# Laboratory Report

Growth of Thin Films by Electron-Beam and Thermal Evaporation System

**Guide: Prof. Padmnabh Rai**

**A R Bathri Narayanan**
Roll no: P0211501
UM DAE Centre for Excellence in Basic Sciences

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# Objectives:

Growth and characterization of thin films by electron-beam and thermal evaporation systems.

1. Chromium and copper thin film deposition on cover glass slips using electron-beam and thermal evaporation techniques, respectively.
2. Thickness determination of the deposited thin films using a profilometer.
3. To measure the resistivity of the thin films using the Four-probe or Van der Pauw method.

# Theory:

1. **Electron Beam Evaporation and Thermal Evaporation:**
   Electron Beam Evaporation is a form of Physical Vapor Deposition (PVD) in which the target material is bombarded with an electron beam from a charged tungsten filament. From crucible, material evaporates and converts into a gaseous state for deposition of the material to be coated onto the substrate. This is carried out in a high vacuum chamber. Thermal Evaporation is one of the simplest PVD techniques. Basically, target material is heated in a vacuum chamber until its surface atoms have sufficient energy to leave its surface. The atoms will traverse the vacuum chamber, at thermal energy and coat a substrate. The pressure in the chamber must be below the critical point where the mean free path is longer than the distance between the evaporation source and the substrate.
2. **Vacuum system:**
   **Turbo Molecular Pump (TMP):** It is used to create high vacuum in the chamber. The ultimate vacuum of TMP is in the range of $5 \times 10^{-10}$ mbar.
   **Rotary pump:** It is a dry pump used to create fore vacuum in the chamber and to serve as a backing pump for the TMP. It achieves an ultimate vacuum in the range of $5.0 \times 10^{-2}$ mbar.
   **Substrate heater:** The heater is used to heat the substrate for better deposition. A 2-inch heater is equipped with this evaporation system which can be used to heat the substrate up to 800°C.
   **Quartz Crystal Microbalance (QCM):** It is used to measure the thickness of the film deposited on a substrate. This is achieved by tracking the frequency response of a quartz crystal during the coating process. The change in frequency can be directly related to the amount of coating material on the crystal surface.
3. **Thickness Profilometer:**
   A thickness profilometer is an essential instrument used for measuring the thickness of thin films and coatings. It works by scanning the surface of a sample and recording the topographical variations with high precision. The device typically uses a stylus or optical method to trace the surface contours, providing detailed information about the film uniformity and thickness.

# Observations: