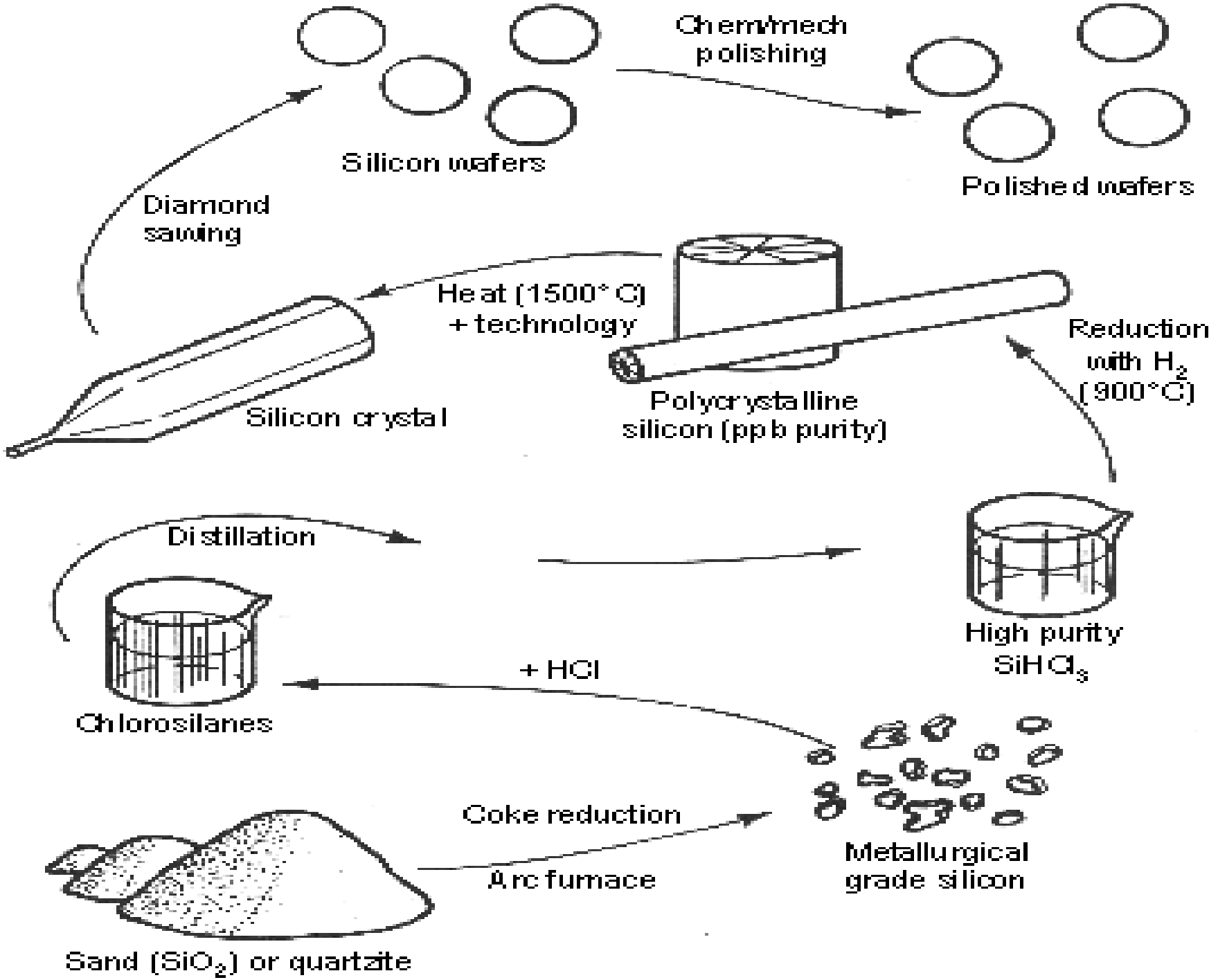
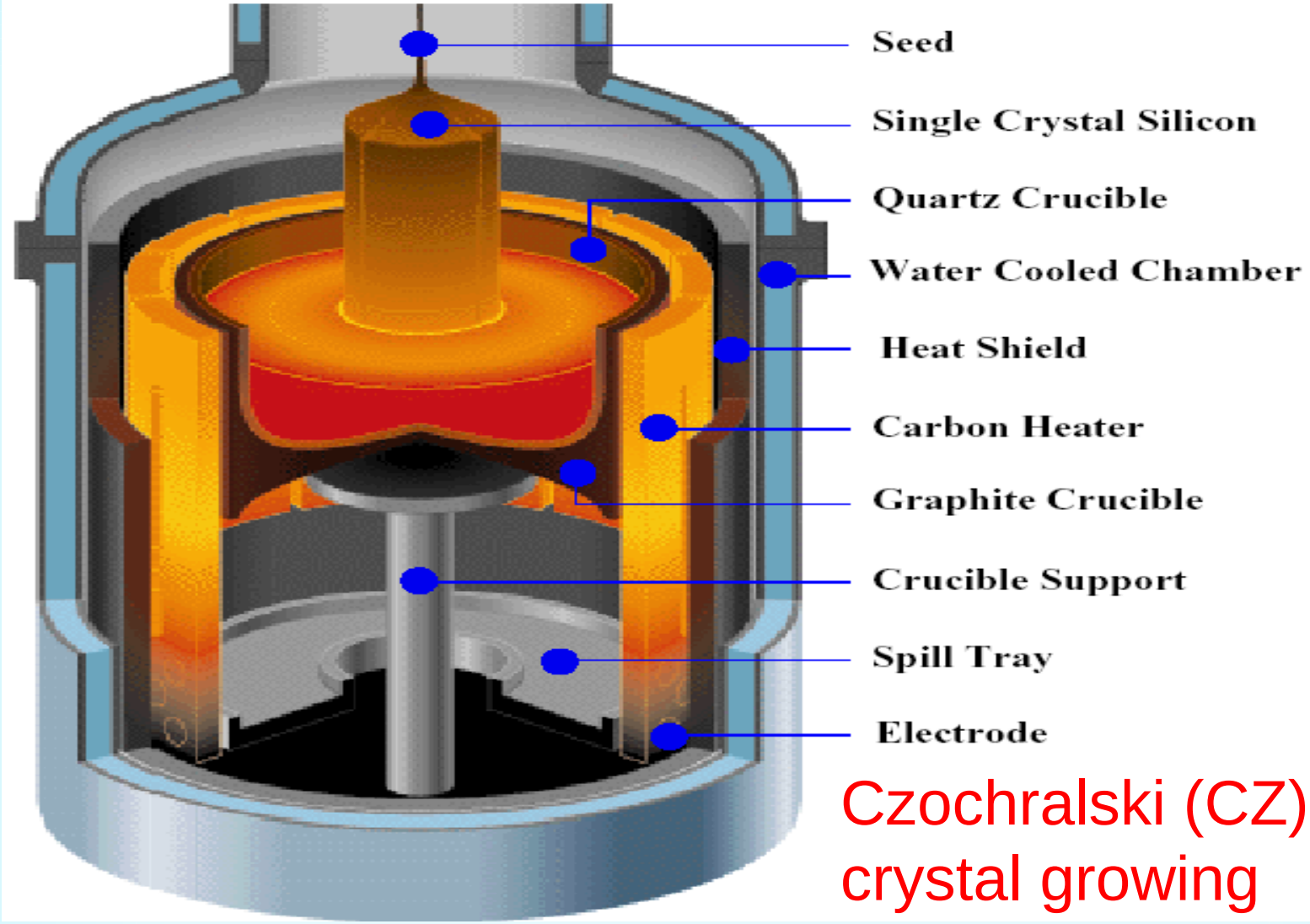
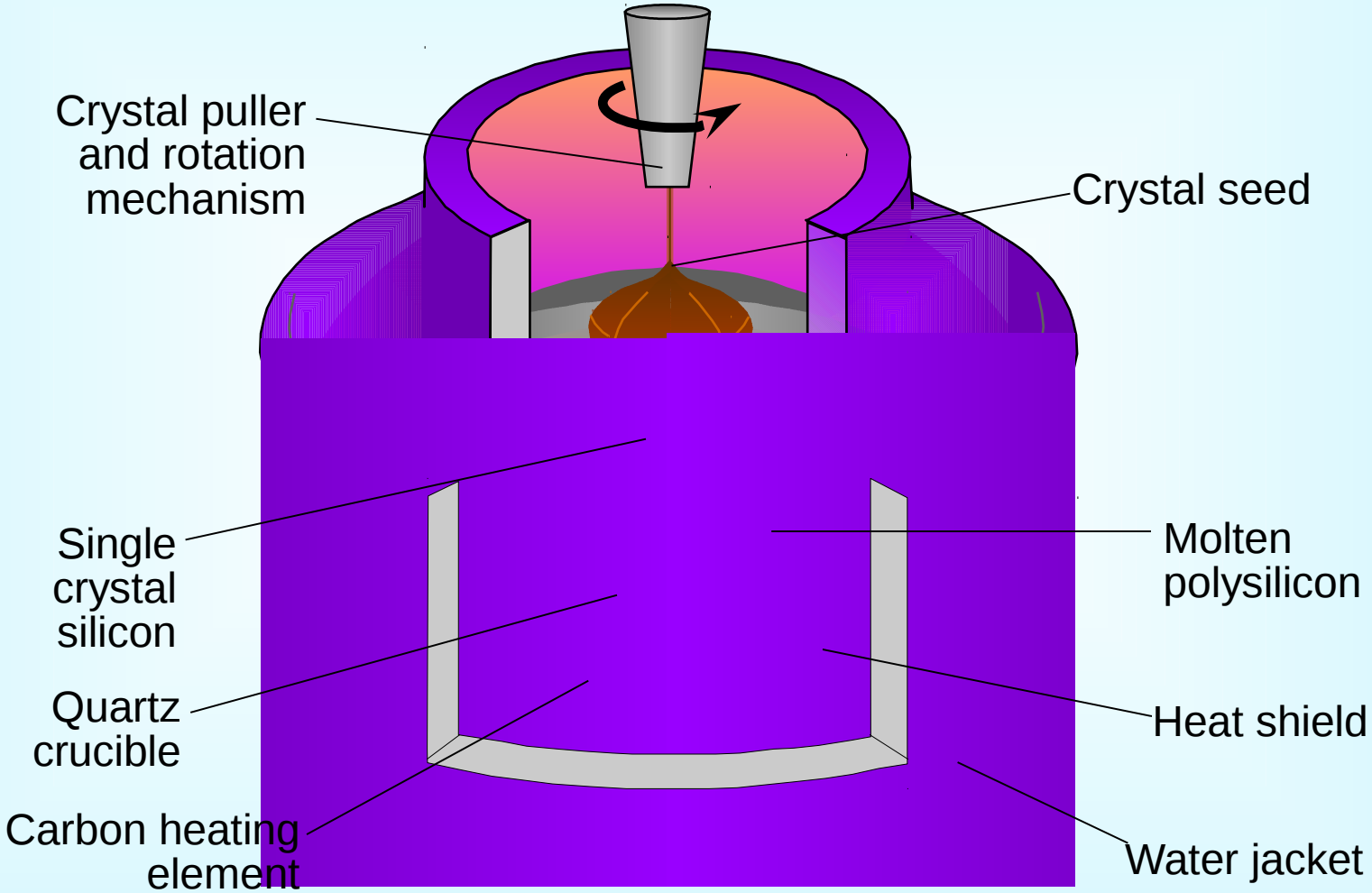

