Bipolar Junction Transistor (BJT)

Dr Mohammad Abdur Rashid

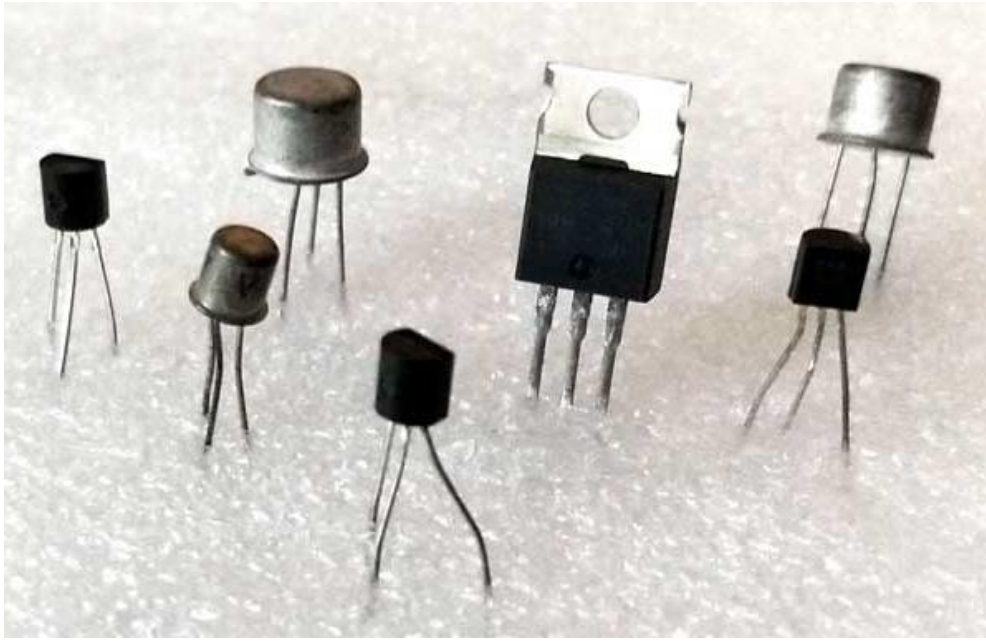
Bipolar Junction Transistor

BJT was invented in 1947

Nobel Prize in 1956

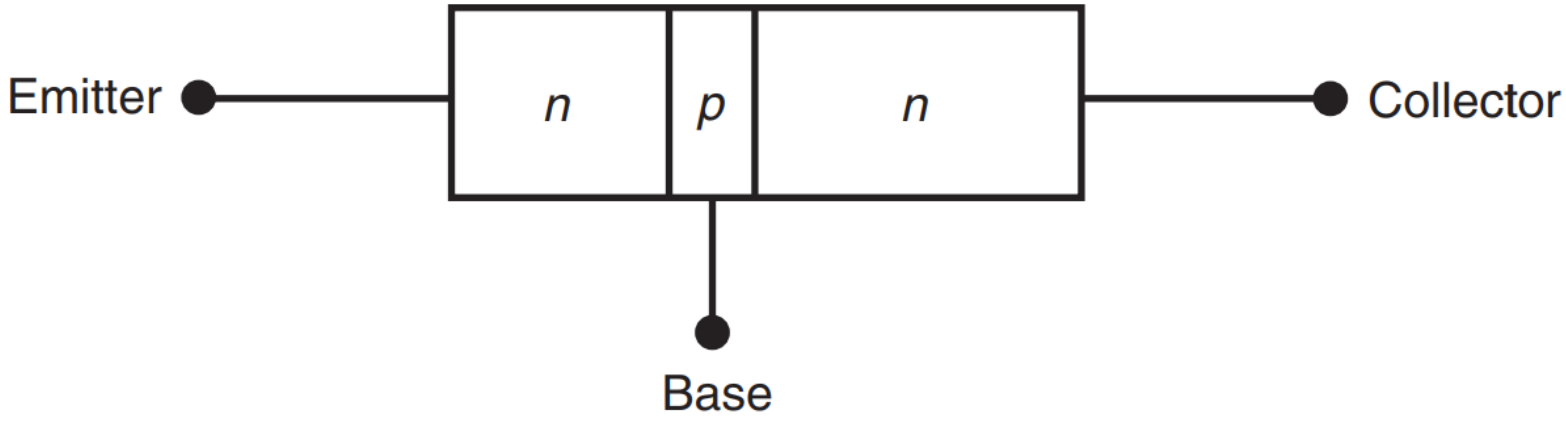
Dr. William Shockley (seated);
Dr. John Bardeen (left); Dr. Walter H. Brattain.

