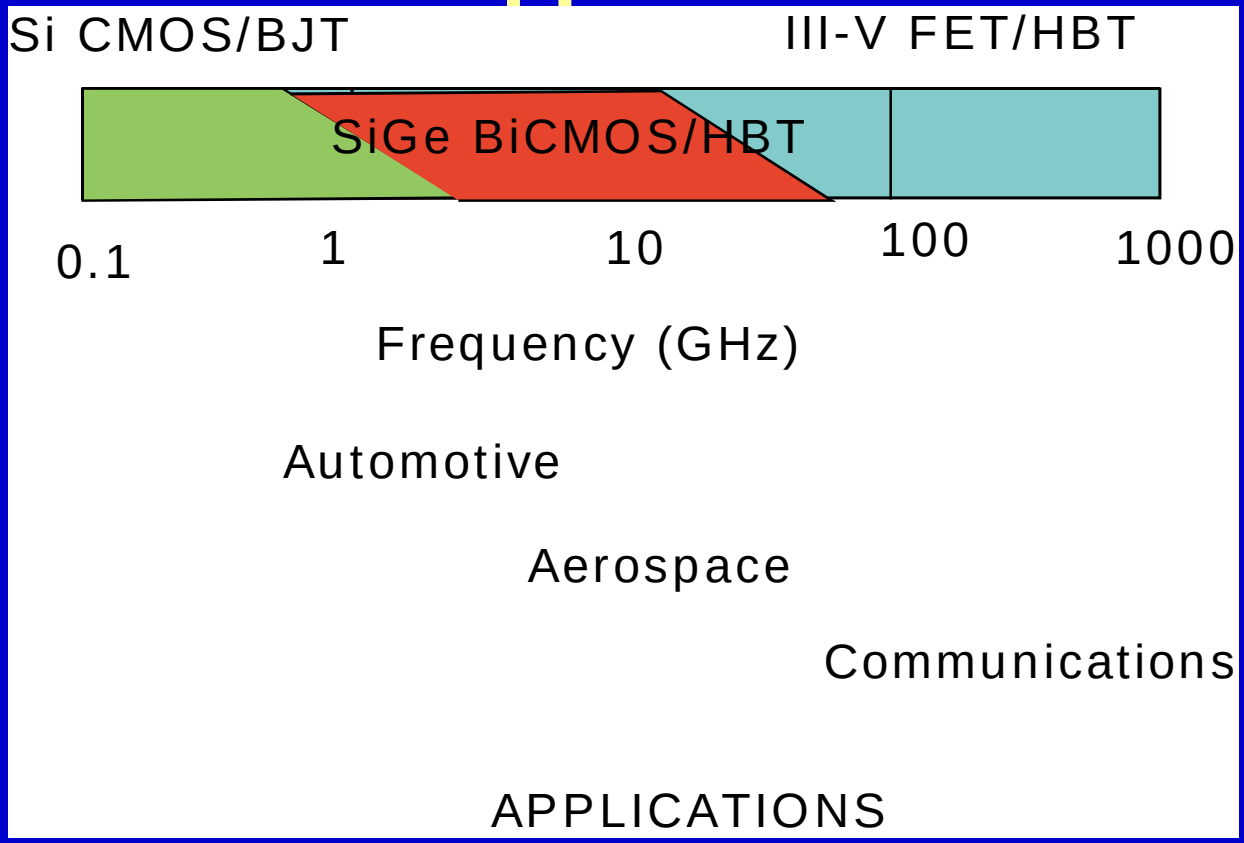

From http://www-3.ibm.com/chips/micronews/vol6_no1/ahlgren.html

# Device Performance

**Si-Ge HBTs $f_T$ = 300 GHz**

**Si-Ge CMOS $g_m$ up to 200 mS/mm**

# Technology Frequency Ranges and Applications




Adopted (with changes) from III-Vs Review, Vol. 11, No. 5, 1998, p. 19

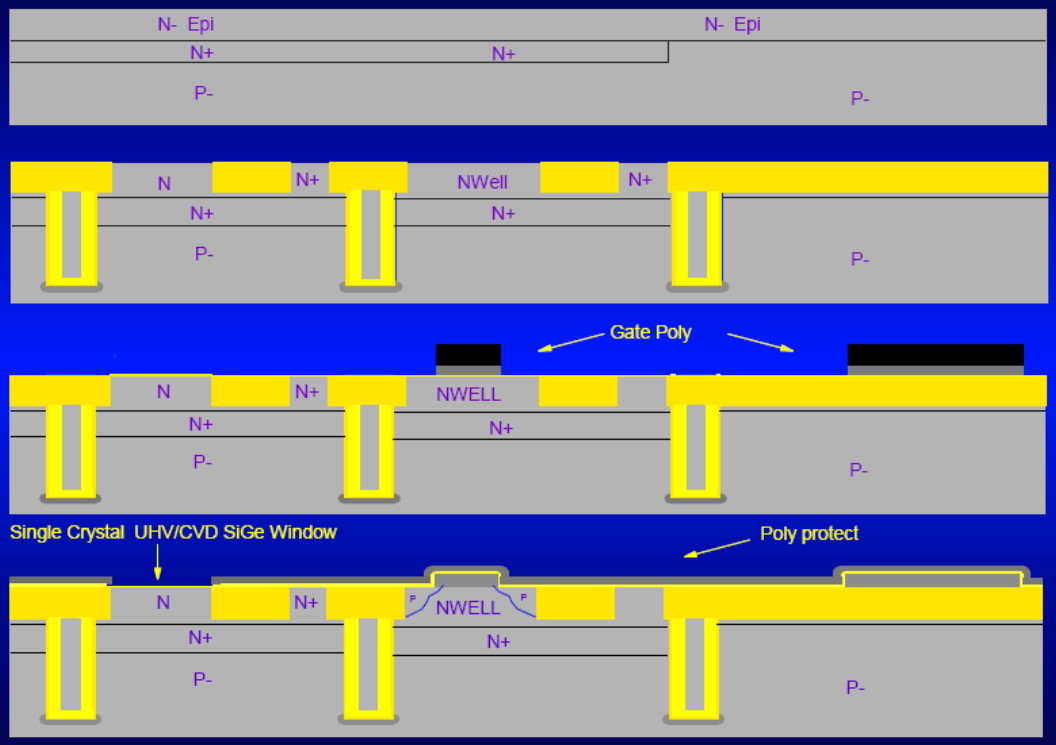
# Status and Trends of SiGe BiCMOS Technology



From

David Harame

## Process Flow for

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