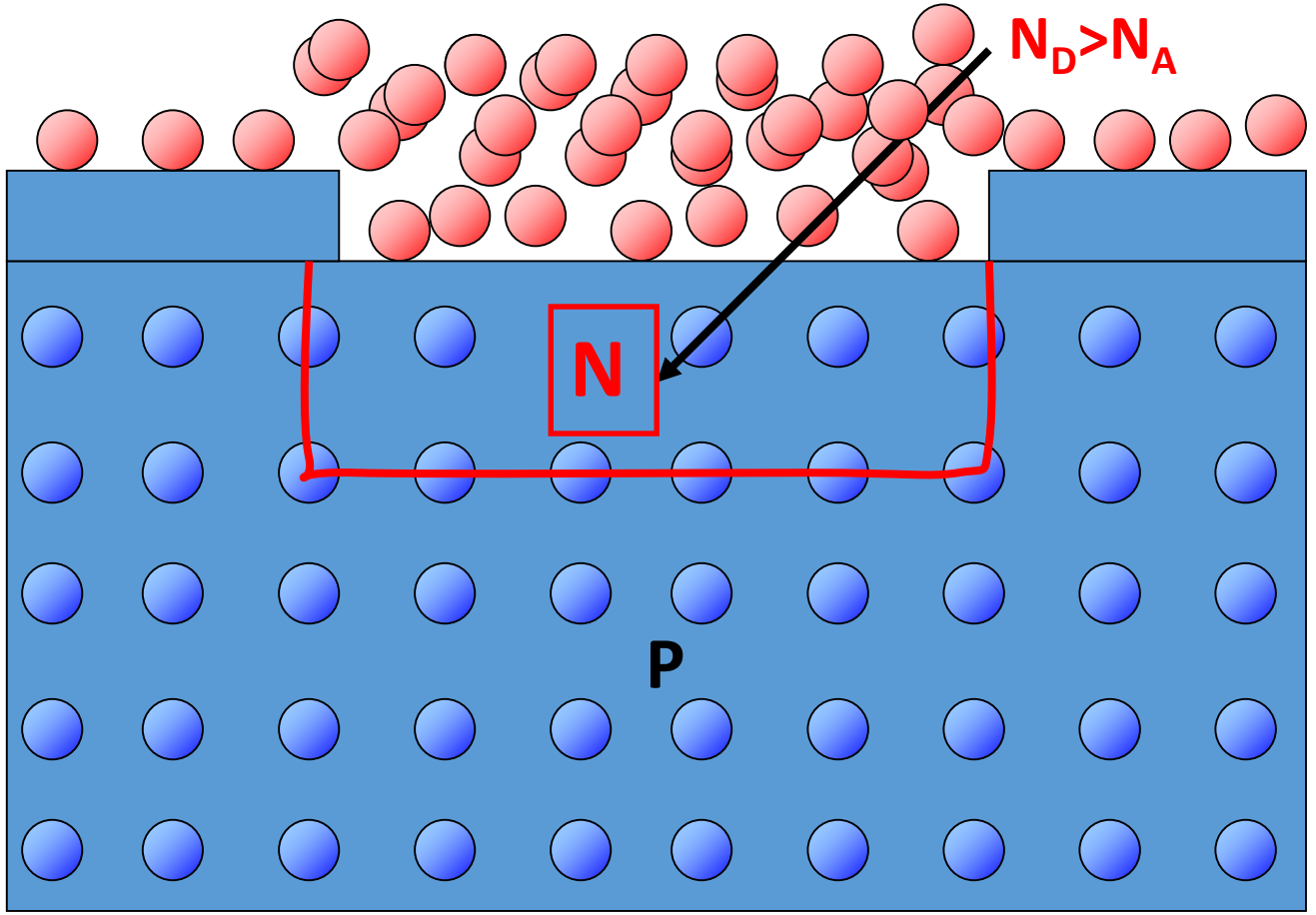
Diffusion

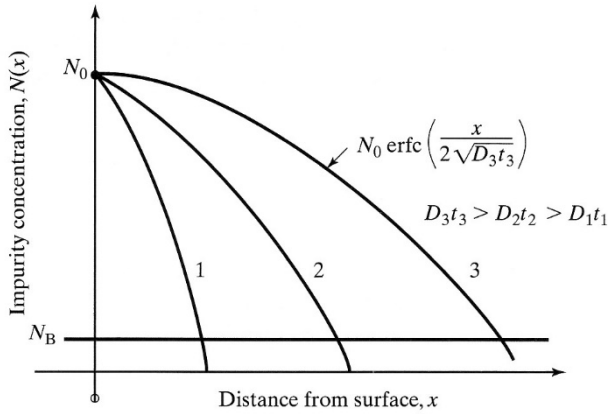
To introduce dopants such as boron, phosphorus into silicon to control majority carrier type and resistivity of regions in wafers by the movement of atoms from high concentration region to low concentration region

