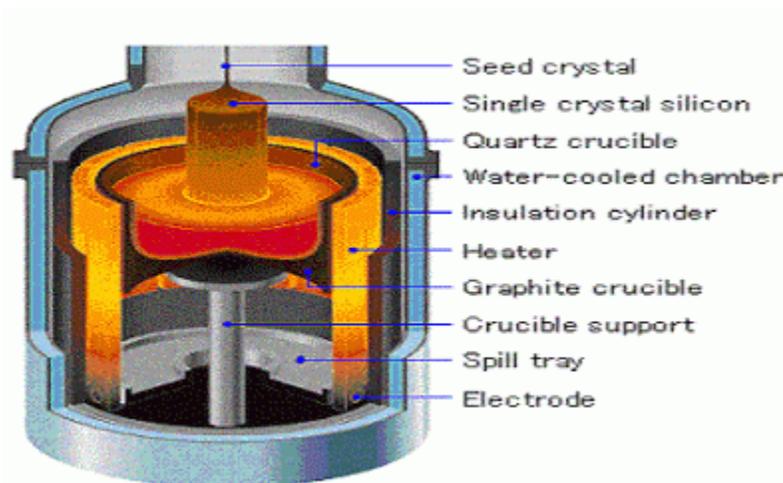


EQUIPMENTS REQUIRED IN VLSI FABRICATION

Several equipments are required for the complete wafer processing into a chip. Some of the important machines are listed here.

- **Crystal growers:** Single crystal ingots are produced by Czochralski (CZ) method. Resistivity is adjusted using the dopants, such as boron and phosphorus.



CZ grower [3] (click on the figure to enlarge it)

- **Wafer slicing machine:** This is used to cut single crystal ingot to wafers.
- **Spinner (Photo resist Coater):** A spinner used to apply photoresist to the surface of a silicon wafer. Spin speed and spin time can be adjusted.
- **Wafer Cleaners:** The processed wafers are cleaned and inspected to be polished wafers.
- **Wafer shaping machines (Lapping machines):** These machines are used to remove surface roughness.
- **Wafer polishing machine:** Used to make the wafer surface highly flat.
- **SIMOX implanter:** Defects made in the wafer surface are removed by annealing and ion implantation. This machine does this job.
- **Epitaxial furnace:** This is shown in the Figure (10). This furnace is used for Chemical Vapor Deposition (CVD) to grow epitaxial layer.
- **Hydrogen annealing furnace:** Used to improve the surface crystalline perfection by hydrogen annealing.
- **Aligner:** This machine is used to align mask to wafer or wafer to wafer.

Generally these machines have 4 modes of operation: proximity, hard and soft contact, vacuum contact. Machine configuration allows processing of 300 inch wafers.



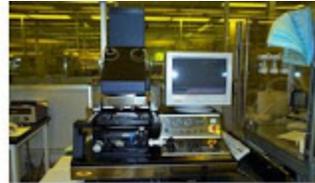
(click on the figure to enlarge it)

- Etchers:** Anisotropic etchings of nitride, oxide, silicon and polymer layers are possible with this machine. Plasma machines generally use chlorine- and fluorine-based chemistries for etching various Si, polysilicon, nitride, tungsten, tungsten silicide films. These machines have different selectivity options. Laser interferometer is used for etch rate determination and end point detection. Some etchers have four independent process chambers. These etchers are capable of metals, oxides and nitrides, silicon and polysilicon. Wafer size can be up to 300 mm.
- E-Beam Lithography System:** This is Ultra high resolution E-beam lithography system. Ultimate resolution specified to 60 nm with sub-30 nm features possible with this machine. E beam is directly exposed to wafers up to 300 mm diameter.
- Sputter Coater machines:** This is used for depositing a conductive coating for visualizing SEM samples.
- Ellipsometer:** Ellipsometer allows measurement of the thickness and refractive index of very thin transparent films.

- **Surface Profile meter:** This instrument is used to measure step heights and roughness of surfaces. It also measures many other surface topography parameters. The measurement technique is either contact or contact less; both are used in the industry. Optical phase shifting interferometry concept is being used in the equipment.
- **Asher:** Used to strip the photo resist from the wafer. Plasma of oxygen and nitrogen reacts with the photo resist and burns off the wafer.



SIMOX implanter [2]



Aligner [3]



Plasma etchers [3]



Deep RIE etcher [3]



E-beam lithography system [3]



Sputtering machine [3]



Surface profile meter [3]



Asher [3]

(click on the figure to enlarge it)

- **Laser Writer (mask making machine):** This machine accepts GDS II format input file and generate mask patterns.
- **Film Thickness Measurement:** This system uses non-contact, spectro-reflectometry (measurement of the intensity of reflective light as a function of incident wavelength) to determine the thickness of transparent films on substrates, such as silicon, that are reflective in the visible range.
- **Resistivity Measurement:** This resistive measurement instrument collects and analyzes sheet resistance data on various conductive layers such as implants, diffusions, epi, metals and bulk substrates.
- **Wafer Dicing saw:** This machine is used to cut the wafers into individual die. It utilizes rotary blade. Some wafer cutting machine diamond saw.

- **Field Emission Scanning Electron Microscope:** This is high resolution imaging instrument. This instrument has a resolution of 5nm and less.
- **Film Stress Tester:** This equipment measures the stress induced by the deposited films on a substrate. Deflection of a scanning laser beam is used for the measurement. With and without the deposited film change in the curvature of the wafer is measured.

Developer: Exposed photo resist wafers are developed with the help of this machine. This machine has facility for dispensing developer and post bake oven station. Number wafers and size of the wafer which can be processed is machine specific.

Source : <http://asic-soc.blogspot.in/search/label/VLSI%20fabrication>