Chem/mech polishing
Silicon wafers
Polished wafers
Diamond sawing
Heat (1500° C) + technology
Reduction with H_2 (900°C)
Silicon crystal
Polycrystalline silicon (ppb purity)
Distillation
High purity $SiHCl_3$
+ HCl
Chlorosilanes
Coke reduction
Arc furnace
Metallurgical grade silicon
Sand (SiO_2) or quartzite



Czochralski (CZ) crystal growing

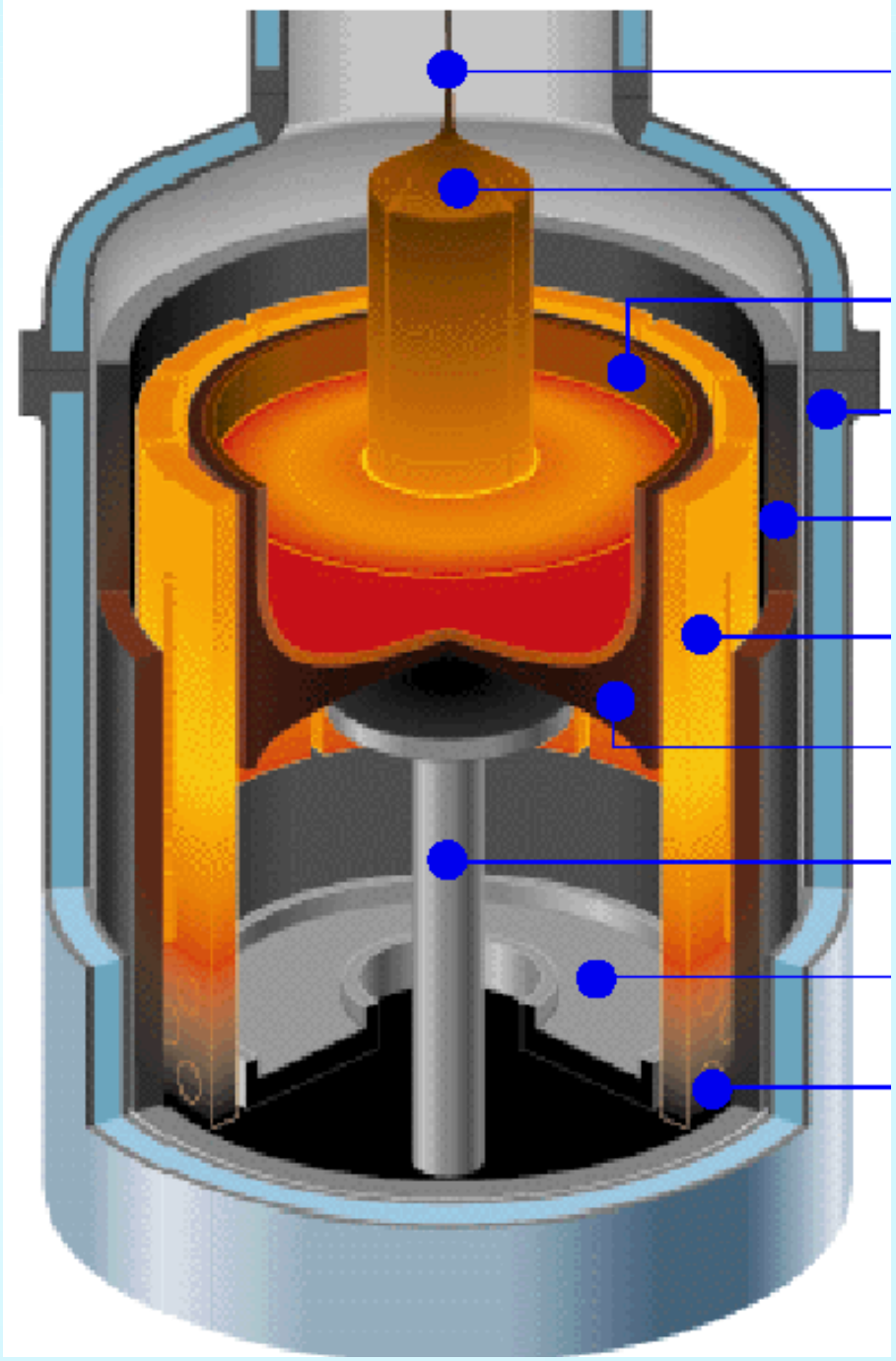
- **Si is purified from SiO2 (sand) by refining, distillation and CVD.**
- **It contains < 1 ppb impurities. Pulled crystals contain O (~1018 cm-3) and C (~1016 cm-3), plus dopants placed in t**

