

**IME 100 - ELECTRONICS MANUFACTURING 2**

**BASIC CLASS NOTES**

**NOVEMBER 11, 2015**

Reading Review and Class Preparation

This should be filled out prior to class.

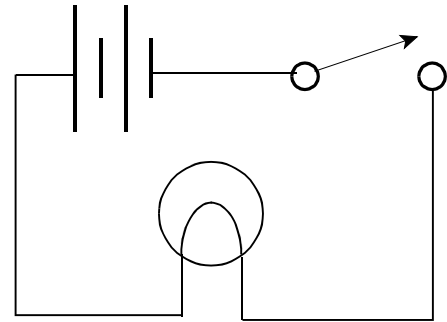
Key Concepts to Be Discussed in Class:

Questions About Subject Matter for Class Session:



Electrical Circuits

- Definition of Circuit
  - A Closed Path for Electricity to Flow in Order to Achieve a Specific Purpose
- Circuits Can Be
  - Hard Wired
  
  - On a Printed Circuit Board
  
  
  
  
  
  
  
  
  
  - On a Silicon Chip Inside a Package



Light Bulb With a Battery and Switch

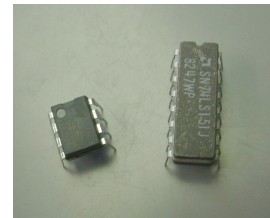
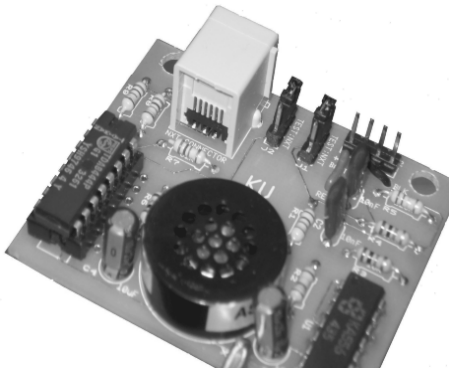
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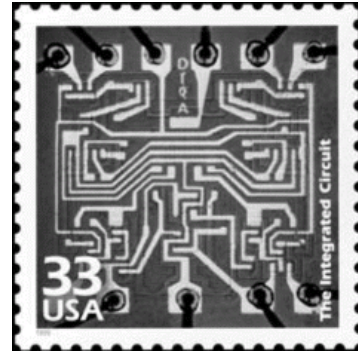
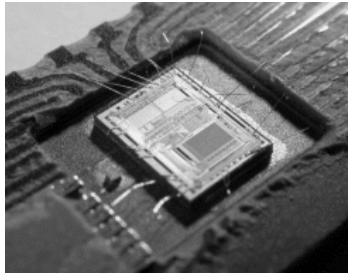
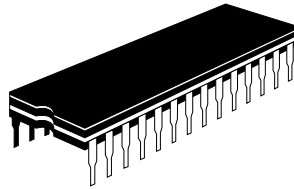
#### Integrated Circuits - Need

- Populated Circuit Boards are Too Large for Many of Today's Applications
  - The Overall Size Would Make Many Products Unrealistic
  - Electronics are Based on IC's
  - Ref: Prof. M. Thompson



Integrated Circuit

- Commonly We Hold the IC Package
  - Integrated Circuit Inside
  - Packaging Surrounds IC



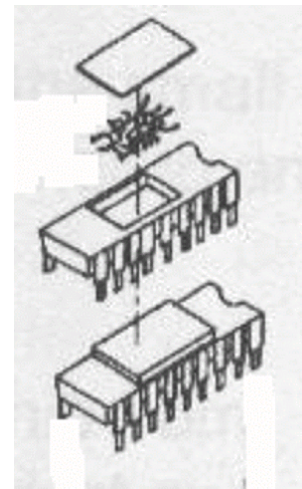
Wikipedia

Prof. M. Thompson

USPS

Packaging

- The Integrated Circuit Must Be Placed in a Package
  - Safety from Surroundings
  - Thermal Dissipation
  - Electrical Connection to Printed Circuit Board



Concept Question

- The Integrated Circuit is
  - Small 3mm x 3mm (or smaller)
  - Contains Upwards of 100,000 Devices
  - Is a Complete Circuit
- How Is This Similar to a Printed Circuit Board?

○ What Features are Necessary?

○ What Processing Steps are Necessary?