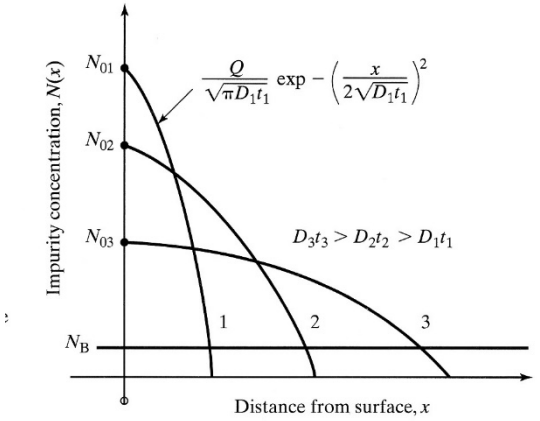


Diffusion

Diffusion is a temperature and time dependent process. It is done in 2 steps:

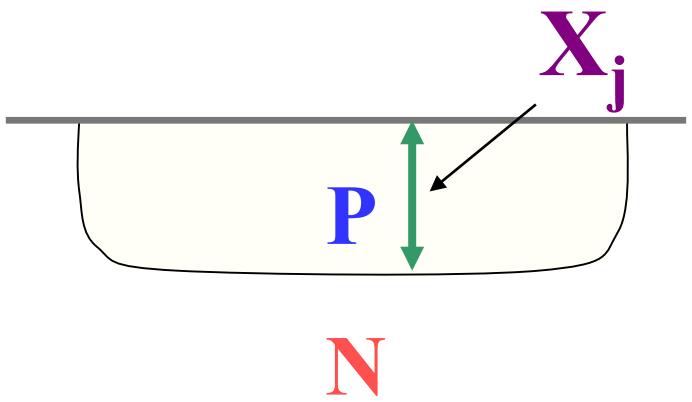
- Predeposition (Constant-Source Diffusion)
- Drive-in (Limited-Source Diffusion)

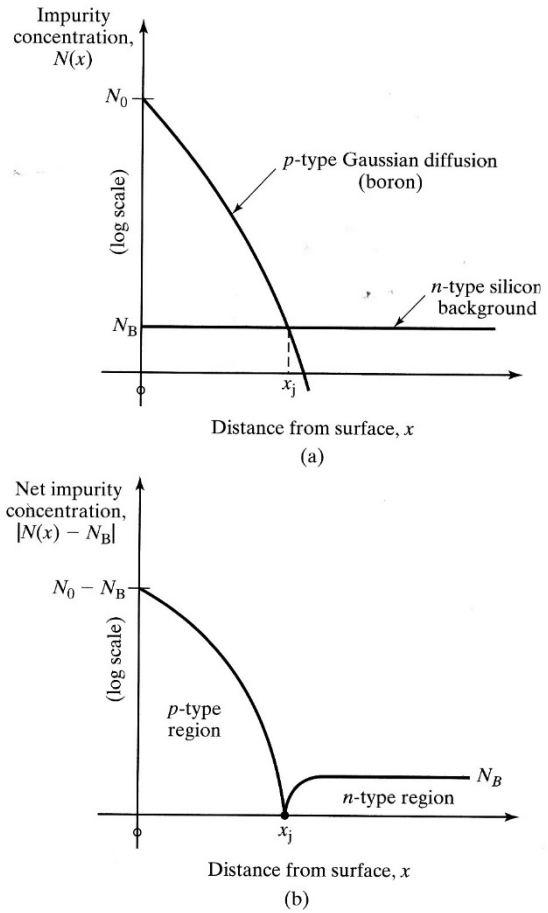




- Predeposition is diffusion taking place under a constant supply of dopants to the process.
- Drive-in diffusion taking place in the absence of the supply of dopants but rather driving in the dopants predeposited.

Diffusion





The junction depth occurs when the diffused dopants concentration is the same as the substrate dopants concentration.