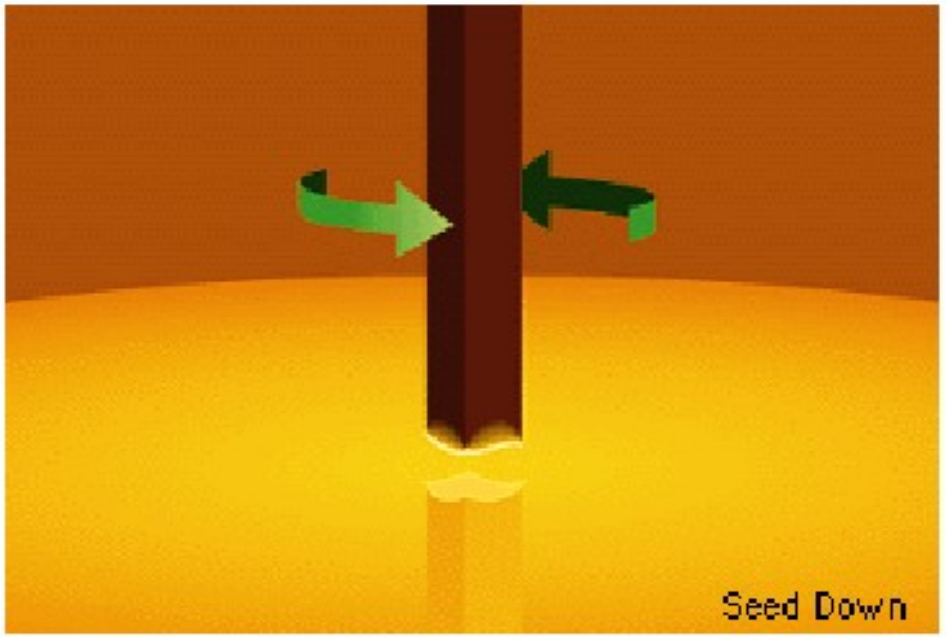
CZ Crystal Puller

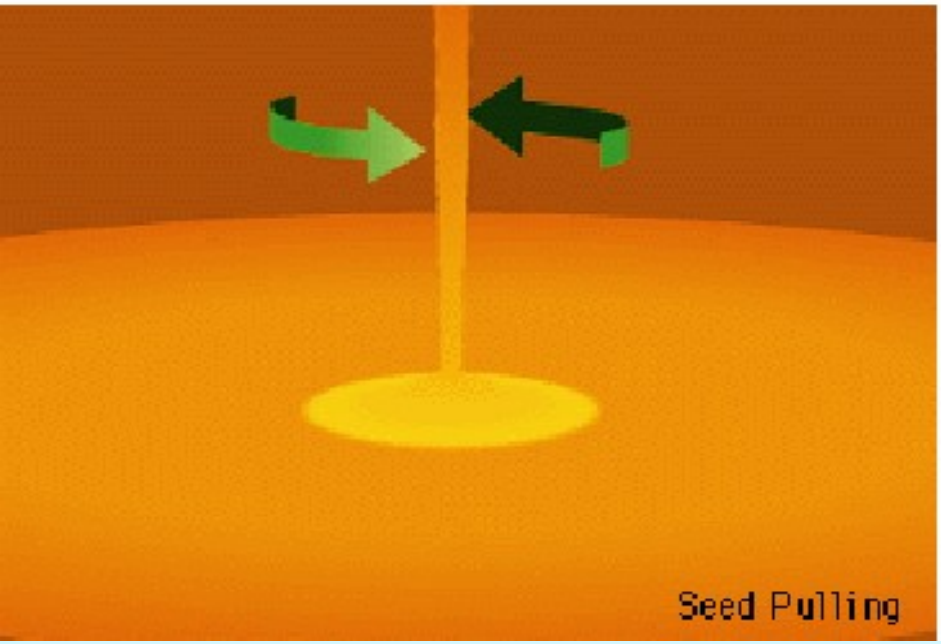


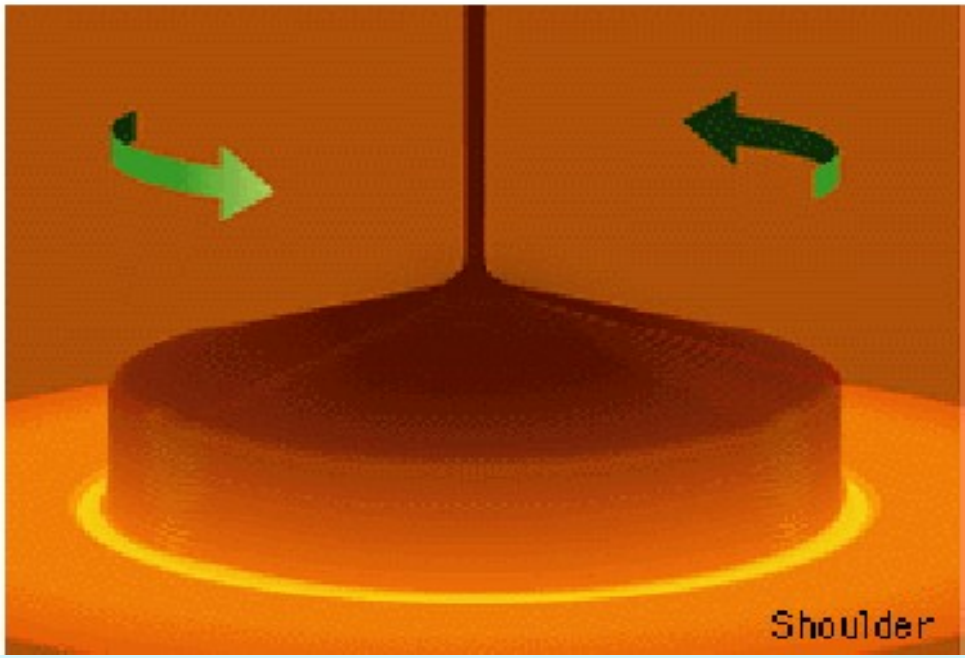
Plummer

- All Si wafers come from “Czochralski” grown crystals.
- Polysilicon is melted, then held just below 1417 °C, and a single crystal seed starts the growth.
- Pull rate, melt temperature and rotation rate control the growth



