Diodes

Session 5b for Electronics and Telecommunications
A Fairfield University E-Course
Powered by LearnLinc

Module: Semiconductor Electronics (in two parts)

- Text: "Electronics," Harry Kybett, Wiley, 1986, ISBN 0-471-00916-4
- References:
  - Electronics Tutorial (Thanks to Alex Pounds)
  - Electronics Tutorial (Thanks to Mark Sokos)
- Semiconductors, Diodes and Bipolar Transistors
  - 5 on-line sessions plus one lab
- FETs, SCRs, Other Devices and Amplifiers
  - 5 on-line sessions plus one lab
- Mastery Test part 3 follows this Module

Section 5: Semiconductors, Diodes and Bipolar Transistors

- 0BJECTIVES: This section reviews semiconductors, doping and junctions. The characteristics and application of Diodes and Bipolar Transistors are then studied.

Section 5 Schedule:

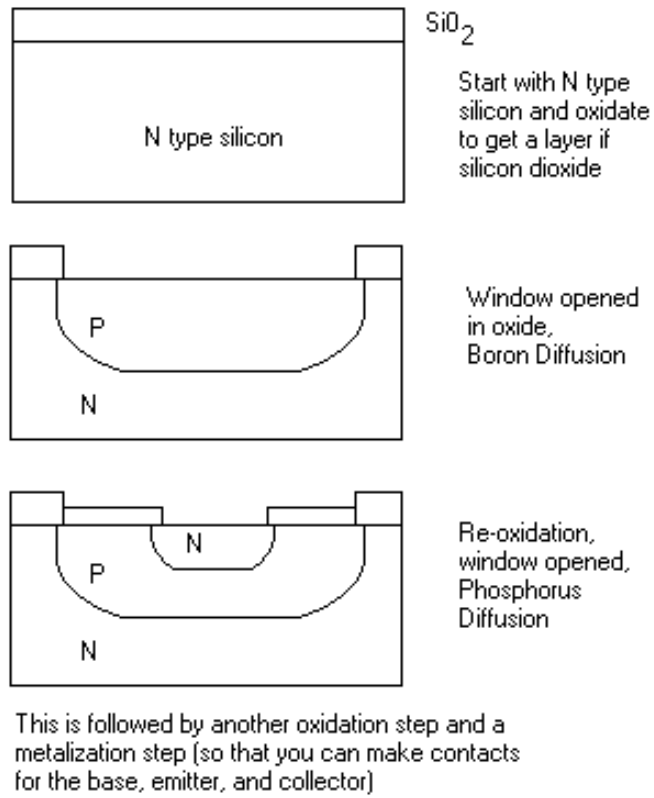
Session 5a	– 09/18	Semiconductors and Doping	Elect 1-7 1.23 – 1.39
MT2 Results	– 09/23	We'll discuss MT2	
Session 5b	**– 09/25**	**Diodes**	**Kybett Chapter 2**
Session 5c	– 09/30	Diode Applications	Kybett Chapter 11
Session 5d	– 10/02	Bipolar Transistors	Kybett pp 51 - 70
(lab - 10/05, Sat.)			
Session 5e	– 10/07	Transistor Amplifiers	Kybett pp 173 - 201
(Quiz 4 due 10/12)			
Session 5f	– 10/14	Review (Discuss Quiz 4)	
Break to introduce Learnlinc version 6.1		About 2 weeks to set up the computers and retrain us	

Semiconductor Review

- Pure semiconductors (Si, Ge, GaAs) are crystals
  - Outer electrons are trapped in covalent bonds
  - High resistivity
- Doping
  - N-Type formed by diffusing group 5 impurities
  - P-Type formed by diffusing group 3 impurities
  - More impurities; Less resistivity
  - “Majority” carriers (electrons or holes) determines “Type” (equal carriers combine to cancel each other)
- PN junctions used to create electronic devices (diodes, transistors, etc.)