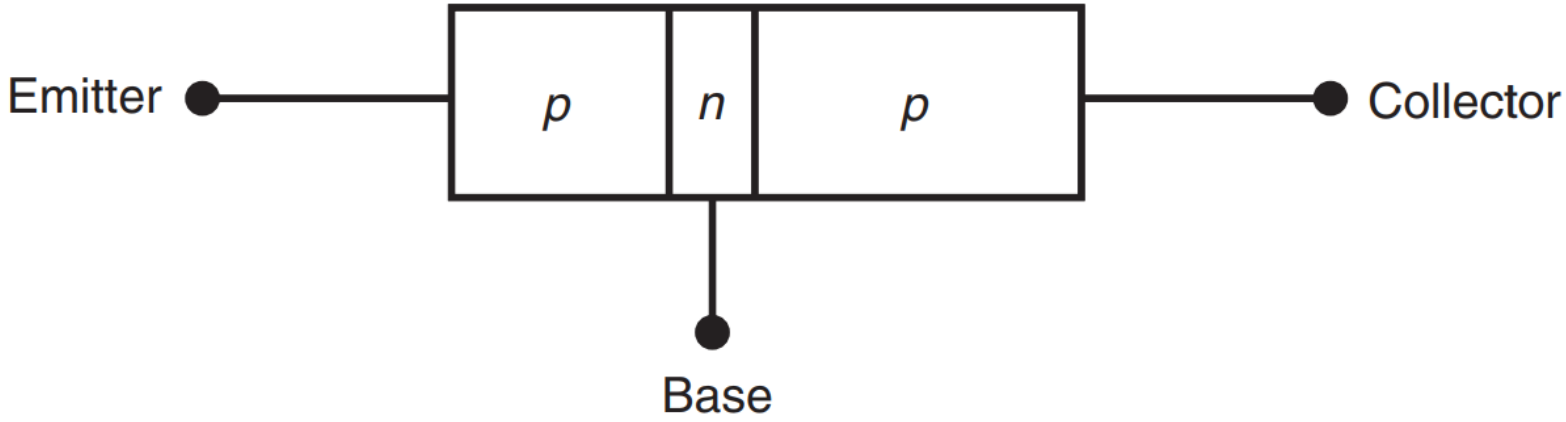
Vacuum tube and transistor



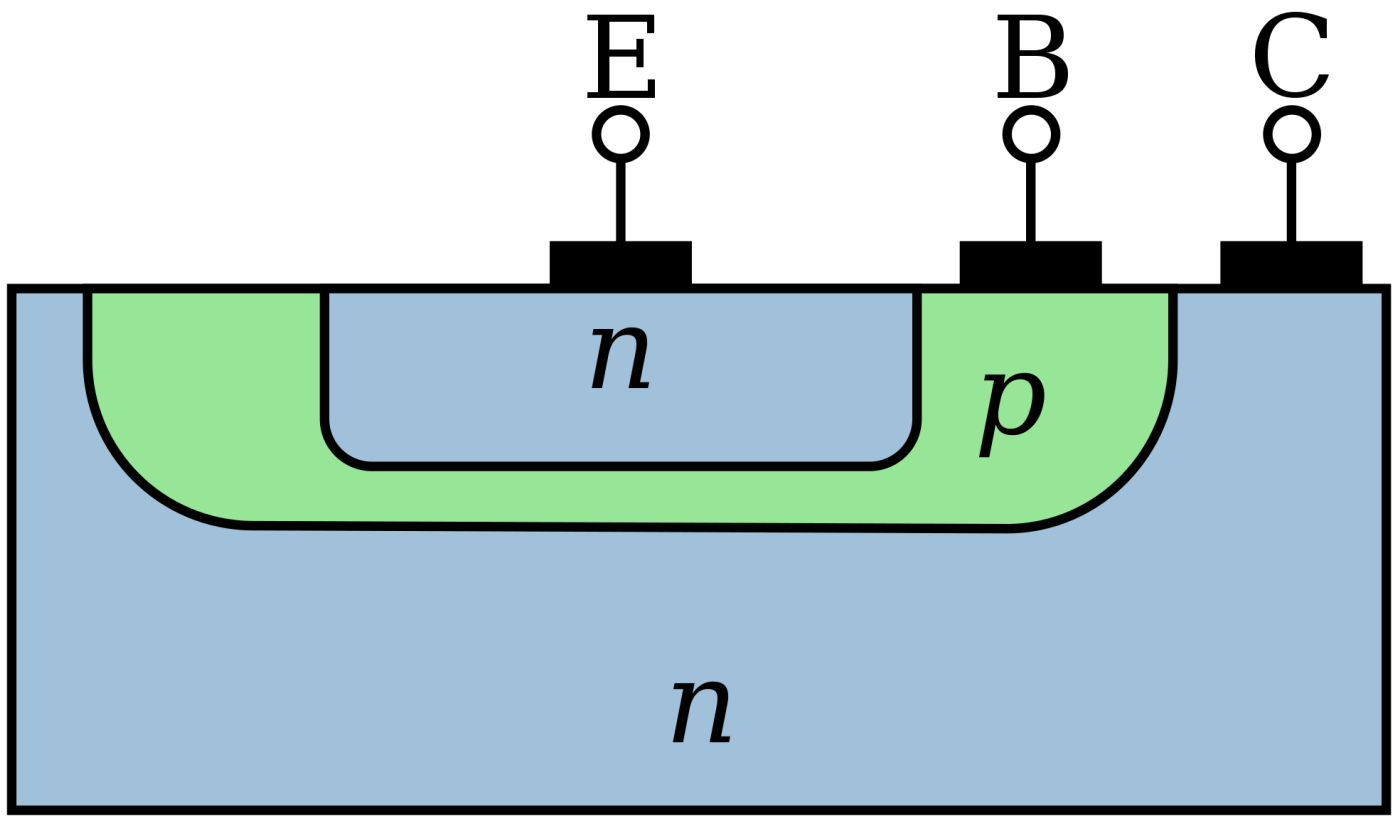
Antique radio

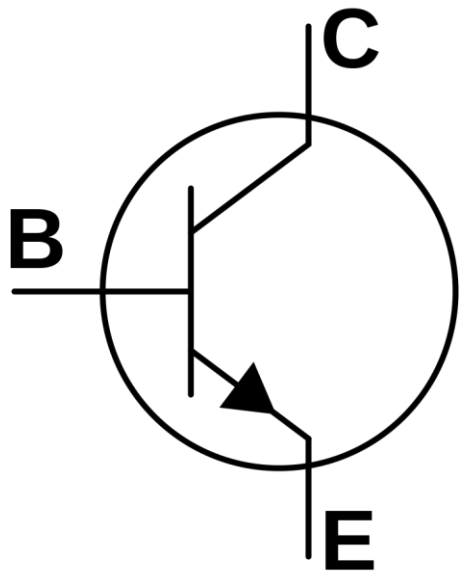
Transistor showing the three doped regions