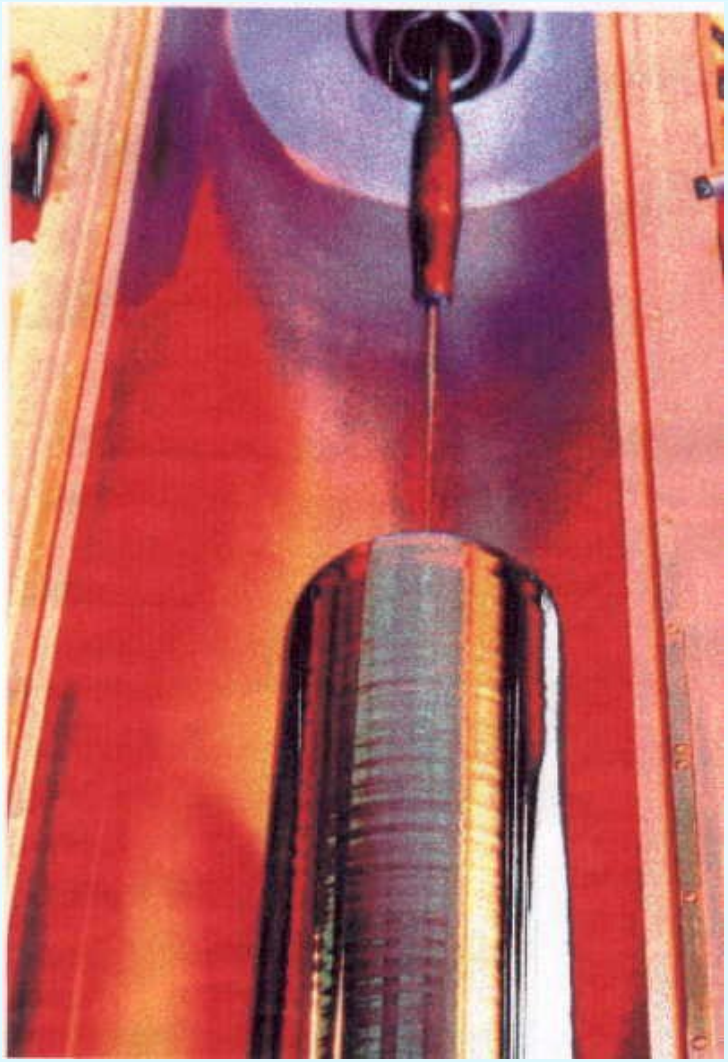






mmer

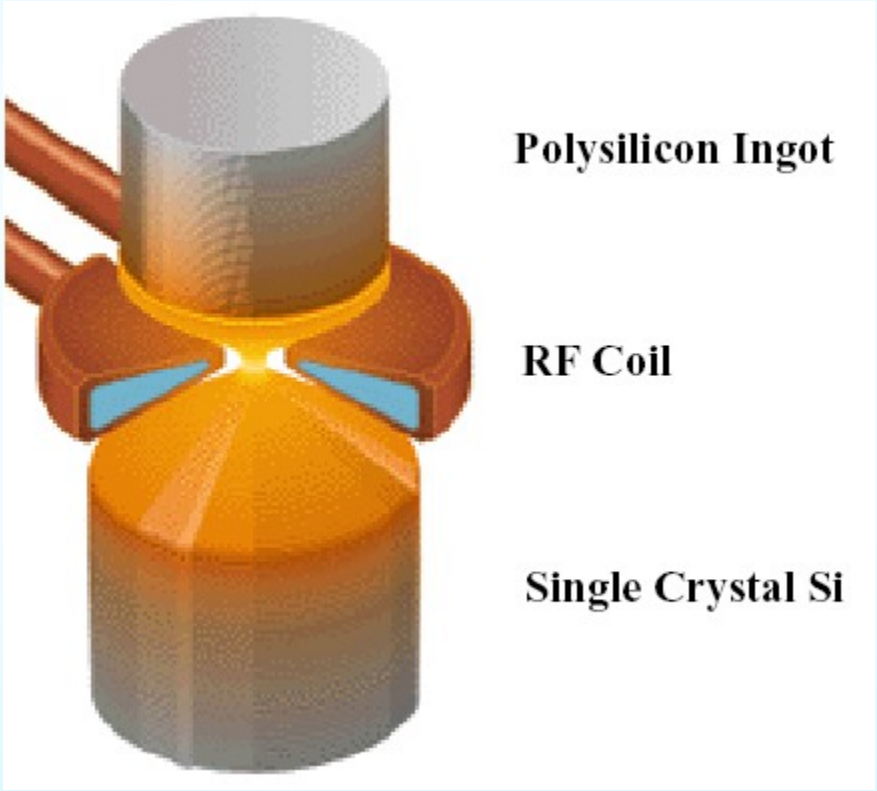
Silicon Ingot Grown by CZ Method



Photograph courtesy of Kayex Corp., 300 mm Si ingot

mmer

An alternative process is the "Float Zone" process which can be used for refining or single crystal growth.



