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Introduction

- Metallization is the fabrication step in which using metal layers , proper interconnection of the circuit element (various device structure fabricated on silicon substrate) is made.
- Aluminium is popular metal used to interconnect various devices .
- Alloys of aluminium with combination of copper and silicon are also used.
- Used because of
  - Low resistivity
  - Adhersion compatibility with SiO_2
  - Easily vacuum deposited
  - High conductivity

Introduction

- The application of metallization can be divided into the three parts:
  - Gate
  - Contacts
  - Interconnects
- For interconnects , fine line metal patterns are used to interconnect the thousands of MOSFETs and BJT devices in IC.
- For Gate ,polysilicon film is used .

Introduction

- The desired properties of metallization for integrated circuits are:
  - Easy to form
  - Easy to etch
  - Low resitivity
  - Mechanically stability: good adherence and low stress.
  - Should not contaminate device, wafer or working apparatus
  - Surface Smoothness
  - Stability throughout processing, including high temperature sinter, dry and wet oxidation gettering etc.
  - Good device characteristics and lifetimes.
  - Environmentally safe material during processing and actual use, and recyclable.
  - Low cost.

Method of Metallization

Physical Vapour Deposition (PVD)

- This method is fundamentally a vapourization coating technique, involving the transfer of the material on an atom level.
- It is alternative process of electro-plating.
- There are two categories of PVD
  - Evaporation
  - Sputtering

Method of Metallization

Evaporation

- The evaporation is most common method of thin film deposition, the three steps of the evaporation process for metallization are:
  - The solid aluminium must be changed into a gaseous vapour.
  - The gaseous aluminium must be transported to the substrate.
  - The gaseous aluminium must condense on the substrate.