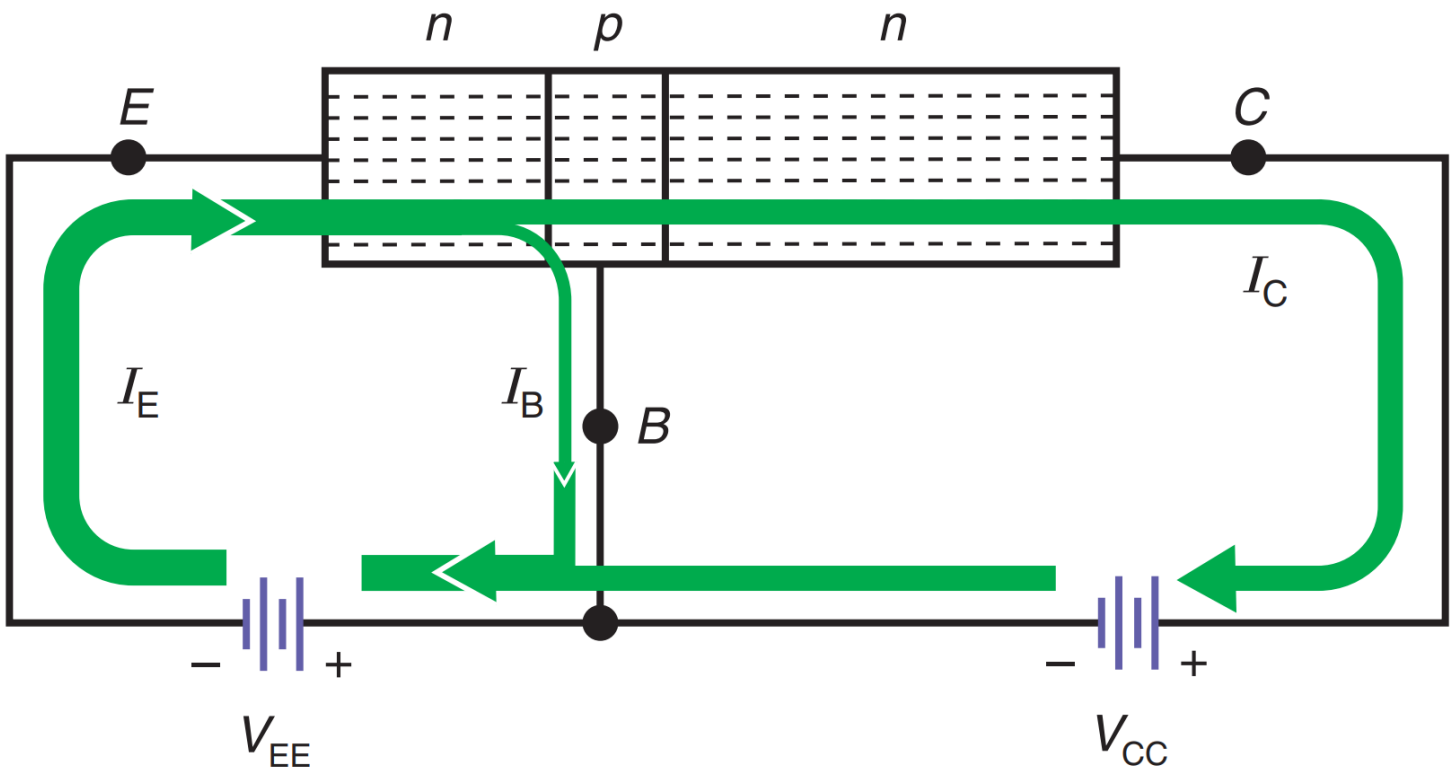


Cross sectional view of *npn* transistor





Transistor Biasing



$$I_E = I_B + I_C$$

$$I_C = I_E - I_B$$

$$I_B = I_E - I_C$$

Transistor specification sheet

MAXIMUM RATINGS

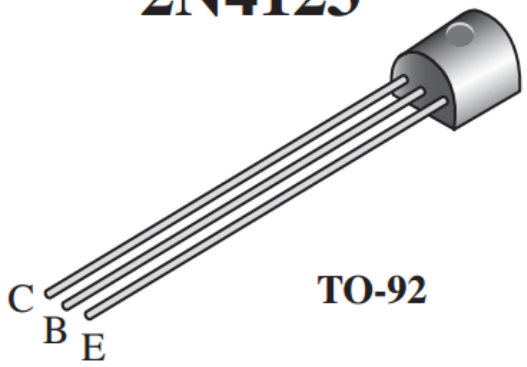
Rating	Symbol	2N4123	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW°C