Float Zone Crystal Growth

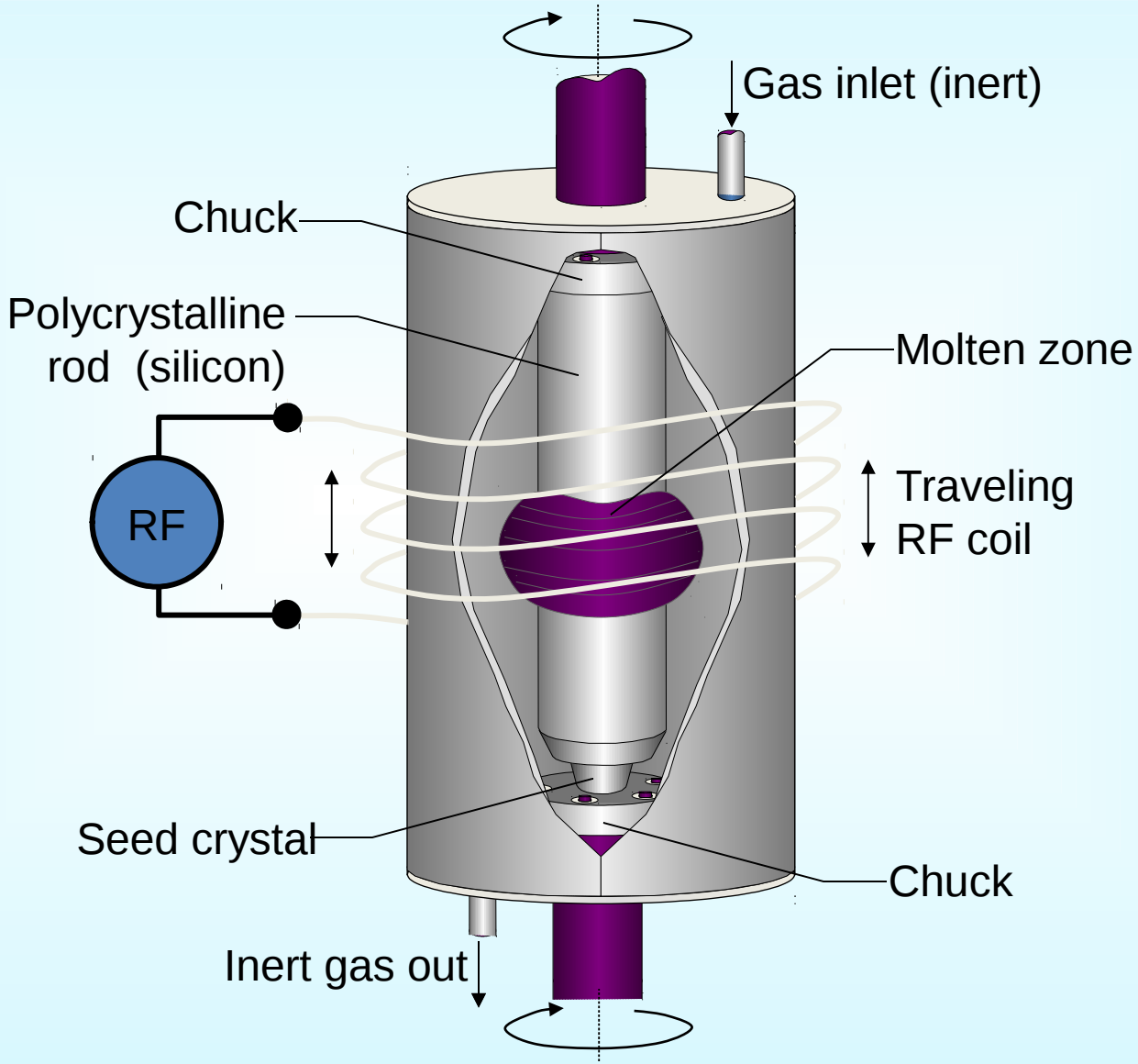
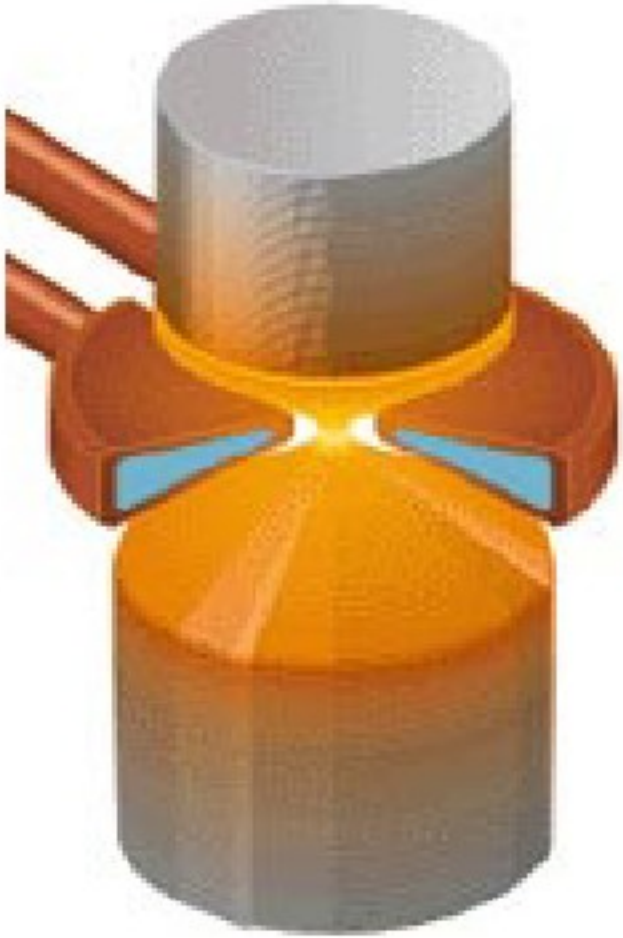
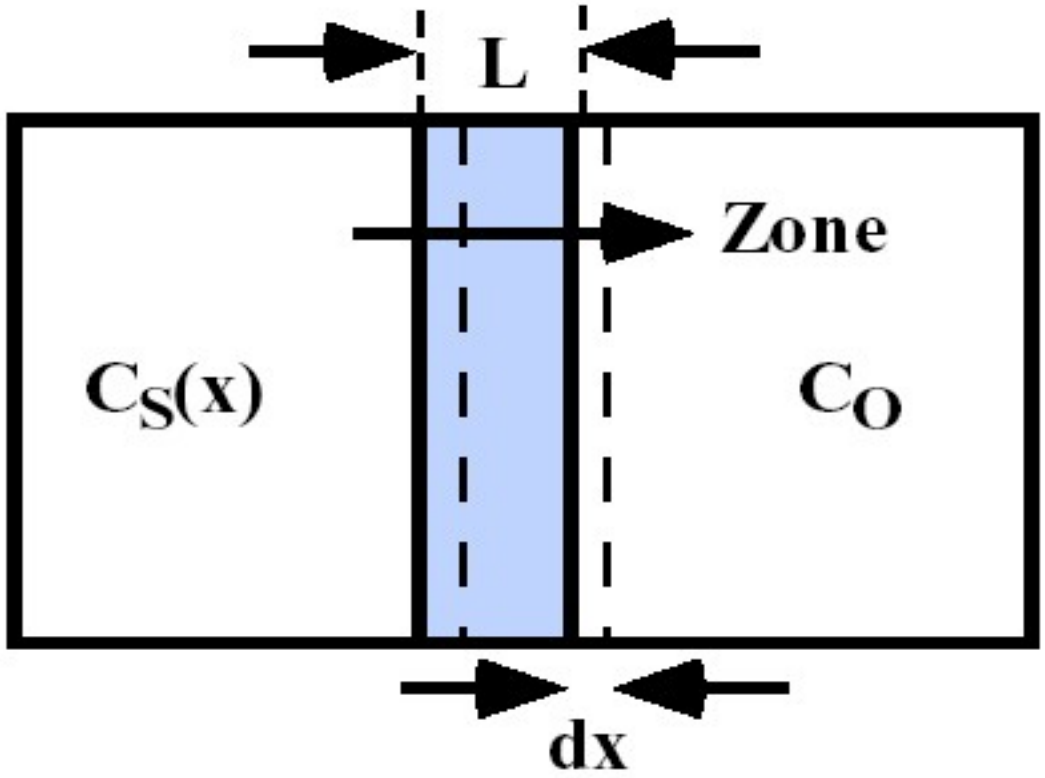