PN Junctions

- Diffusion creates junctions just below the surface
- A diode is formed as one PN junction
- A bi-polar transistor is two pn junctions separated by a very narrow “base” region

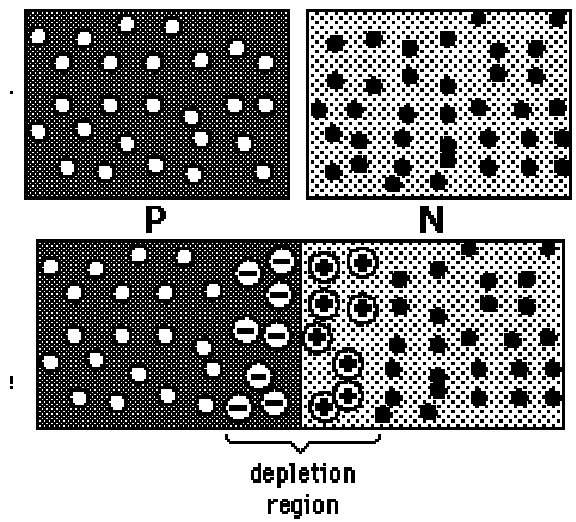


Point Contact diodes

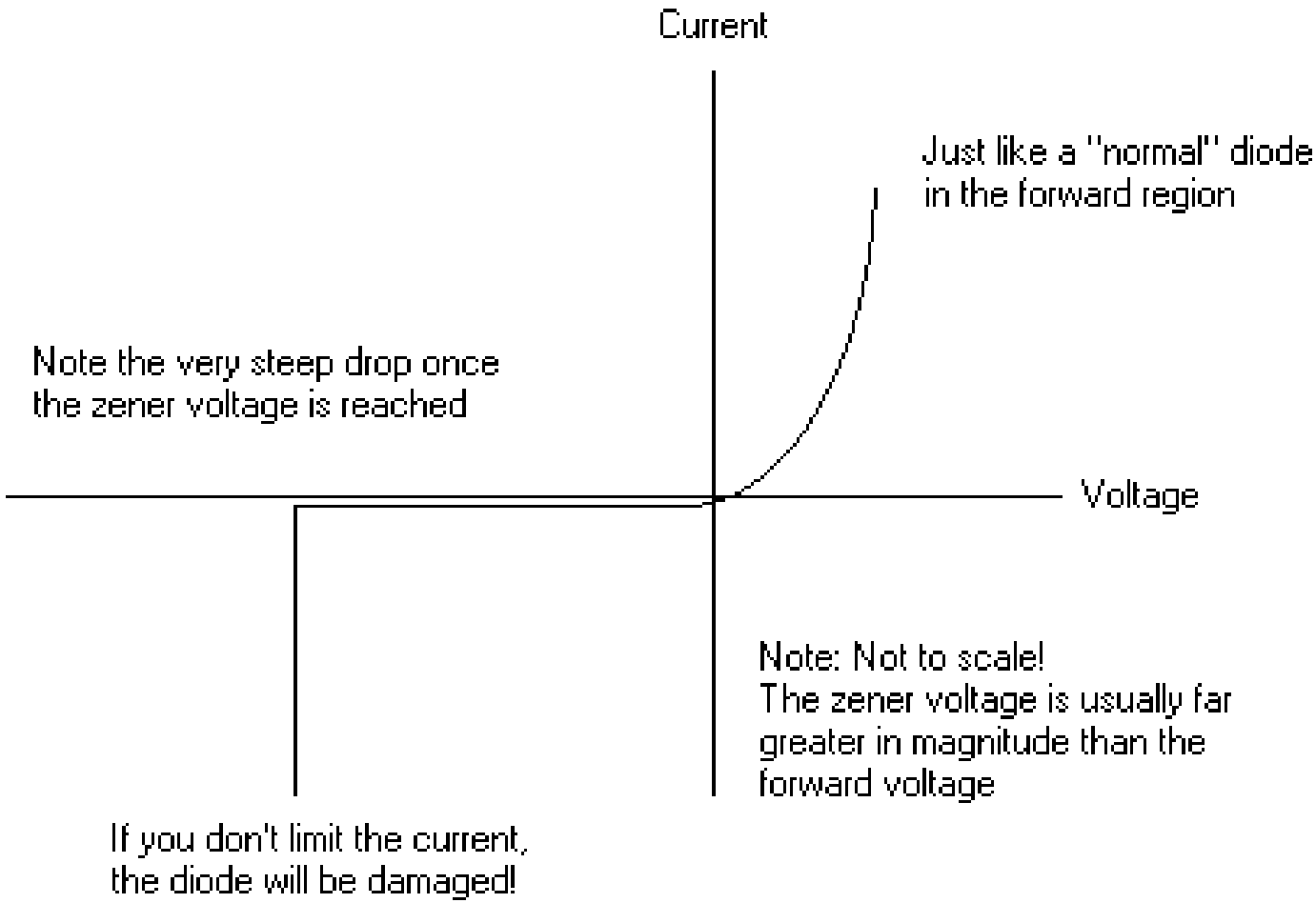
- First diodes formed by probing a mineral (Galena) with a stiff wire.
- Used as detectors in early radios (Crystal Sets)