Operating and Storage Junction Temperature Range	T_j, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C W

FAIRCHILD
SEMICONDUCTOR ™

2N4123



TO-92

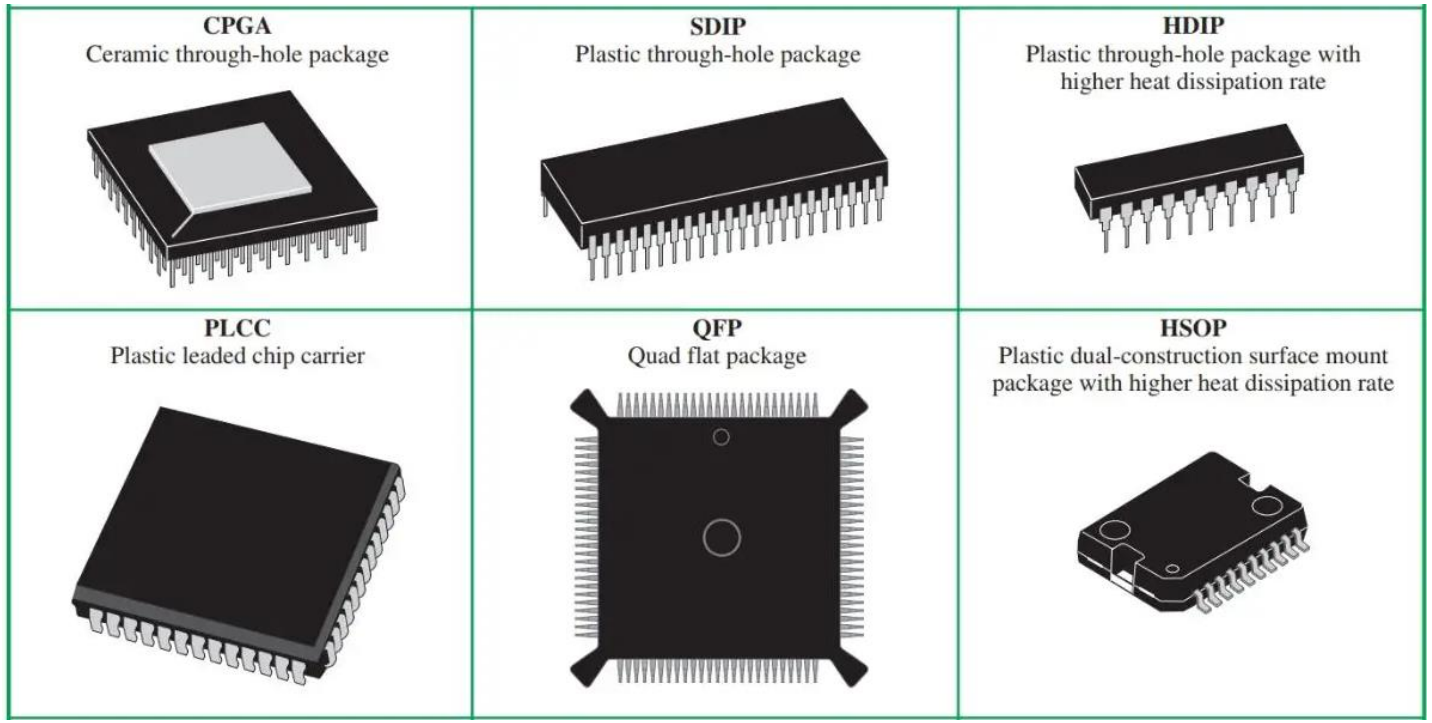
General Purpose Transistor NPN Silicon

AMD Ryzen™ 9 3900X

Cores	12
Threads	24
Transistors	19.2 billions
Dimensions	1.57 x 1.57 x 0.24 inches
Weight	45.1 g
Released	July 7, 2019