Figure 4.11

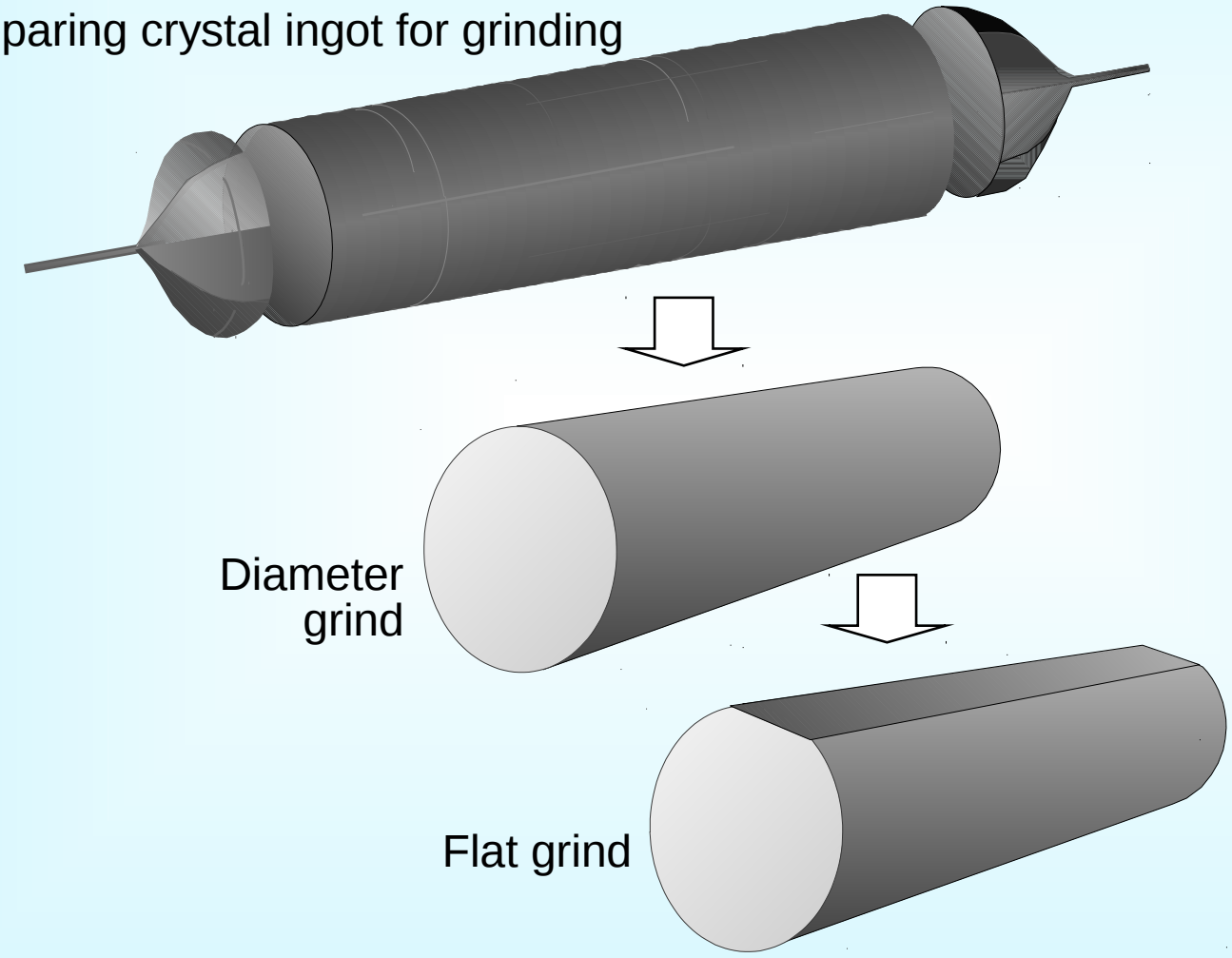
ummer





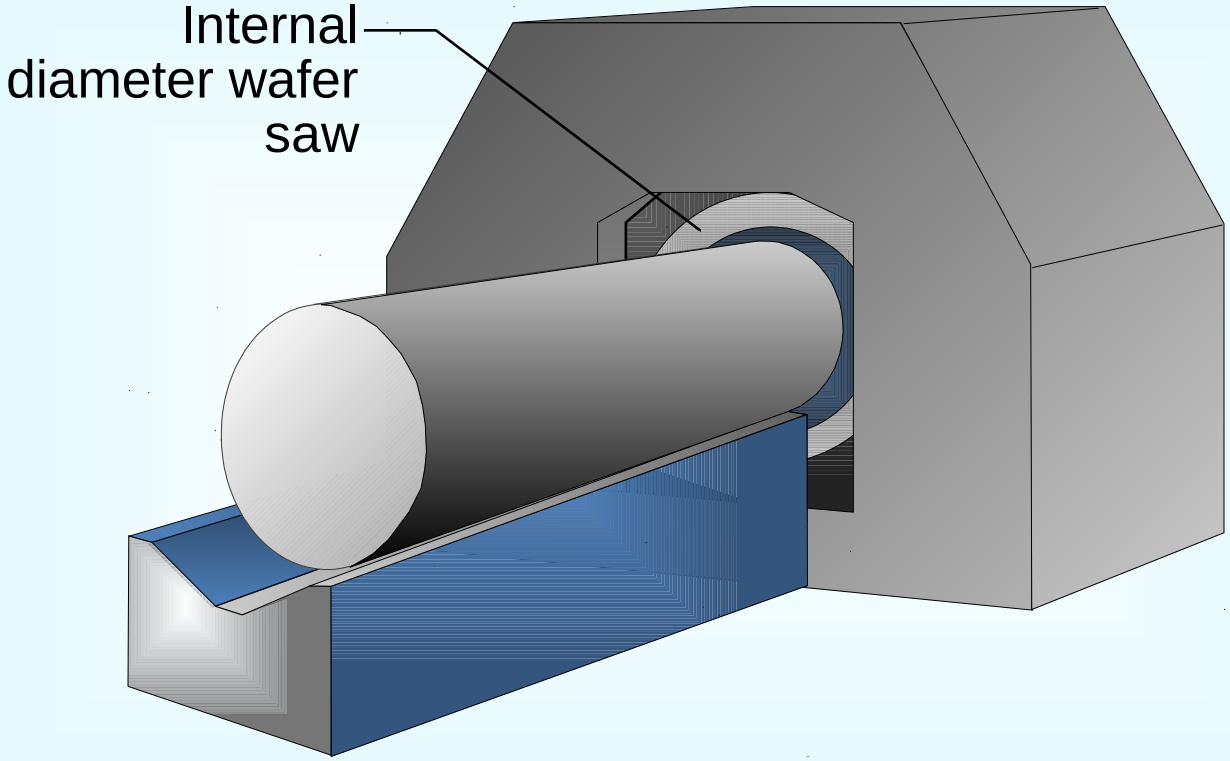
• **In the float zone process, dopants and other impurities are rejected by the regrowing silicon crystal. Impurities tend to stay in the liquid and refining can be accomplished, especially with multiple passes.**
(See the Plummer for models of this process)