○ Think Like Aristotle

Silicon

- Silicon is an Intrinsic Semiconductor
  - Small But Measureable at Room Temperature
  - $\sigma=4.5 \times 10^{-6} (\Omega\text{cm})^{-1}$

|    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|
| H  |    |    |    |    |    |    | He |
| Li | Be | B  | C  | N  | O  | F  | Ne |
| Na | Mg | Al | Si | P  | S  | Cl | Ar |
| K  | Ca | Ga | Ge | As | Se | Br | Kr |
| Rb | Sr | In | Sn | Sb | Te | I  | Xe |
| Cs | Ba | Tl | Pb | Bi | Po | At | Rn |

Versatility of Silicon


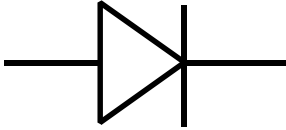
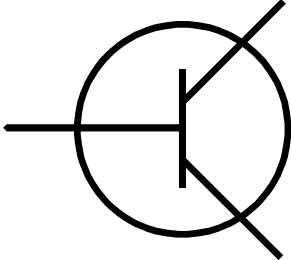
- Can Change Conductivity / Resistivity
  - Add B, Al -OR- P, As
- Can Metallize
  - Deposit Metal on to Si
  - Create Polysilicon
- Can Create Insulating Layer
  - Oxidize form Silica
- Made From Most Abundant Material on Earth

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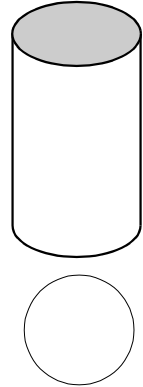
Making Devices [Components]

|            |  |   |
|------------|--|---|
| Resistor   |   | Add a p-type or n-type Dopant             |
| Diode      |   | Create Adjacent p-type and n-type Regions |
| Transistor |  | Create p-n-p or n-p-n Regions             |



Single Crystal Silicon Wafer

- Must Be Extremely Pure (EGS)
  - React Silica with C in Furnace
  - 98% Pure Si Forms
  - Form Trichlorosilane
  - Purify
  - Form Si from Trichlorosilane
  - Form Single Crystal



Adding Impurities

- Two Methods
  - Diffusion
  - Ion Implantation
- Chemical Reactions
  - Metallization
  - Oxidation

|   |
|---|
| <p><b><u>Diffusion</u></b></p> <p><b>When Different Materials are Placed in Contact - They Will Mix Even in Solid State</b></p> |
| <p><b><u>Ion Implantation</u></b></p> <p><b>Use Electrical Field to Force Ions into Material</b></p>                            |




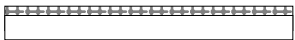


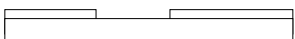
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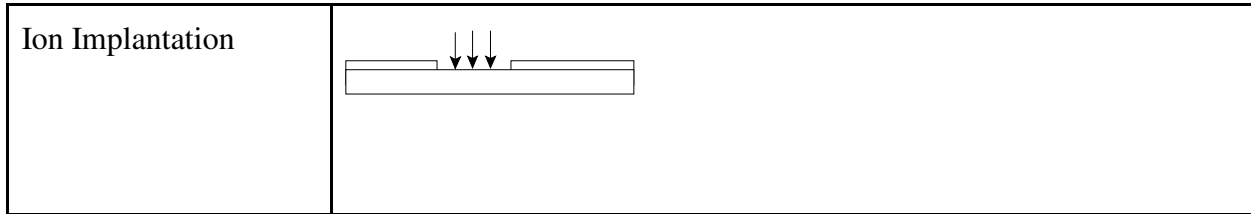
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Making Diode (n-p)

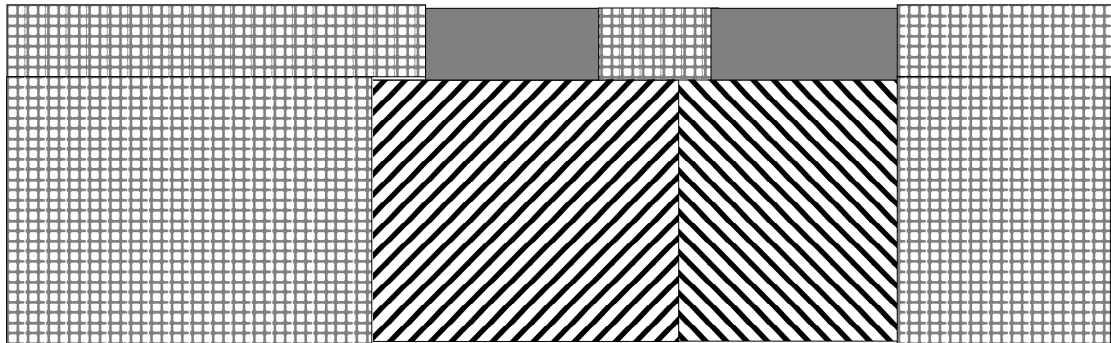
- Need to Make Adjacent n and p regions

|                     |   |
|---------------------|---|
| Silicon Wafer       |    |
| n-type dopant       |    |
| n-Silicon           |    |
| Add Photoresist     |  |
| Pattern Exposure    |  |
| Develop Photoresist |  |
| Etch Photoresist    |  |



Finishing Job

- Need to Add Metal and Insulation for Devices on Circuit



This is one device on the IC  
There may be  $10^5$  or More.

