RAMA UNIVERSITY

www.ramauniversity.ac.in

FACULTY OF ENGINEERING AND TECHNOLOGY

MEMS-035

Lecture -06

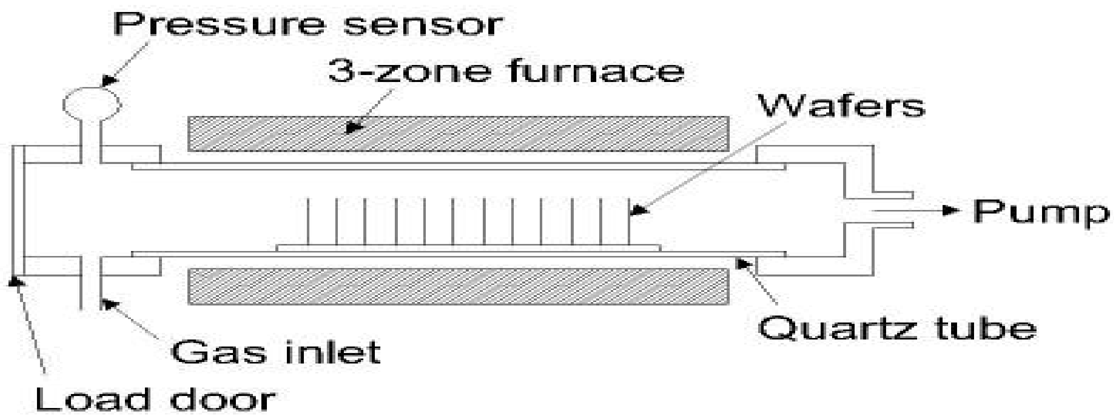
DEPOSITIONS THAT HAPPEN BECAUSE OF A **PHYSICAL** REACTION

- **P**hysical **V**apor **D**eposition (PVD)
- Casting

CHEMICAL VAPOR DEPOSITION (CVD)

The substrate is placed inside a reactor to which a number of gases are supplied. The fundamental principle of the process is that a chemical reaction takes place between the source gases. The product of that reaction is a solid material with condenses on all surfaces inside the reactor.

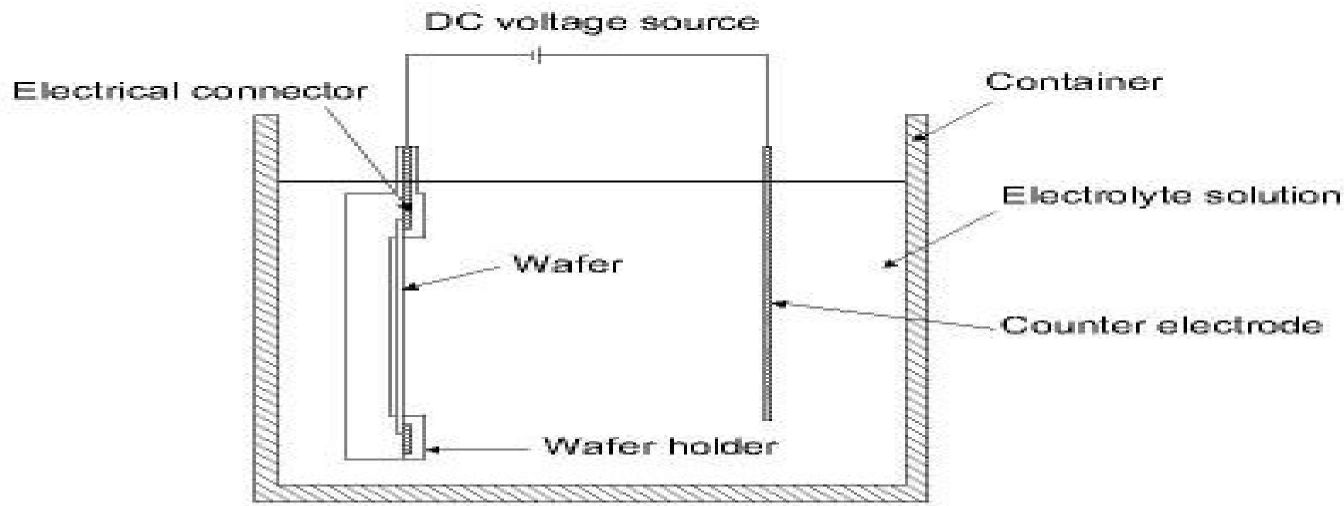
The two most important CVD technologies in MEMS are the **L**ow **P**ressure CVD (LPCVD) and **P**lasma **E**nhanced CVD (PECVD). The LPCVD process produces layers with excellent uniformity of thickness and material characteristics. The main problems with the process are the high deposition temperature (higher than 600°C) and the relatively slow deposition rate. The PECVD process can operate at lower temperatures (down to 300° C) thanks to the extra energy supplied to the gas molecules by the plasma in the reactor. However, the quality of the films tends to be inferior to processes running at higher temperatures. Secondly, most PECVD deposition systems can only deposit the material on one side of the wafers on 1 to 4 wafers at a time. LPCVD systems deposit films on both sides of at least 25 wafers at a time. A schematic diagram of a typical LPCVD reactor is shown in the figure below.