Ingot Diameter Grind

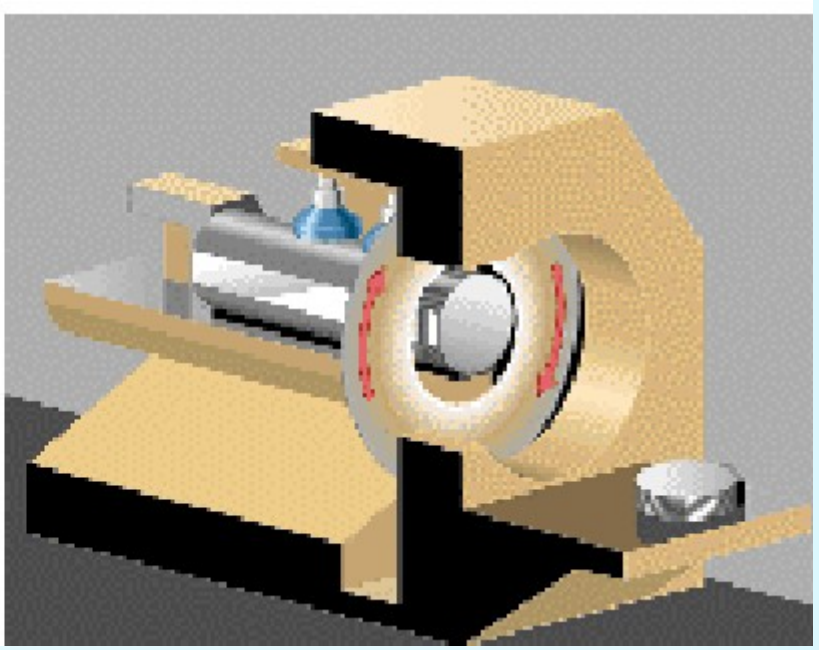


Plummer

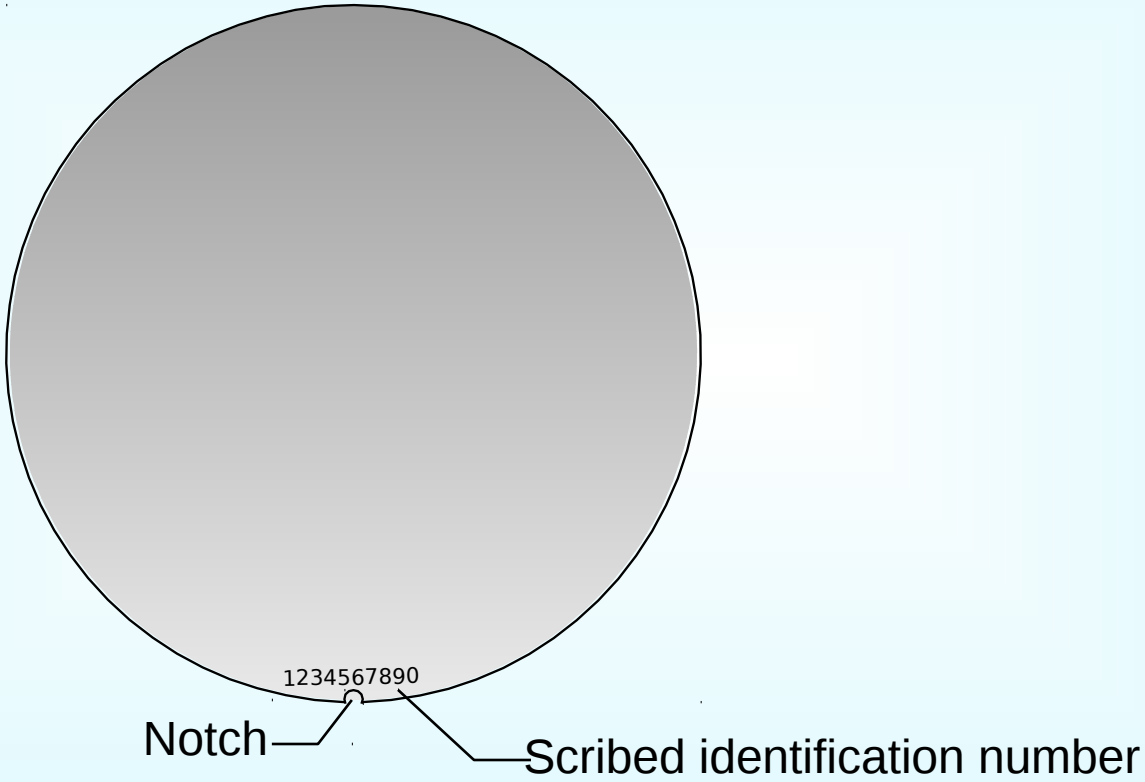
Internal Diameter Saw



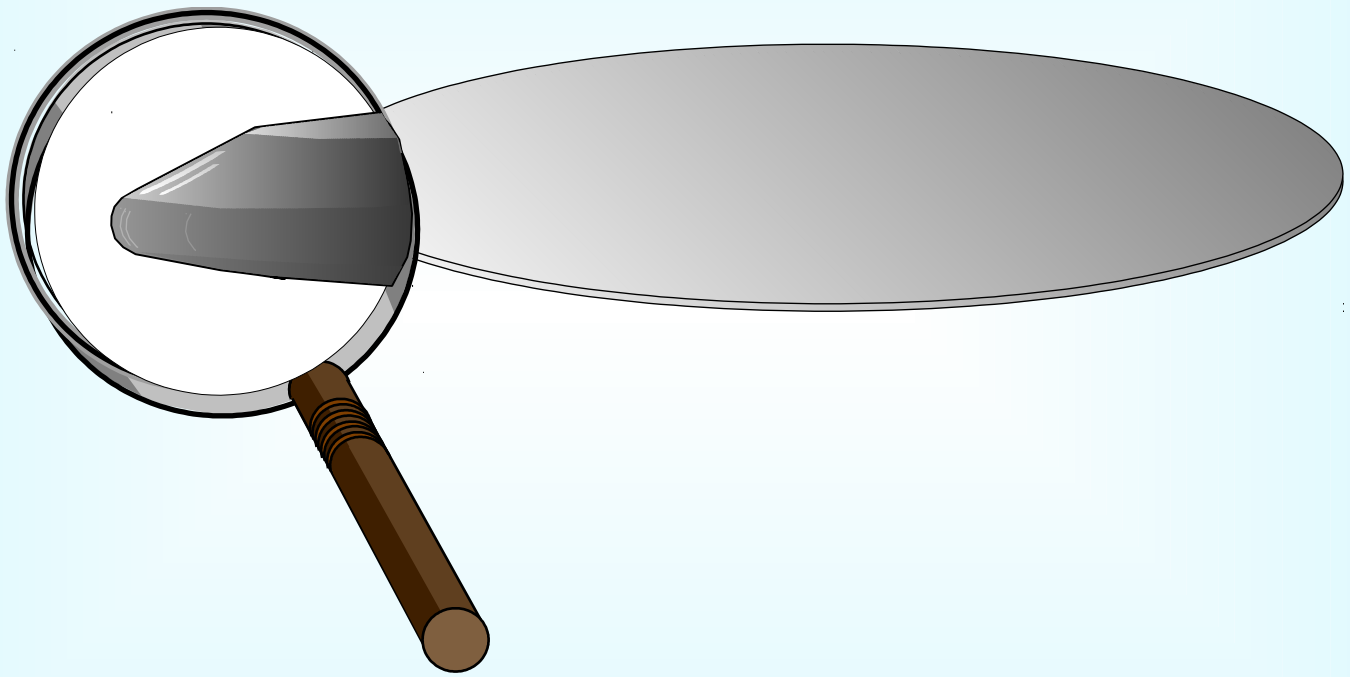
After crystal pulling, the boule is shaped and cut into wafers which are then polished on one side.