Method of Metallization

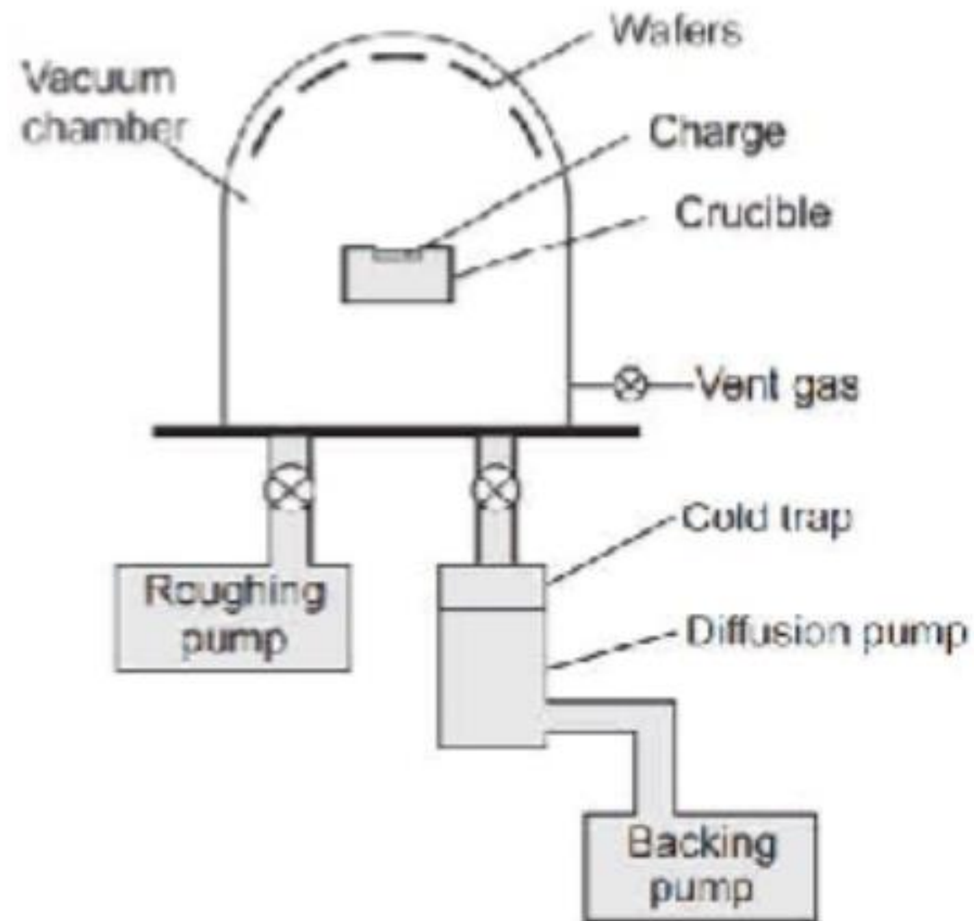


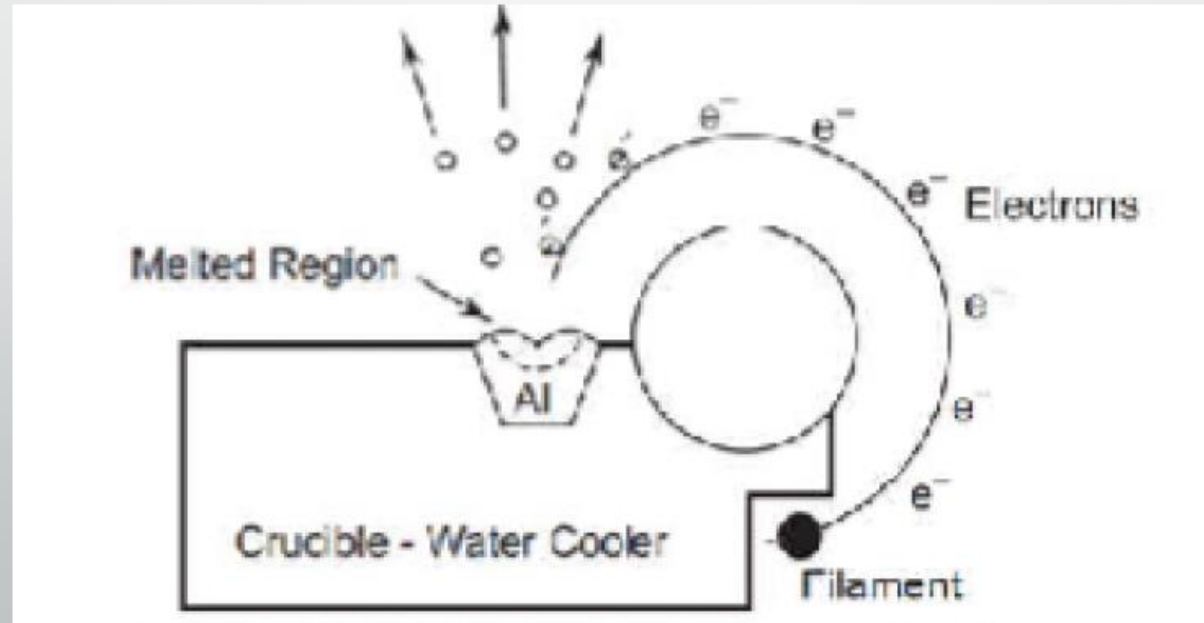
Fig. 11.11 *Evaporation Process*

Method of Metallization

- The process chamber is shown in figure which consist of quartz bell jar, in which element is heated by thermal resistance, and vaccum of 0.00005 torr is established for the process.
- As the temperature rises , the metal in the crucible chamber starts to melt, then the current through the filament is further increased, until metal (crucible) vapourised.
- The vapourised metal is set on the substrate with the help of mask.
- The metal vapor then condensed on substrate of semiconductor wafer,forming a desired layer.

Method of Metallization

- We can use also e-beam in place of filament or heating or vapourisation.
- The e beam evaporation uses a focussed beam of electron to heat the metal for deposition.
- The metal is kept in a water cooled crucible and exposed to e beam causing it to vaporization and condense on wafer.



Method of Metallization

Sputtering

sputtering is the term used to describe the mechanism in which atoms are ejected from the surface of material when that surface is stuck by sufficiently energetic particles for metallization.