Junction Diode Operation

- PN junction forms at the PN boundary
- Holes (P) and free electrons (N) combine
- "Depletion" Region forms (no free carriers)
- Forward "bias"; allows current
  - positive voltage on P
  - negative voltage on N
- Reverse "bias"; no current
  - positive voltage on N
  - negative voltage on P

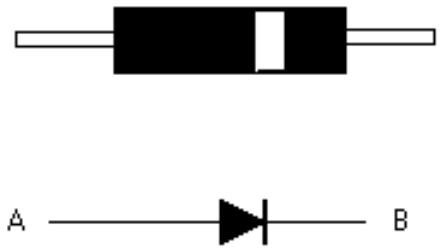


Diode VI Curve



Diode Characteristics

- Diodes act as imperfect one-way valves
- Forward Voltage Drop
  - Silicon: about 0.7 volts
  - Germanium: about 0.3 volts
  - "Schotky": less than 0.1 volt
- Reverse "Leakage" Current (μA)
- Breakdown (Zener) Voltage
- P-region is the "Anode";
  N-region is the "Cathode"
  - The line on a diode marks the cathode
  - The arrow on the schematic symbol points in the direction of allowed current flow

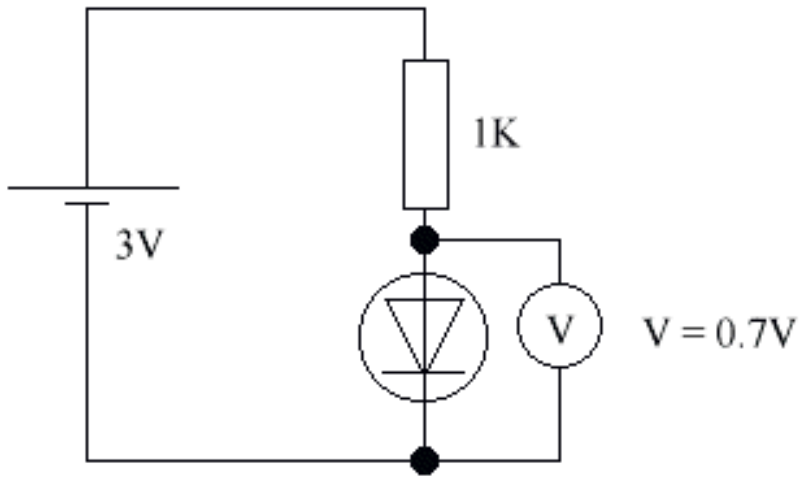


Note - the line on the diode matches the line on its schematic symbol.

Current flows from A to B but not from B to A.

A Diode Circuit

- What is the “loop” current?
- The resistor voltage is: $V_r = 3 – 0.7 = 2.3$ volts
- Using Ohm’s Law $I_r = 2.3 / 1000 = 2.3$ mA which is also the loop current



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