Microelectronics

Basics

- *Microelectronics* is an inexhaustible topic in itself; it fills many books and we will encounter it in its own lectures. A taste of it is offered in the Hyperscript "Electronic Materials". At the very heart of microelectronics is the **Si wafer** and the structures integrated into it or on top of the the **Si**.
  - How is it done? By **defect engineering** - and there is the connection to defects! However, here this expression is used in a totally different context from that of an process engineer in a "wafer fab" i.e. a factory that makes **chips** (= integrated circuits) by processing wafers.
  - A process engineer considers "defect engineering" to be everything related to what produces "defective" chips, e.g. embedded particles, short-circuits etc.
- We, however, mean defects in the sense of this lecture, i.e. point defects, dislocations, etc. "*Defect engineering*" then comprises:
  - Growth of a **Si** single crystal with *no* grain boundaries or dislocations whatsoever, and very small and preferably very few point defect agglomerates and impurity precipitates.
  - Keeping that crystal clean and dislocation free - despite the fact that during the many high temperature processes necessary to make a chip, a lot of impurity atoms would like to diffuse into the **Si**. Temperature gradients, in addition, introduce mechanical stress which tends to relax by generation and movement of dislocations.
  - Get the right amount of dopant atoms in the right positions. This always involves defects - either generated by ion-implantation of the dopant, or the ones necessary for the diffusion. Still, they must be gone again in the end.
  - Have the right interface reactions, e.g. for forming an oxide. This involves point defects, too - oxidation, e.g., injects **Si** interstitials. Avoid, at all costs, to have those interstitials agglomerate into stacking faults!
- In summary: Chip making is indeed an exercise in defect engineering - as well as in equipment engineering, electrical engineering and so on.