Given the substrate dopant concentration, the junction depth increases with:

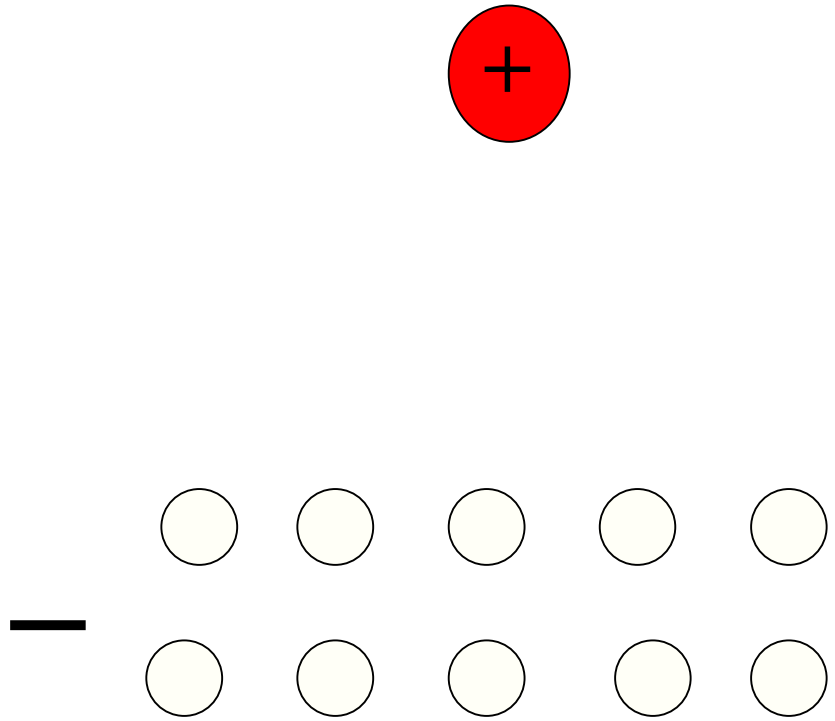
- Increased Temperature
- Increased Time

Calculation of diffused junction depth to be covered in Advanced Wafer Fabrication Technology

