

## 2.1.3 Some Relevant Properties and Products

### Some General Topics

- Let's look at some general properties that come up for *pretty much* all technical semiconductors.
- From now on qualifiers like "pretty much" or "almost all" will be omitted. We simply assume from now on that there might be exceptions to "hard" rules that are given in what follows.
  - What do we have? Let's see:
- Bandgap.** This is, after all, what defines a semiconductor.
- We need to know the value in **eV** and the type: direct - indirect. What are we looking for? How can we get what we need?  
**Class Exercise:** *How would you like your bandgap, Sir?*
- Doping.** Ideally, you would like to be able to adjust the carrier density for both types - electrons and holes - within several orders of magnitude. Ideally, this is easy: Introduce the right concentration of defects that produce shallow levels at the band edges.
- In reality, this may be already the end of many promising semiconducting materials. Dirty words like "**Fermi level pinning**" may come up in this context.  
**Class Exercise:** *What does it mean to dope a semiconductor in reality?*
- Structure and Shape.** We already looked at this to some extent. Keyword are crystallinity, size, thin film or bulk, lattice type and constant, ..
- **Class Exercise:** *Come up with 2 - 3 examples where product requirements transfer to shape / structure requirements.*
- Money.** Can you afford to make it? Can you still afford to make it if your present product is hugely successful? Can you make it cheaper?
- **Class Exercise:** *Can you still afford it if your present product is hugely successful? - What could that mean?*

### Looking at Products

- Let's look at a list of semiconductor products and components and see if we can make out what specific semiconductor property is essential for the function and the commercial success of these *products*
- **Integrated circuit (IC)**,  
e.g. memories or microprocessors.
  - **Solar cell**
  - **Liquid crystal display (LCD)**  
Where is semiconductor technology involved?
  - **OLED displays.**
  - **Micro electronic and mechanical systems (MEMS)**
  - **Light emitting diodes (LED)**
  - **(Diode) Lasers**
  - **Thermoelectric devices**
  - **Sensors**
  - **Weird stuff.**
  - **Class Exercise:** *Provide examples (and criteria) for each entry.*
- And those are just *direct* products.
- Direct semiconductor products are often not useful by themselves (who needs a chip?) but as part of end products like computers, cars, TV's, any modern machine from a toothbrush via a house-sized printing press to small-town sized power plants,...
  - Then we have the machines that one needs to make semiconductor products: Crystal growers, furnaces, plasma etchers, ion implanters "steppers", ...
- In short: Semiconductors and semiconductor technology are behind a good part of the world-wide industry. The industrial sector described above is by far the largest in the world as we know it now, accounting for **> 10<sup>12</sup> €** turnover over year.
- **40** years back, when I was your age, semiconductors and products containing semiconductors accounted for next to nothing!

