Chapter 7

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Universal gates and Physics of Integrated circuits

Semiconductor purification : Zone refining : Silicon and germanium are mostly used semiconductor materials. Among those two silicon has wide use. Silicon material is prepared by the chemical decomposition of the compounds like SiO_2, $SiCl_4$ etc.

Through different chemical rexns, silicon is prepared with impurity concentration of about one part per million. The purified silicon is melted and cast into ingots. This ingot is polycrystalline in nature and it consists a large number of small single crystals having random orientation. This required purity level in silicon is obtained by a method known as zone refining.

Zone refining works on the principal that the impurities have higher solubility in the melt as compared to that in the solid. In this process, an impure silicon ingot is taken (the rod) is placed inside the zone refiner. An inert gas is filled inside zone refiner. A series of circular mobile heating coils are placed along the rod. The heater moves from one end to another end and the impurity atoms are shifted from one end to another end due to the melting of the rod by heater. The impurity gets collected at one of the end. By cutting the end at which the impurity is concentrated, the pure silicon semiconductor can be obtained.

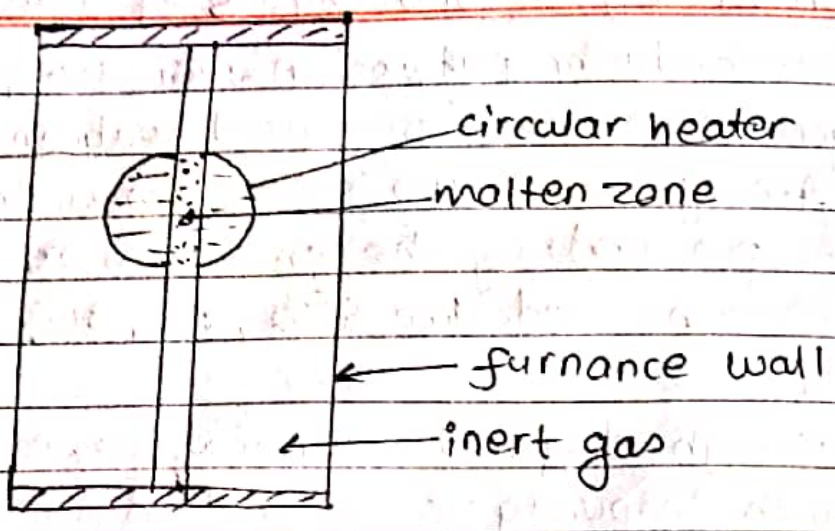


fig:- Zone refining

Single Crystal growth : To produce the silicon single crystal, the polycrystalline ingots are transferred into large single crystals. The method for growing large single crystals is called single crystal growth. Some of the single crystal growth methods are as;

(i) Czochralski method
(ii) Bridgmann-stockbarger method
(iii) Floating zone method.
(iv) Epitaxy.

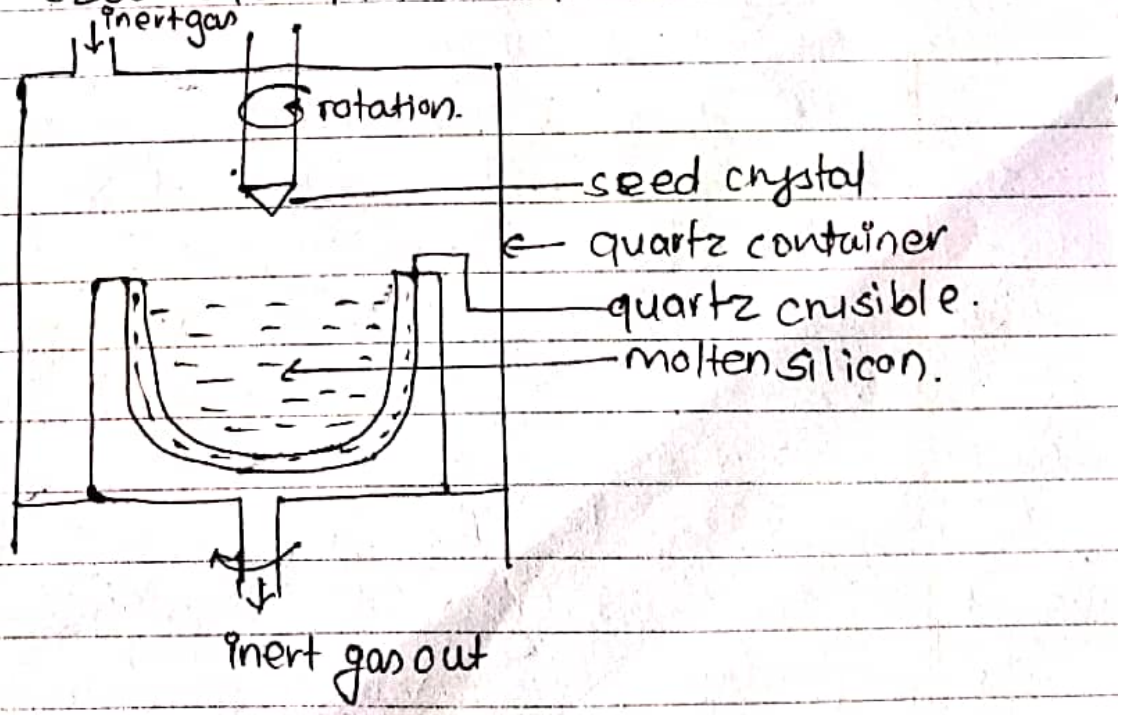
(i) Czochralski method : This method involves the following steps;

→ Preparation of highly pure molten silicon:-

- In this method, the highly pure silicon is used as molten form to produce the single crystal silicon. The solid form of silicon is heated to its melting points into a crusible (pot) made of quartz.

→ Dipping of seed crystal: The seed crystal is a small piece of single crystal material which is used to grow a large crystal of some material. When it is dipped into the saturated molten solution of silicon and then cooled, large crystal will grow.

→ Pulling seed upward: The seed is pulled upward from the molten silicon. During this process the rod and crusible rotate in opposite direction. to minimize the effect temperature on seed crystal. The seed crystal is slowly raised up, the molten silicon will solidify as on seed. This process is also called growing. The diagram of single crystal growth by czochralski method is shown below;



(11) Bridgmann. stock barger method

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* Process of IC production (IC - integrated circuit)