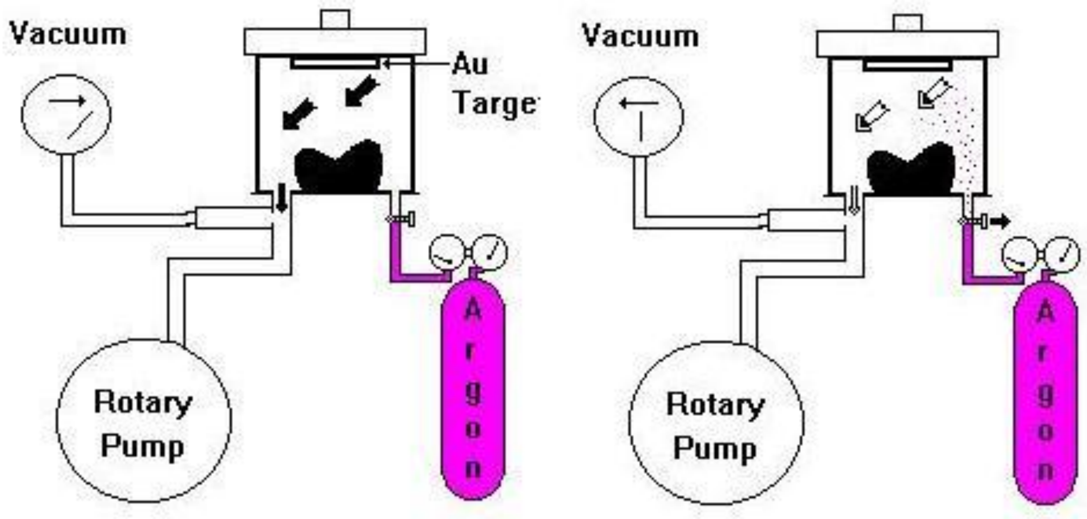
Plasma Sputter Coating

In conventional SEM sputter coating a gold (gold-palladium, or platinum) target is bombarded with heavy gas atoms (usually argon but air is a fair substitute). Metal atoms ejected from the target by the ionized gas cross the plasma to deposit onto the any surface within the coating unit including the specimen. A low vacuum environment is used (0.1 to 0.05 mbar), which with one of the modern low voltage sputter coaters, enables metal to be deposited at up to 1nm/s[1].

Sputtered metals are deposited in the form of islands, NOT a continuous coating. Although the coating will be relatively random, a coating unit should be tuned in order to obtain the optimum grain size, coating penetration and coating thickness, for the task in hand.

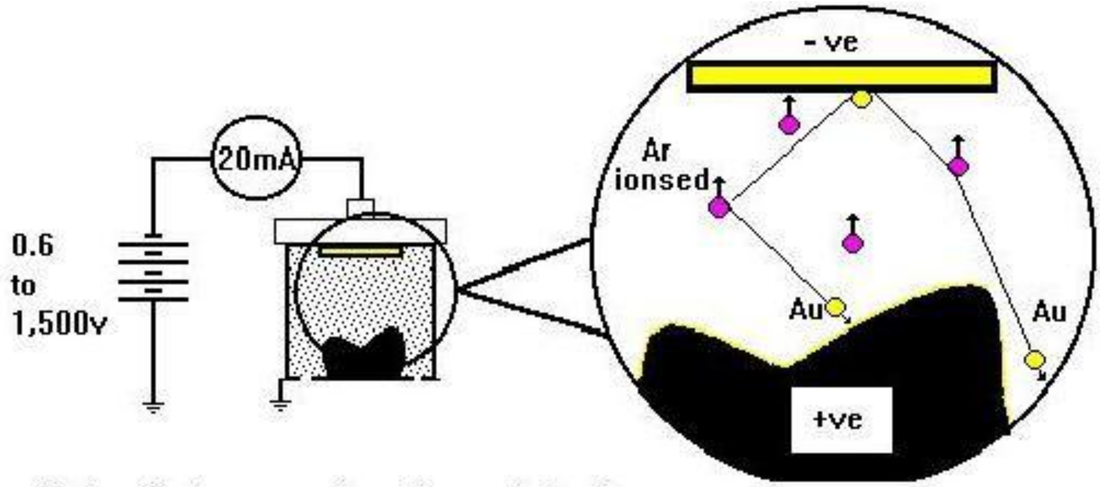
Operation

The conventional sputter chamber is pumped with a rotary pump until the vacuum level is beyond half scale on whatever gauge the manufacturer supplies (do not worry about the vacuum units). Leak argon gas into the chamber to flood the chamber, allow the vacuum to recover. Apply the lowest voltage that will allow a plasma to strike, determined by the tests below.