Integrated Circuit (IC)

An Integrated circuit (IC) is an array of electronic circuits that has been diffused normally onto a silicon chip. The positive impact of integrated circuits is evident in the pace of technology advancement. Almost all electronic devices have been using ICs to build miniature circuits that is cost effective and energy efficient.

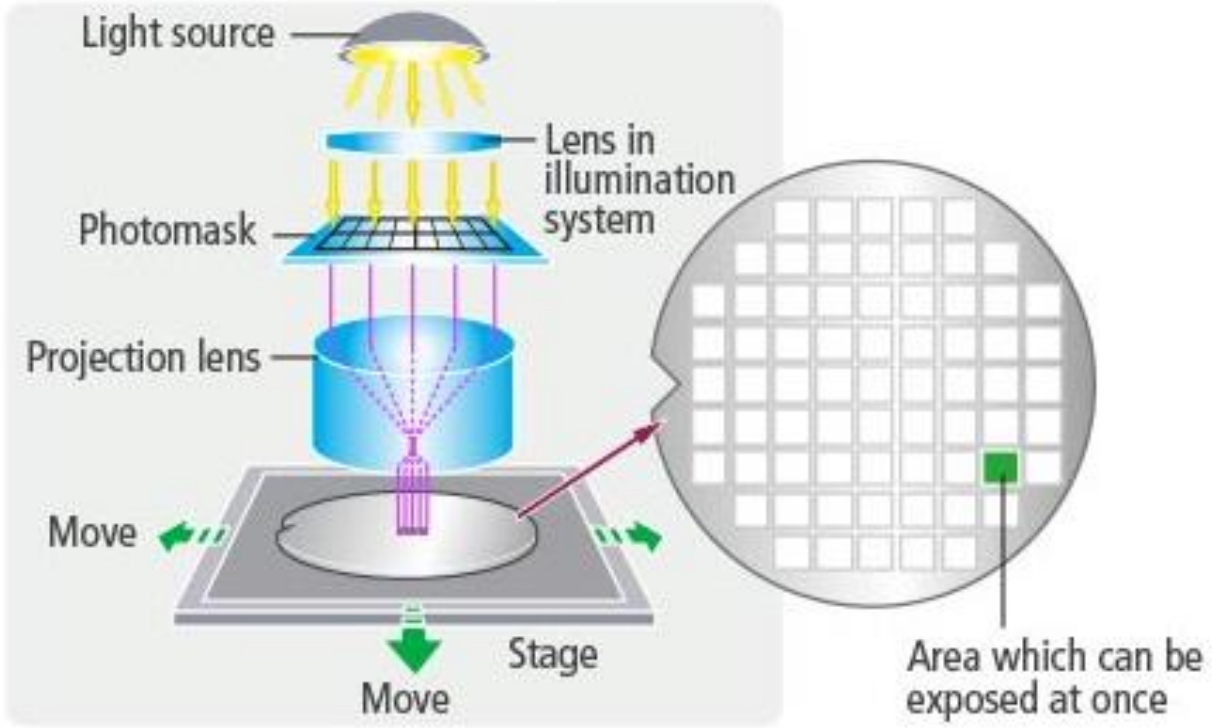


Common IC fabrication processes

- Lithography
- Etching
- Deposition
- Chemical Mechanical Polishing
- Oxidation
- Ion Implantation
- Diffusion

