

## LAB REPORT - IV

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**Objective:** Sputtering by using Physical Vapor Deposition

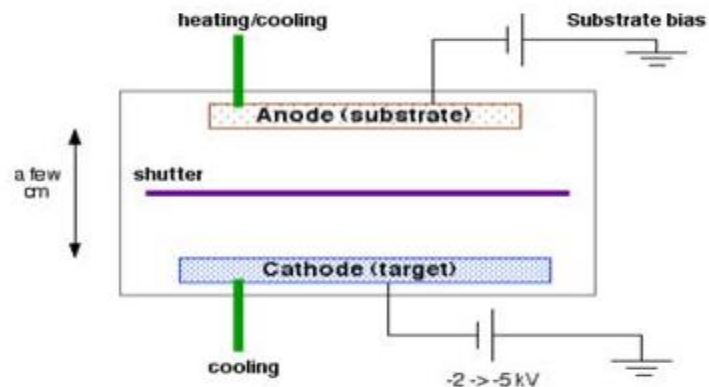
### **Theory:**

#### **Sputtering:**

Sputtering is highly versatile vacuum coating system which is used for deposition of various coating materials.

Plasma gas is used to knock atoms out of the target. As a result, atoms get deposited on wafers as shown. Higher pressure generates better coverage. The excess energy of metal ions helps to increase surface mobility (i.e. movement of atoms on surface).

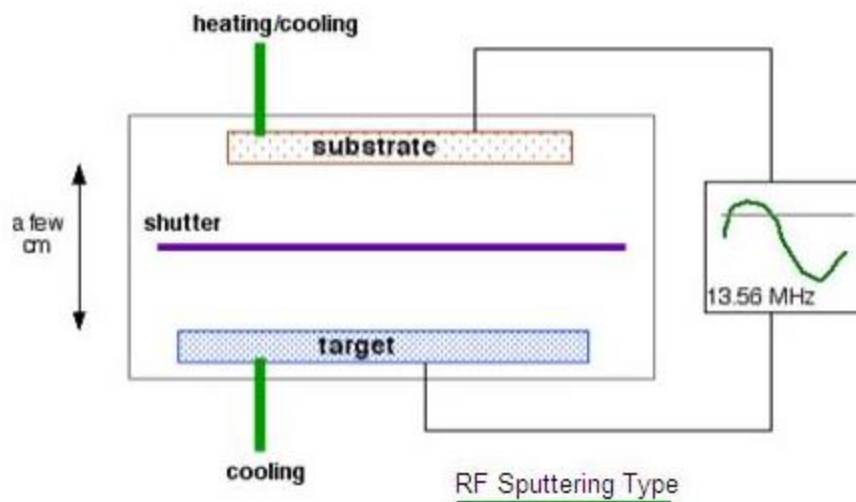
#### **DC sputtering:**



- DC power is usually preferred for electrically conductive target materials as it is easy to control DC power.
- Chamber pressure is usually 1 to 100 mTorr
- It is cheaper technique when large quantities of large substrates are dealt with.

- In this technique, positively charged sputtering gas is accelerated towards the target. This results in ejection of atoms which gets deposited on substrate.
- In **DC sputtering**, source of power is DC (Direct Current) type.

## RF sputtering



- RF power is suitable for all the materials but most commonly used for depositing films from dielectric target materials.
- Deposition rate is low compare to DC sputtering.

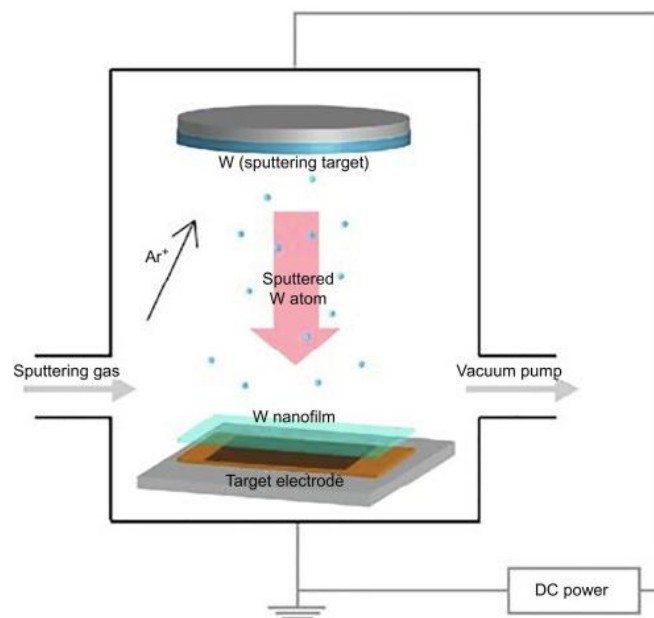
## Reactive sputtering:

. RF or Radio Frequency Sputtering is the technique involved in alternating the electrical potential of the current in the vacuum environment at radio frequencies to avoid a charge building up on certain types of sputtering target materials, which over time can result in arcing into the plasma that spews droplets

## Physical Vapor Deposition (PVD)

In the first step of PVD, atoms are removed from the target material by using a high-energy ion source in the presence of a vacuum and an inert gas, usually argon. A high-energy source is provided to the target material, so atoms are vaporized from the target surface. Then the vaporized atom moves toward the substrate surface and is placed in the chamber. The reaction occurs when the deposited material is a metal oxide, carbide, or nitride, otherwise it will not occur. The vaporized atoms reach the substrate surface and are deposited there in the form of a thin layer.

The PVD process generates a uniform layer, on the nanoscale to the visible scale, on the substrate surface. This technique can be used to incorporate the layers of almost all inorganic materials, and even some organic materials. Less resistance is induced in the PVD process, so through heterogeneous nucleation a tight layer formation occurs with improved mechanical properties like hardness and wear resistance.



## Procedure for Sputtering Physical Vapour Deposition:

- ➔ In this experiment we are using silver as target material and Titanium oxide as a substrate.
- ➔ Nano PVD is used to creating, vacuum, plasma, to pump the Ar gas and to establish temperature in the chamber. With this we can control the pressure level We are using Ar gas for creating the plasma.



- This sputtering gas we are pumping in quantity like 1 standard cubic cm(scm ). Here we created 10 scm.
- Here we are giving DC power to create plasma by using Nano PVD.
- For our experiment we use turbo pump(to create very less vacuum value and rotary pump creating vacuum level less than  $5 \times 10^{-5}$  mill bar. In general it will take around 30 minutes to reach required vacuum level. By this vacuum we are reducing the pressure in the chamber. Vacuum increases the directivity and uniformity.
- Placing a target material Silver inside the chamber.



- **Pre sputtering:** After crating the plasma to remove the contaminants a we perform sputtering is called pre sputtering. With is pre sputtering top layer is cleaned.
- After pre sputtering we have to go for the substrate rotation to achieve uniform deposition on the substrate.
- With help of shutter we close the chamber and wait for creation of plasma for 10 to 15 mentis. Then opens the shutter until we achieve the required thickness of Silver layer on the Ti, we can track the thickness level in PC which is connected with chamber.
- Ar and Nitrogen cylinders

*& explain the procedure properly*



**Precautions:** Before switching ON the Nano PVD , we need to switch ON chiller( which is used to reduce the temperature.

- ➔ For opening the chamber we need to create room pressure inside for that we using Air gas again. This blackening pressure process takes 20 minutes. Simultaneously turbo pump speed decrease, when turbo speed reduce to 40%, then we need to pump Air gas inside the chamber.



