Design and Construction of a Deposition Chamber for Thin Metal Films Research

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Abstract

A high vacuum deposition chamber is being built at Houghton College for studies of thin metal films. Metal atoms evaporated via an electron beam will contact a silicon wafer at near normal incidence, growing a uniform thin film. An ion mill will be constructed for cleaning the silicon wafers and for ion beam assisted deposition (IBAD). A computer-controlled shield will enable deposition of samples of varying thickness.

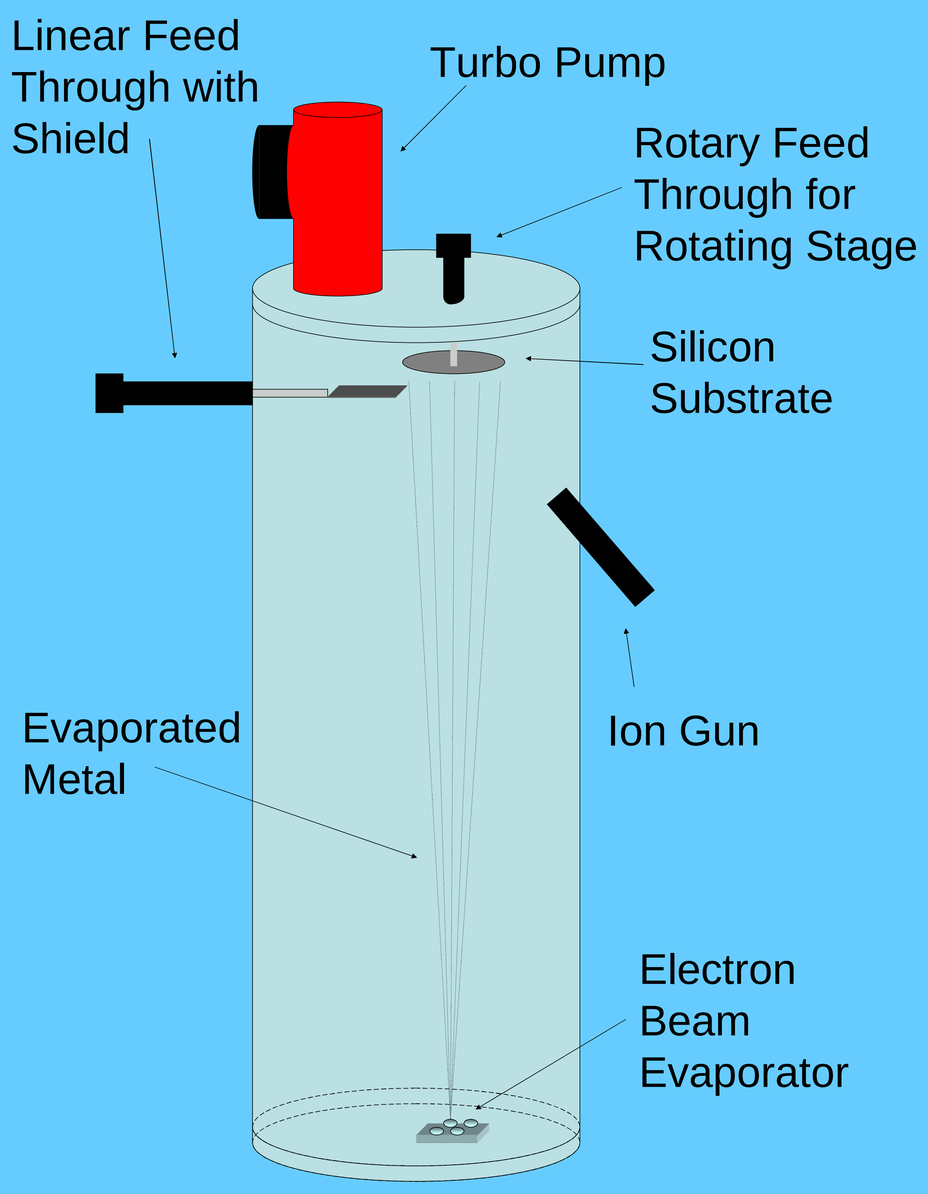

Figure 1 Completed Deposition Chamber

Motivation

Thin metal films are used in many applications from small integrated circuits to mirrors. Large stresses are inherent to these films and are not well understood. It is hoped that a model can be produced that will enable accurate prediction and even tailoring of the mechanical properties of the films.

Design

Chamber - The aluminum chamber (Fig. 1) is 3 feet tall to cause the metal atoms to contact the silicon wafer at an angle close to normal.

Vacuum Pumps - The chamber will be pumped down first using a rough pump and then will be pumped down further using a turbo pump with the expected final pressure being in the 10^{-7} torr range.

Rotating Stage - The silicon wafers will be mounted to a rotating stage so that the sample may be rotated during deposition to even out any inconsistencies in deposition rate across the sample.