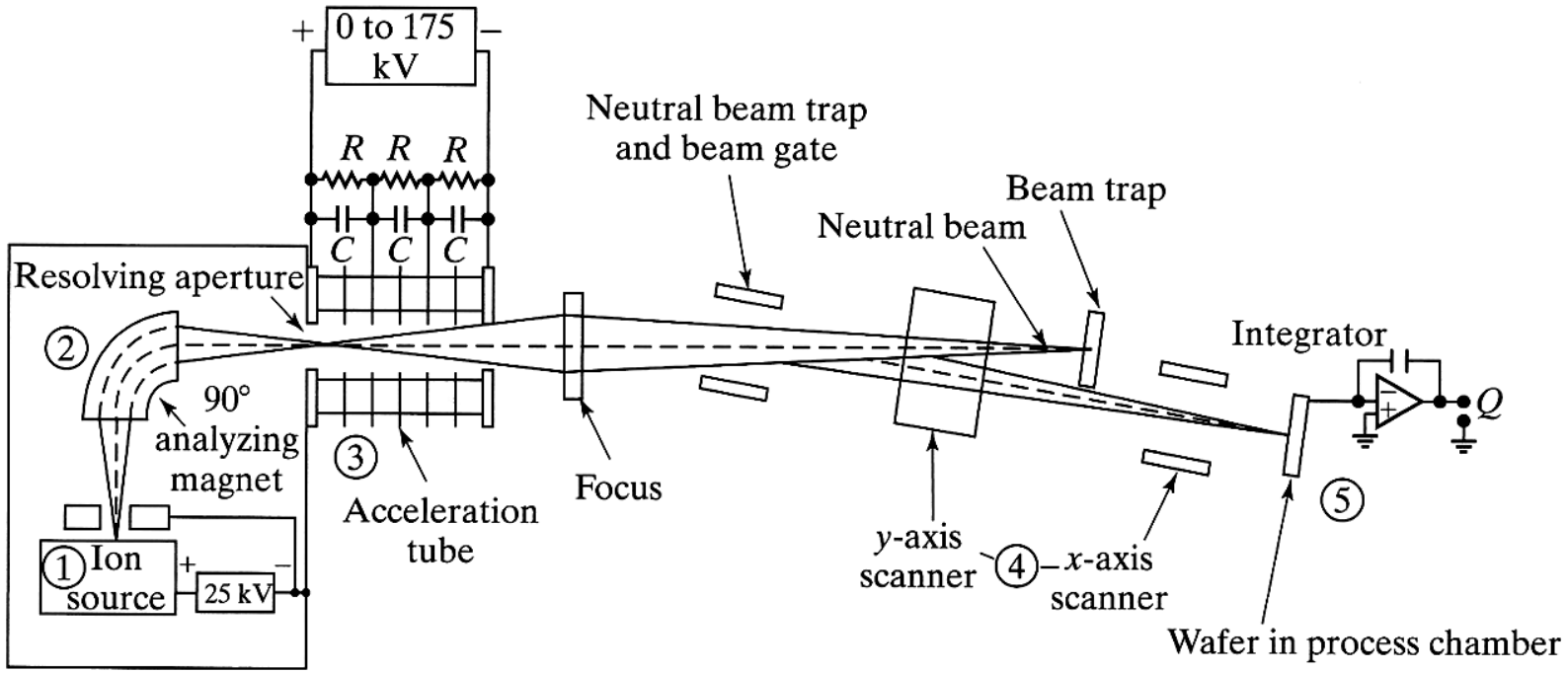
Ion Implantation

Ion Implantation is the acceleration of ionized dopants at high energy into the surface of the wafer:

- Junction depth is dependent on the acceleration energy and substrate concentration.
- The maximum concentration of the dopants in the wafer is dependent on the dose of dopants ions accelerated.



Ion Implantation



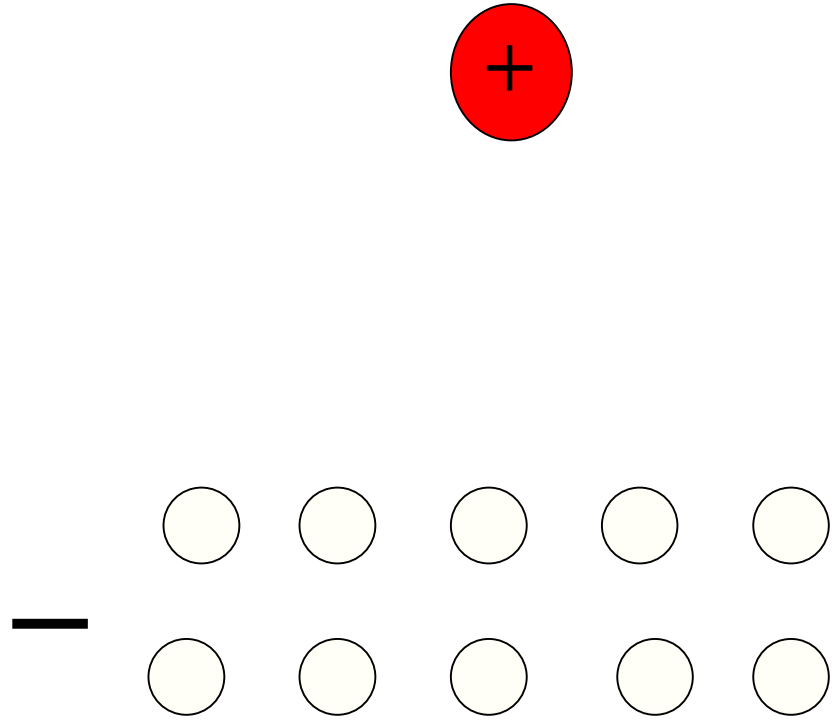
Schematic drawing of a typical ion implanter showing (1) ion source, (2) mass spectrometer, (3) high-voltage accelerator column, (4) *x*- and *y*-axis deflection system, and (5) target chamber.

Ion Implantation

- Low temperature process -> Photoresist, metal films etc. can be used as barrier mask
- Wider range of impurity species can be used
- Tight process control

Lattice Damage & Annealing:

- Ion impact can knock atoms out of the silicon lattice.
- Implantation damage can be removed by an annealing step
- At high temperature, silicon atoms can move back to the lattice sites



Diffusion versus Ion Implantation

Diffusion	Ion Implantation
High Temperature	Low temperature process
Narrow range of impurity species	Wider range
Maximum conc. at surface	Uniform profile
Simple	High cost
No crystal damage	Crystal damage