Tuning a Sputter Coater

For fairly smooth surfaces deposition rate tests may be conducted using a glass slide or a piece of white typing paper. The variables are, gas pressure, specimen to target distance, discharge current and operating voltage. A grey coating on the white paper should be sufficient for most work. Adjust the coating unit to obtain this level of coating in the shortest time, but over the widest possible area. Take care, as it is possible for the coater to deposit at different rates in different areas of the specimen stage! Typical values could be on a variable voltage system: - 0.8kV, 20mA, 5cm working distance, 0.1 mbar, for 30 seconds, to achieve a 2nm coating.



Modern Coaters use a deposition control or the gas flow to adjust the current at a low sputtering voltage. Older style coaters use a higher sputtering voltage the current being controlled by a voltage regulator or the gas flow.

Deposition Rate and Film Thickness

Coating speed is depended on target material and sputtering current and coating time. The following formula can be used to estimated gold and platinum film thickness

D = K I T

Here:

- D= film thickness (A)
- K = material constant , for gold material in Ar gas, K ~ 0.17, and for Pt, K ~ 0.9
- I = Sputtering current (mA) , which is adjusted by Ar gas partial pressure
- t = time (S)

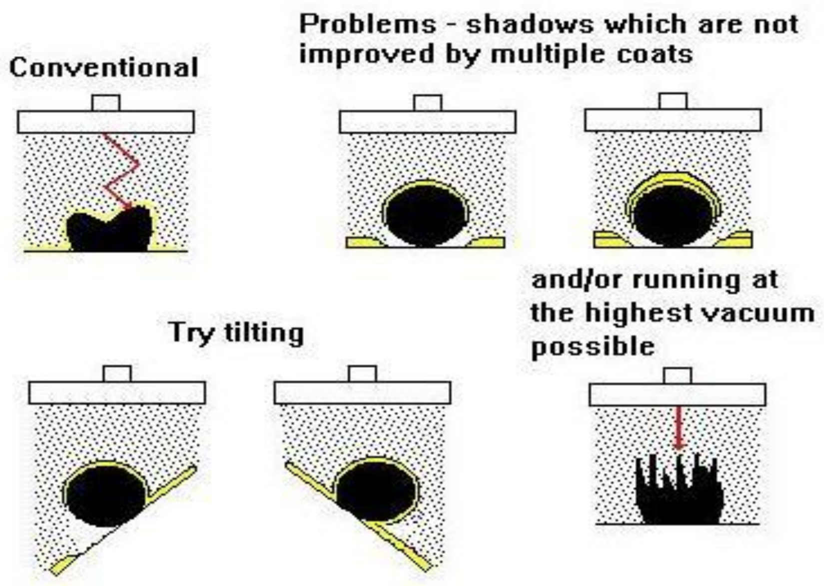
For example, for gold film under Ar partial pressure with current 8 mA for sputtering 100 s, film thickness is about 0.17x8x100 = 136A. You may repeat coating to obtain thick film.

For different materials, you shall practice by yourselves to achieve best parameters and experience.

Modern Low Voltage systems use a variable frequency rather than a variable voltage to change the deposition rate. These instruments run between 400 and 600 volts and usually require very low currents for a suitable coating e.g. 10mA for 30 seconds.

To determine the optimum conditions for penetration into rough surfaces you require a set of nuts (as in nuts and bolts) varying in height between 2 and 5mm and varying in hole diameter between 1 mm and 3mm. Once again vary the operating conditions, but this time the object is to deposit metal onto the paper but within the nuts. A good coater, well set up, should be able to deposit metal down a hole 5mm deep by 2mm diameter, without making the surround any more than a pink colour. You will find that the better vacuum level the easier it will be to deposit metal deep within structures, in other words turn off the gas inlet and give the system plenty of time to pump down.

In the case of small particles, the shadow created in the coating by the particle, may be sufficient to prevent a continuous conducting layer. Even a very thick coating will rarely overcome this problem. The ideal solution is to coat the specimen tilted at 45 degrees to the target and then repeat with the specimen tilted in the opposite direction.



Tooth brush shaped specimens may also need a "straight line" coat by running the system with the gas turned off. Leakage is usually enough to enable you to strike a plasma but a higher than normal voltage will be required.