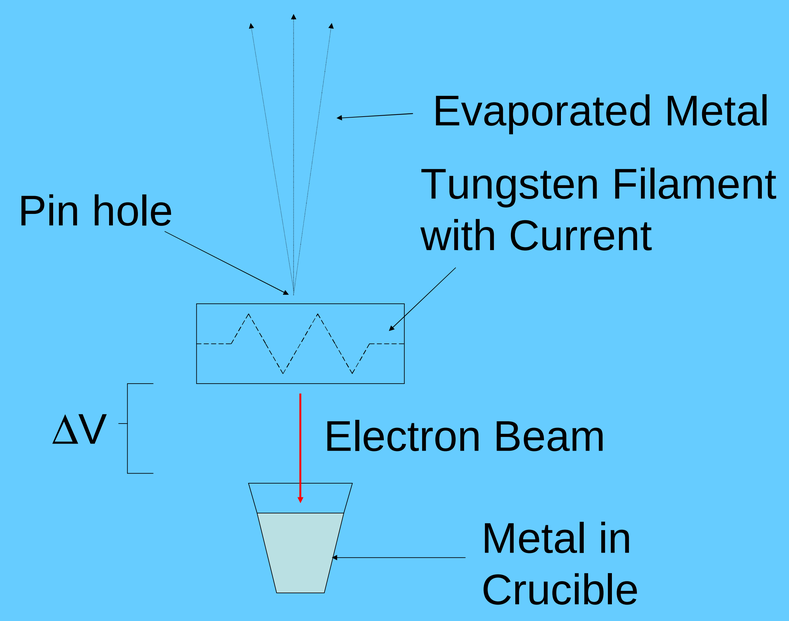

Figure 2 Electron Beam Evaporator

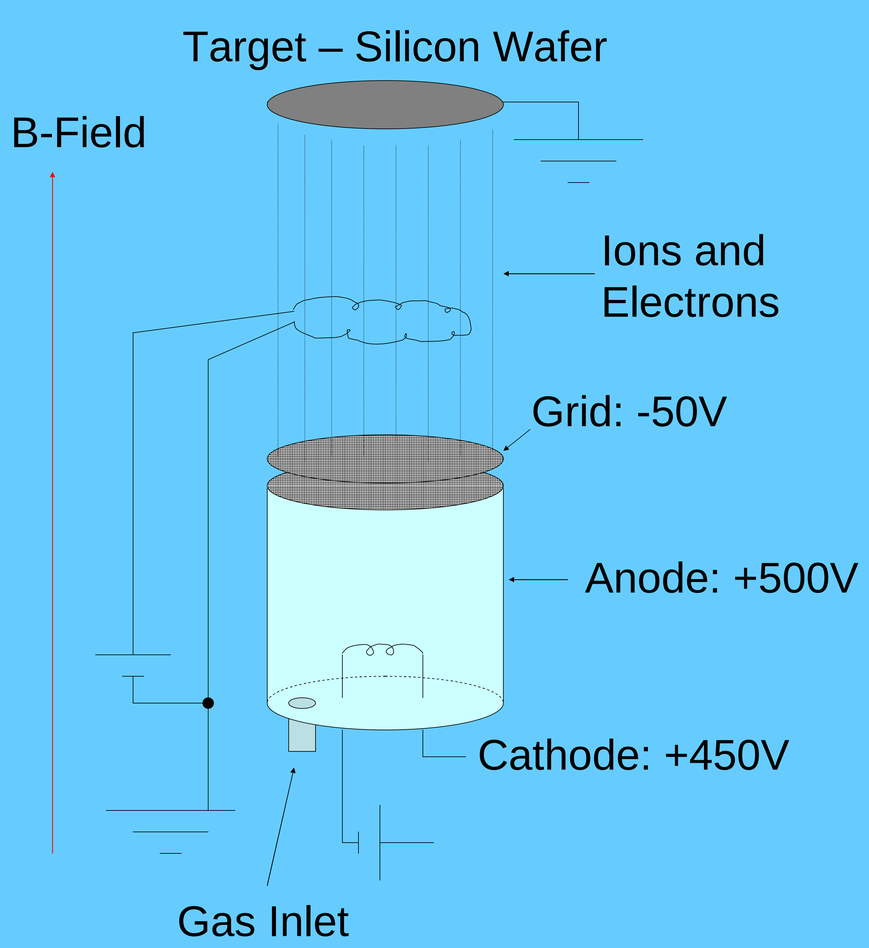

Figure 3 Ion Gun

Electron Beam Evaporator – As shown in Figure 2, a current will be run through a tungsten filament causing electrons to come off of the wire. They will then be accelerated through a potential difference that directs them to a crucible containing the metal to be evaporated. Because a portion of the metal atoms will be ionized, the high voltage current will be proportional to the deposition rate. There will be four crucibles with individual tungsten filaments allowing for up to four different metals to be deposited on to one sample without having to break vacuum and risk contaminating the sample.

Ion Gun- As shown in Figure 3, gas will be leaked into the gun and electrons will be emitted by the cathode and accelerated towards the anode. The magnetic field will be created by a coil around the outside of the gun. This will curve the path of the electrons, increasing the likelihood of a collision with a gas atom. In these collisions, the gas atoms will be ionized. When these ions travel out of the first grid they will be accelerated through the second, towards the sample. During the trip they will be supplemented with electrons by the coil that is in the path so that the ion-beam as a whole is neutral and the sample is not charged.