Need of sputtering

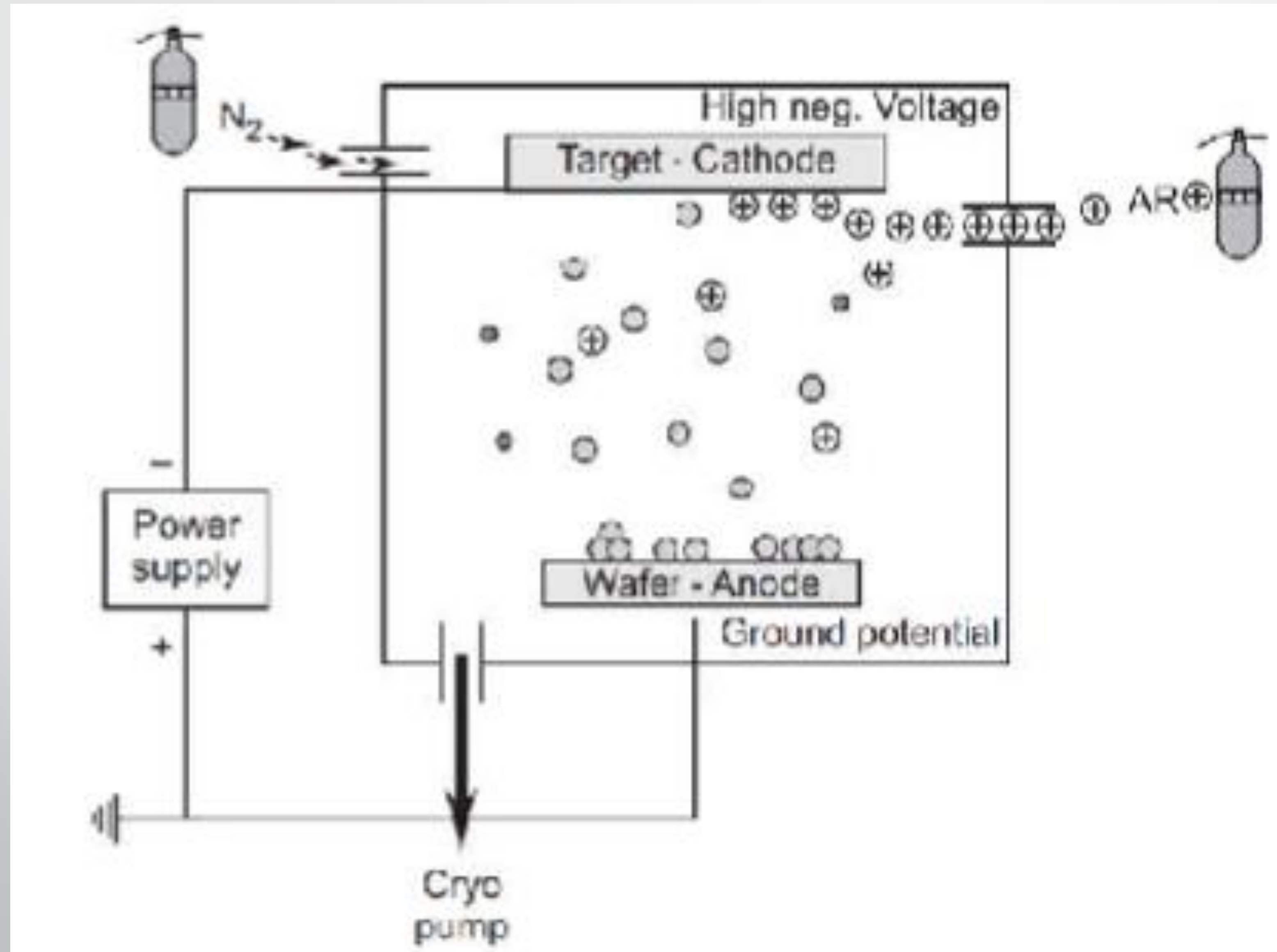
- **It is uses large area targets which give uniform thickness over the eafer**
- **It controls the thickness by depth-time and other parmeters.**
- **It also controls the film properties as step coverage and grain structure.**
- **Sputter cleaned the surface in vacuum prior to deposition.**

Method of Metallization

Steps of Sputtering

- Ions are generated in the chamber, the argon gas is usually used for this purpose .The ions are ionised to positive charged atom.
- The positively charged atoms /ions are attracted to the ground target.Ions start sputtering the target atom.
- The sputtered atom/molecules scatter in the chamber with some coming to rest on wafer..
- Atom condense and form thin film or metallic line as required.

Method of Metallization



Method of Metallization

Table 11.5: Comparison of Evaporation and Sputtering

Evaporation	*Sputtering*
1. low energy atoms	higher energy atoms
2. high vacuum path	low vacuum, plasma path
• few collisions	• many collisions
• line of sight deposition	• less line of sight deposition
• little gas in film	• gas in film
3. larger grain size	smaller grain size
4. fewer grain orientation	many grain orientation
5. poor adhersion	better adhersion