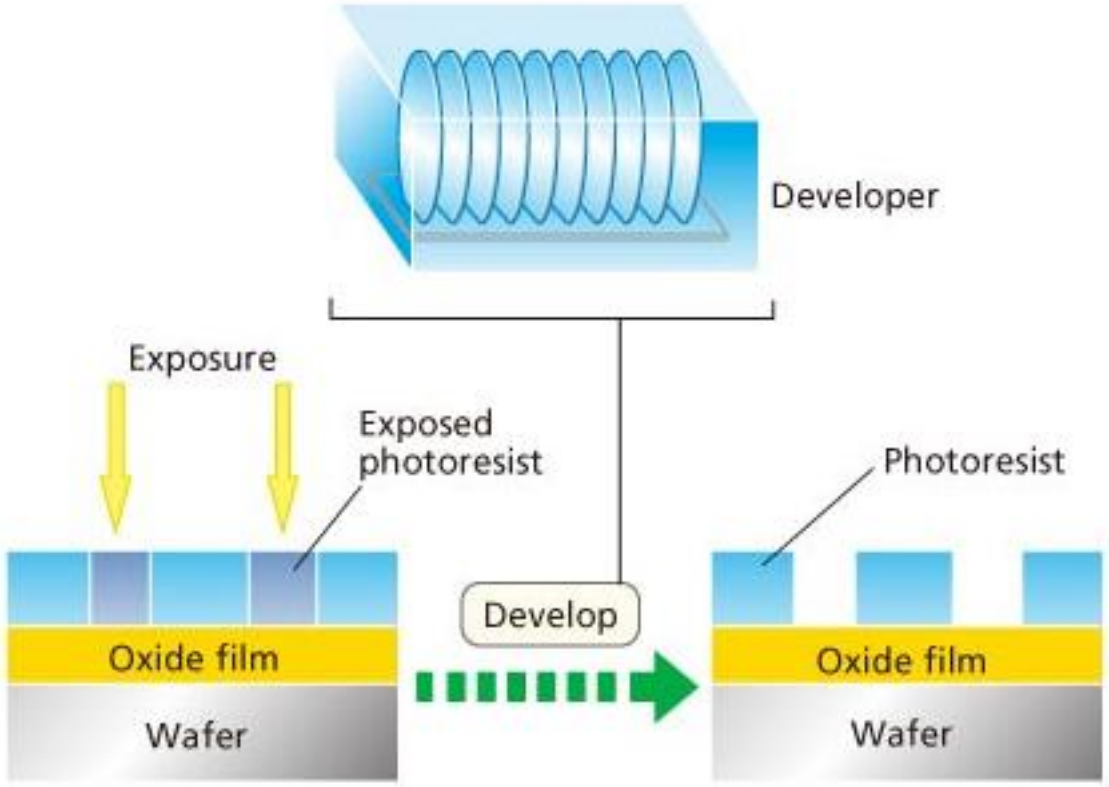
Lithography

A method that uses ultraviolet light to expose IC pattern onto the wafer surface. Though other types of IC lithography exist having similar principles and processes, such as ion beam, electron beam, and x-ray lithography.