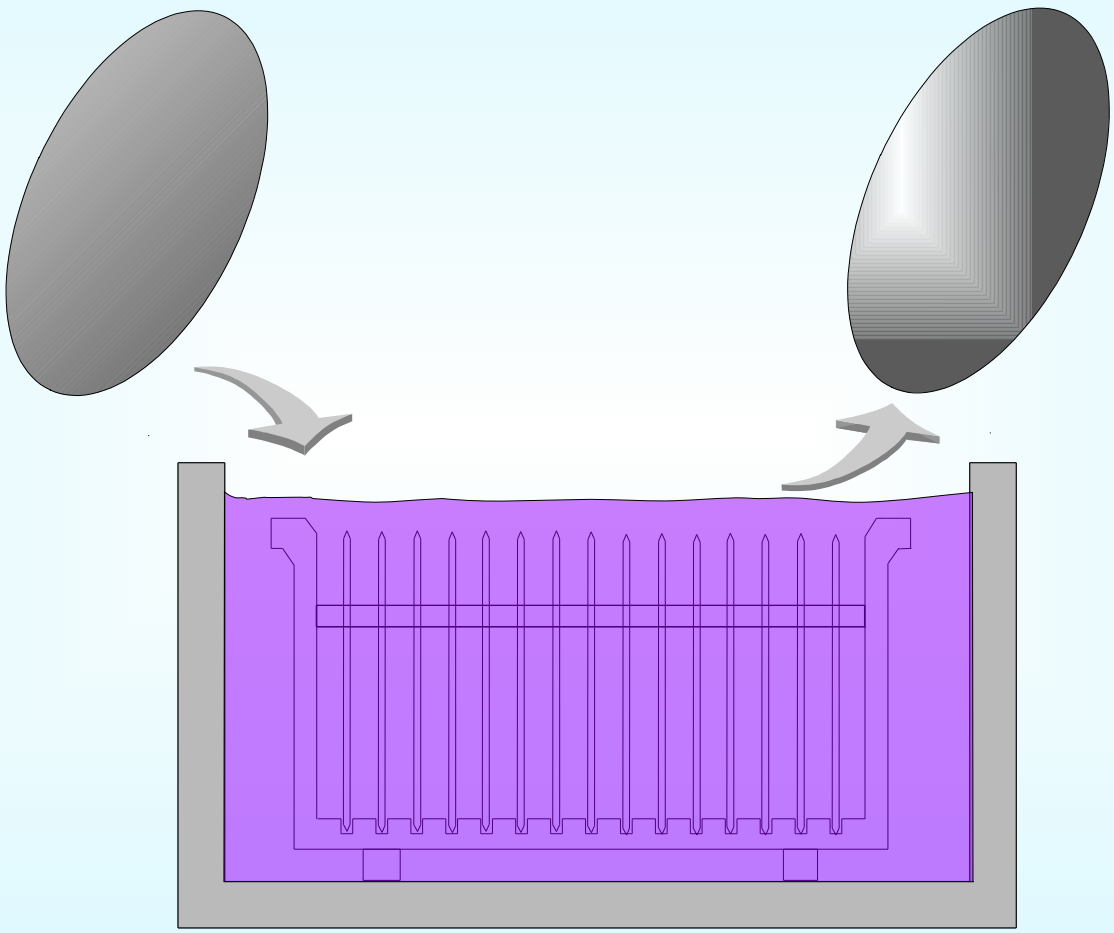
Wafer Notch and Laser Scribe



Polished Wafer Edge



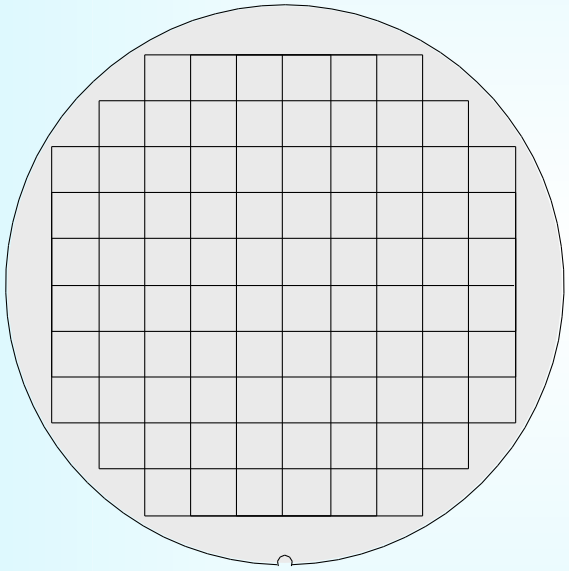
Chemical Etch of Wafer Surface to Remove Sawing Damage



Wafer Dimensions & Attributes

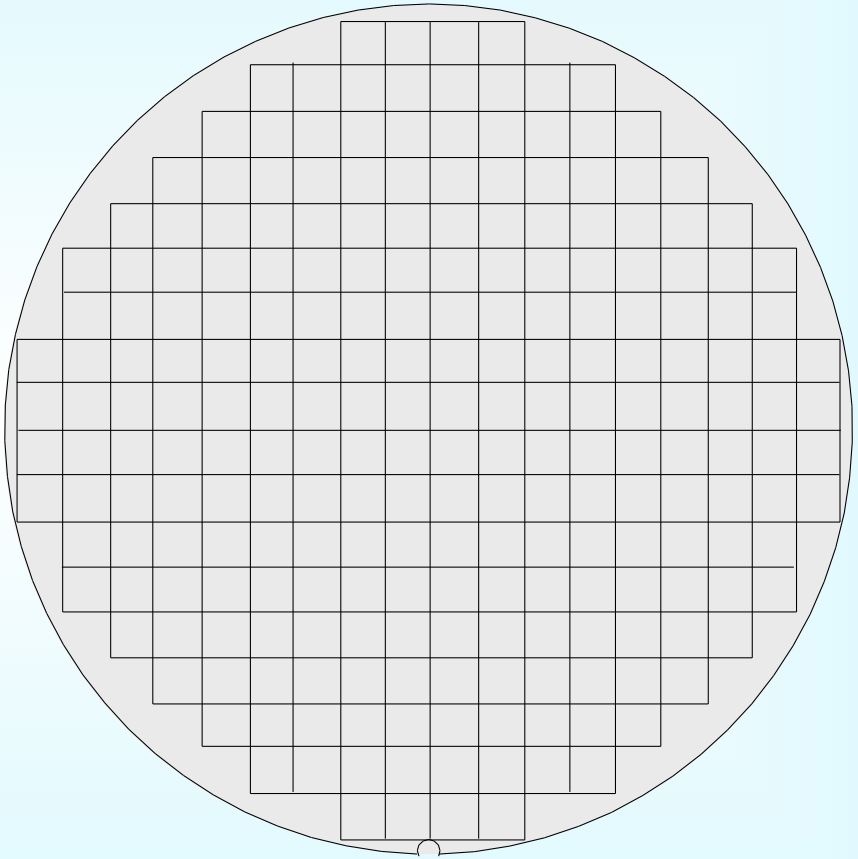
Diameter (mm)	Thickness (μm)	Area (cm^2)	Weight (grams/lbs)	Weight/25 Wafers (lbs)
150	675 ± 20	176.71	28 / 0.06	**1.5**
200	725 ± 20	314.16	53.08 / 0.12	**3**
300	775 ± 20	706.86	127.64 / 0.28	**7**
400	825 ± 20	1256.64	241.56 / 0.53	**13**

Increase in Number of Chips on Larger Wafer Diameters (Assume large 1.5 x 1.5 cm microprocessors)



88 die

200-mm wafer



232 die

300-mm wafer

Wafer Polishing