6.1.4 Summary to: 6.1 Materials and Processes for Silicon Technology

- Making "metallurgical" (= "dirty") **Si_{met}** is easy: ⇒
  - A large scale **Si_{met}** production (**> 1 Mio tons/a**) exists for metallurgical ("alloying") and chemical ("silicones") uses
- A small amount of **Si_{met}** (some **20.000 to/a**) is purified (factor **10^9** or so) to "semiconductor grade **Si**" ⇒
  - Produce high-purity trichlorosilane (**$SiHCl_3$**) gas in a reactor and distill.
  - Use **$SiHCl_3$** and **H_2** to deposit **Si** on some **Si** core by a **CVD** process
- The final result is ultra-high purity (and expensive) **poly Si** (already doped if so desired)

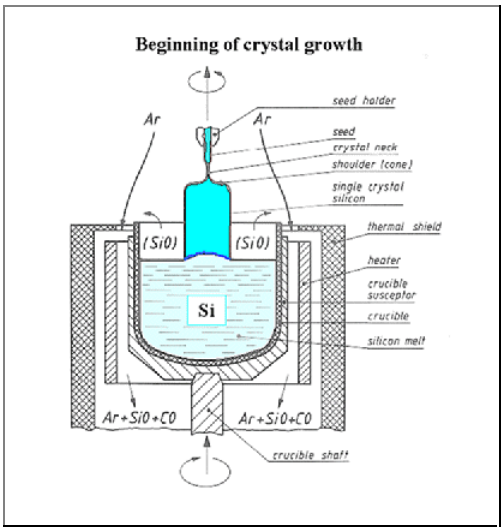
$$SiO_2 + 2C \Rightarrow Si_{met} + 2CO$$

$$Si + 3HCl \Rightarrow SiHCl_3 + H_2$$

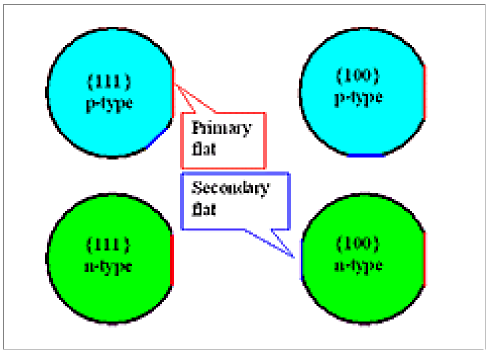
$$SiHCl_3 + H_2 \Rightarrow Si + 3\,HCl$$

- Growing a "perfect" single crystal from this **poly-Si** is not easy - but possible.
  - The major crystal growth method is the **CZ** (= Czrochalski) method: "Pull" the crystal from a crucible full of molten **Si**. ⇒
  - Some (ususally **< 300 mm** diameter) crystals are grown by the **FZ** (= float zone) method. Somewhat better perfection, but more expensive than **CZ**.
- Major problem: Impurity segregation = general tendency for most impurities (including doping atoms) to remain (= enrich) in the melt.
  - Segregation coeffcient = c_{cryst}/c_{melt} at interface, often **<< 1** and dependent on parameters like growth speed (usually a few **mm/min**).
  - **+** Crystal is purer than melt.

    – It is practically impossible to grow a crystal with a uniform impuritiy (including dopant!) concentration along its length.



- Produce wafers by cutting, grinding and polishing
  - Extreme precision for a mass product is needed.
  - "Flats" or "notches" (for wafers **> 200 mm**) identify the crystallographic orientation and the doping type.
  - Beware! Flats are often custome specific and different from the norm. ⇒



Questionaire

Multiple Choice questions to all of 6.1