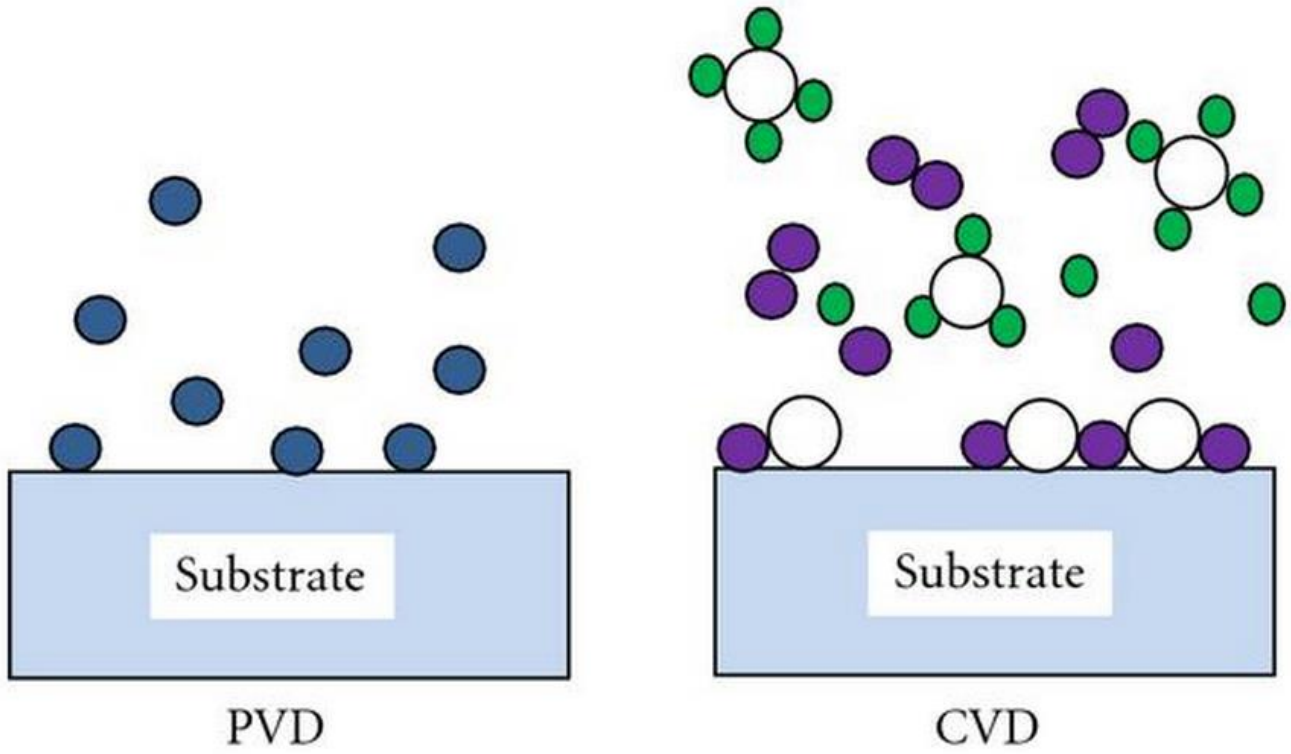
Etching

It is an important process module that selectively removes unwanted material from the surface of the wafer. The pattern of the photo-resist is transferred to the wafer by means of etching agents.



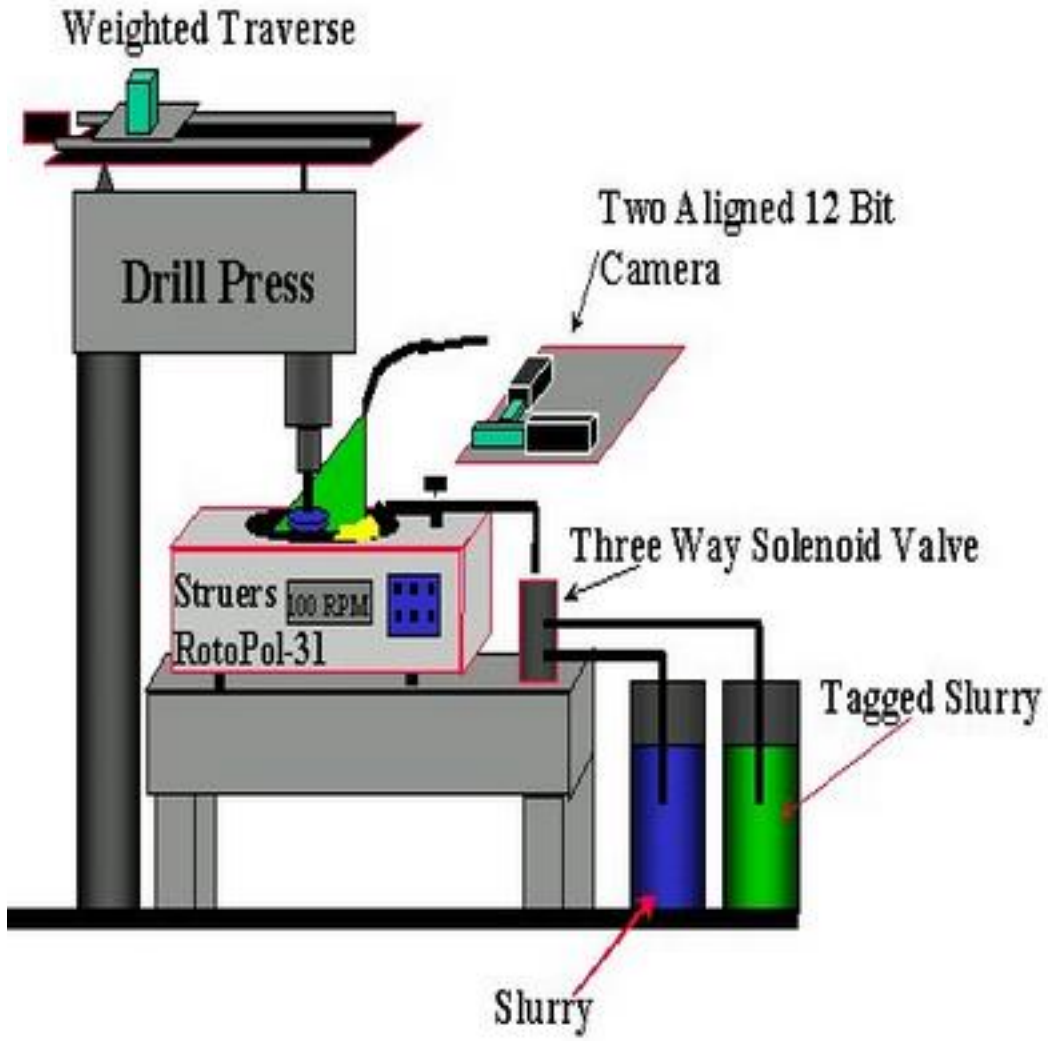
Deposition

It is a general procedure of forming a layer of material on the surface. Films of the various materials are applied on the wafer. The two kind of deposition used are physical vapor deposition (PVD) and chemical vapor deposition (CVD).