ELECTRO DEPOSITION\

This process is also known as "electroplating" and is typically restricted to electrically conductive materials. There are basically two technologies for plating: Electroplating and Electroless plating. In the electroplating process the substrate is placed in a liquid solution (electrolyte). When an electrical potential is applied between a conducting area on the substrate and a counter electrode (usually platinum) in the liquid, a chemical redox process takes place resulting in the formation of a layer of material on the substrate and usually some gas generation at the counter electrode.

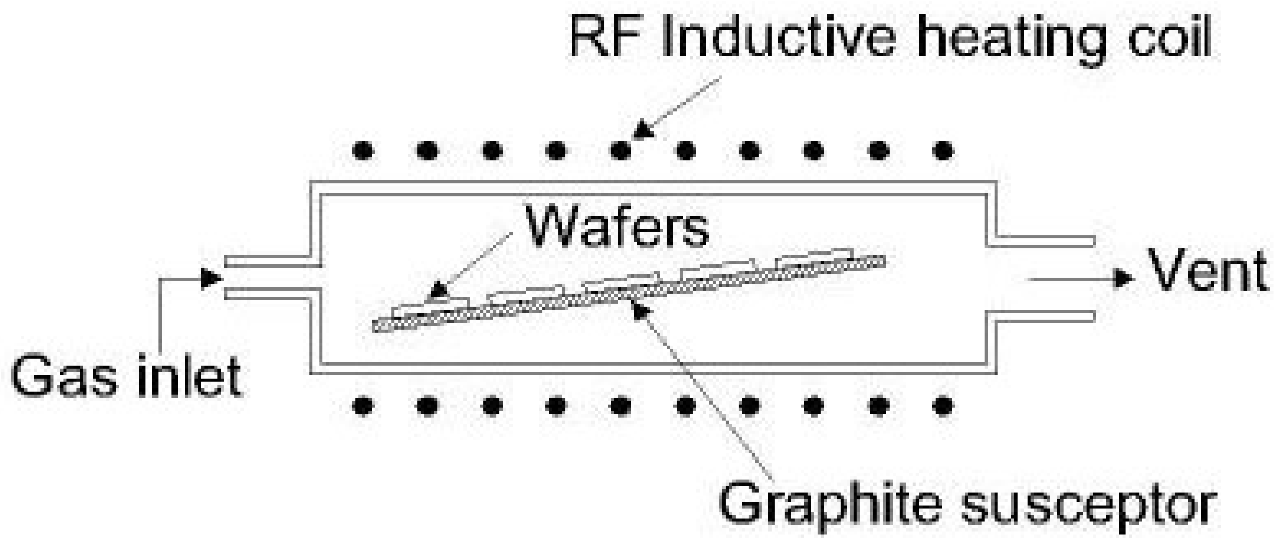
In the electroless plating process a more complex chemical solution is used, in which deposition happens spontaneously on any surface which forms a sufficiently high electrochemical potential with the solution. This process is desirable since it does not require any external electrical potential and contact to the substrate during processing. Unfortunately, it is also more difficult to control with regards to film thickness and uniformity. A schematic diagram of a typical setup for electroplating is shown in the figure below.



This technology is quite similar to what happens in CVD processes, however, if the substrate is an ordered semiconductor crystal (i.e. silicon, gallium arsenide), it is possible with this process to continue building on the substrate with the same crystallographic orientation with the substrate acting as a seed for the deposition. If an amorphous/polycrystalline substrate surface is used, the film will also be amorphous or polycrystalline.

There are several technologies for creating the conditions inside a reactor needed to support epitaxial growth, of which the most important is **V**apor **P**hase **E**pitaxy (VPE). In this process, a number of gases are introduced in an induction heated reactor where only the substrate is heated. The temperature of the substrate typically must be at least 50% of the melting point of the material to be deposited.

An advantage of epitaxy is the high growth rate of material, which allows the formation of films with considerable thickness (>100µm). Epitaxy is a widely used technology for producing silicon on insulator (SOI) substrates. The technology is primarily used for deposition of silicon. A schematic diagram of a typical vapor phase epitaxial reactor is shown in the figure below.


RF Inductive heating coil
Wafers
Vent
Gas inlet
Graphite susceptor