# Lecture #20

## ANNOUNCEMENT

No Coffee Hour today ☹

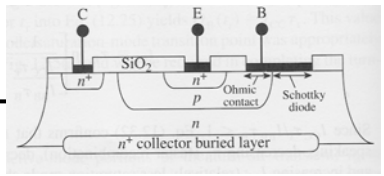
## OUTLINE

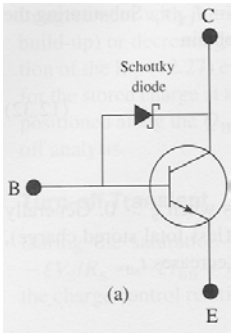
- The BJT: final comments
- PNPN thyristor

Reading: Chapter 13



## Schottky-Clamped BJT




- When the BJT enters the saturation mode, the Schottky diode begins to conduct and "clamps" the C-B junction voltage at a relatively low positive value.
  → reduced stored charge in quasi-neutral base

# Reducing $\tau_B$ for Faster Turn-Off

- The speed at which a BJT is turned off is dependent on the amount of excess minority-carrier charge stored in the base, and also the recombination lifetime $\tau_B$
  - By reducing $\tau_B$, the carrier removal rate is increased

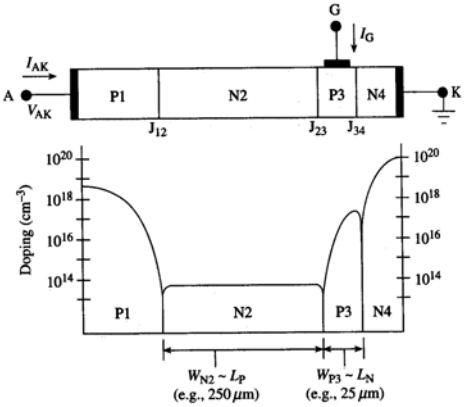
    Example:

    Add recombination centers (Au atoms) in the base



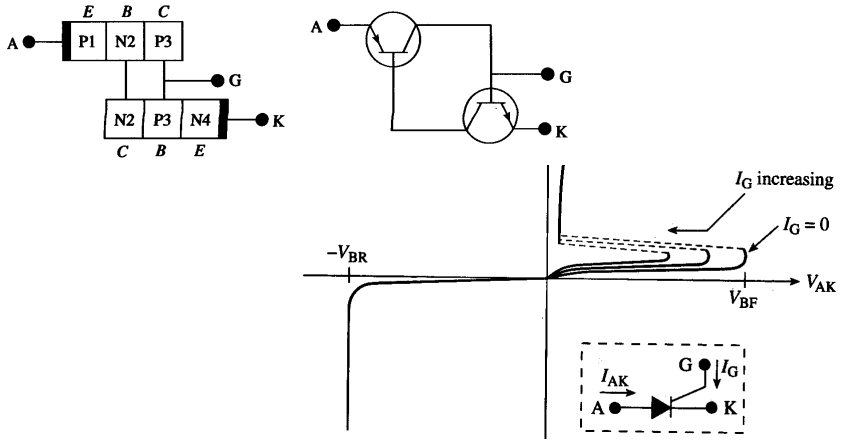
# The Silicon Controlled Rectifier (Thyristor)

- The SCR is a PNPN device
  - Used in high-power switching applications



# SCR Operation

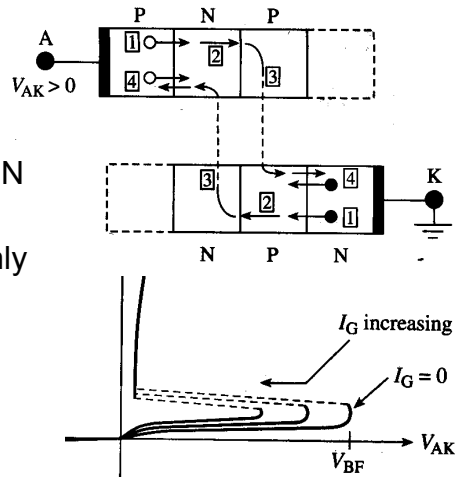
- The SCR can be modeled as 2 interconnected BJTs






# Forward blocking state

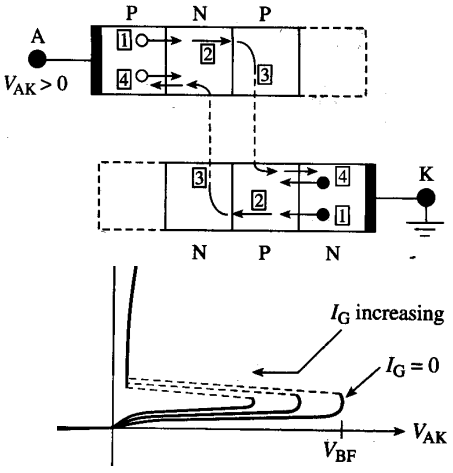
- Few holes injected into N region
- Thermal R-G current only



# Conducting State

1. Holes injected into N
2. Due to wide N-P depletion region, holes are swept into P, turning on PNP device
3. This turns on NPN device

- This regenerative effect maintains conduction even at low voltage, down to a minimum "holding current".






# Quantitative Analysis

- We can write:

$$I_{AK} = \alpha_1 I_{AK} + I_{R01} + \alpha_2 I_{AK} + I_{R02}$$

$$I_{AK} = \frac{I_{R01} + I_{R02}}{1 - (\alpha_1 + \alpha_2)}$$

- Normally, $(\alpha_1+\alpha_2) < 1$

- However, as $V_{AK} \uparrow$, base width narrowing causes $(\alpha_1+\alpha_2) \rightarrow 1$, $I_{AK} \uparrow$