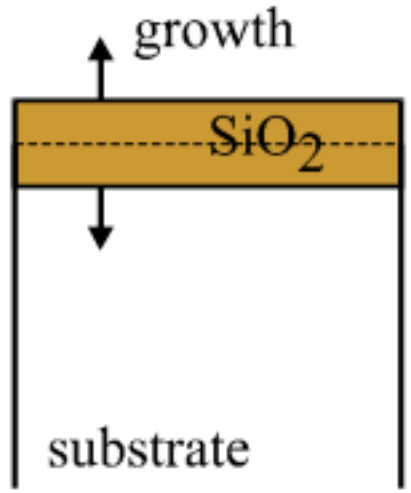
Chemical Mechanical Polishing

It is a process of smoothing surfaces with the combination of chemical and mechanical forces. A planarization technique by applying a chemical slurry with etchant agents to the wafer surface.



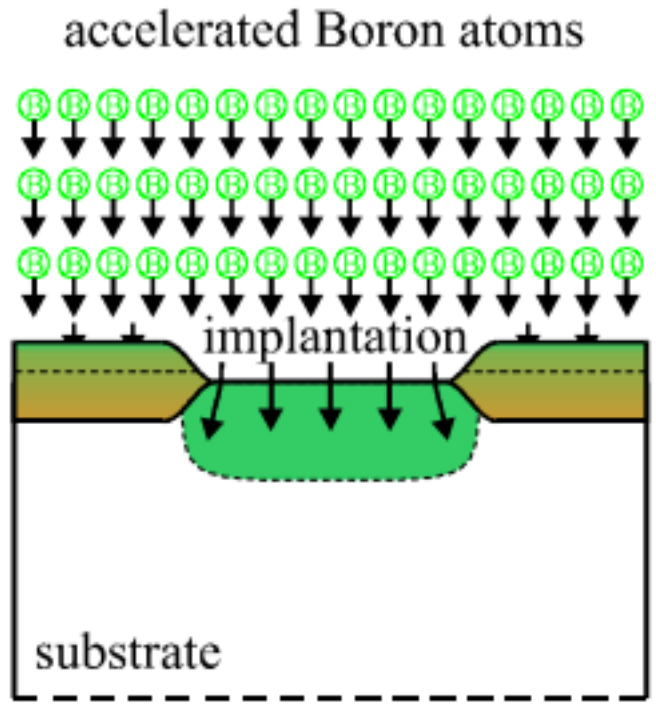
Oxidation

One of the simplest steps in IC processing is thermal oxidation, the growth of a layer of silicon dioxide (SiO_2) on the substrate surface. Oxide forms due to the chemical reaction between oxygen in the ambient and silicon in the substrate. One of the reasons why silicon is widely used is because it oxidizes quite readily.



Ion Implantation

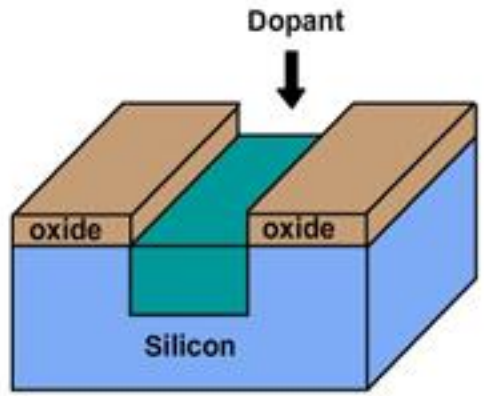
Ion implantation is the most important doping method because of the precise control it provides. It is the most widely used technique to introduce dopant impurities into semiconductor. The ionized particles are accelerated through an electrical field and targeted at the semiconductor wafer.



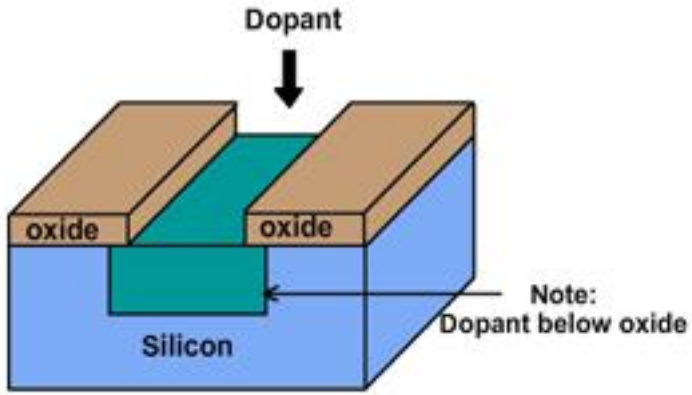
Diffusion

It is the movement of impurity atoms in a semiconductor material at high temperatures. It is the method used to anneal bombardment-induced lattice defects after ion implantation or to introduce dopant atoms into silicon from a chemical vapor source.

However, diffusion can also be an unwanted parasitic effect, because it takes place during all high temperature process steps.



Ideal Case
Diffusion in one direction



Actual case
Lateral Diffusion

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