2.1.2 Compound Semiconductors

Some General Points

- The elemental semiconductors give us the all-important **Si** and, far less important, **Ge**. on the outer fringe there is **Se**. Forget about the rest.
  - Anything else coming up in semiconductor technology, by definition, must be a **compound semiconductor**. In fact, the periodic table provides for untold compounds or "Verbindungen" and among the solid ones are a lot of semiconductors.
  - How can we tell? Either by having experimental proof that there is a band gap with about **0.5 eV** - **5 eV** (those are of course arbitrary numbers) or by reliable band structure calculations for the compound in question. Both approaches might be tricky, and there are most likely compounds out there that have not yet been recognized as semiconductors. We have looked at some known semiconductors before - here is the link.
  - We have also discussed that the vast majority is of no interest to semiconductor technology at present.
    Class Exercise: *What makes a semiconductor interesting for technology?*
  - What is left (at present) is shown in the table:

Type	Examples	Remarks
Group **IV** and compounds	**Si**, **Ge** (**C**); **SiGe**, **SiC**	Only **Si**is extremely important, rest so-so
III-V compounds **Al**, **Ga**, **In**- **N**, **P** , **As**, **Sb**.	**GaAs**, **GaP**, **GaN**, **InP**, ...; $In_xGa_{1-x}As_yP_{1-y}$, ...	Some combinations are more important than others
II-VI compounds **Zn**, **Cd**, (**Be**, **Mg**) - **O**, **S**, **Se**, **Te**	**CdSe**, **CdTe**, **ZnO**, **ZnSe**	Much research, few products
Metal oxides	**TiO_2**, **ZnO**	Investigated for solar cells
Chalkogenides **A_xB_y(S, Se, Te)$_2$**	**CdTe**, **$CuInSe_2$** (**"CIS"**), **$Cu_xGa_{1-x}In_yS_ySe_{1-y}$ "CIGS"**;	All in production for solar cells
Others	Organic semiconductors	Used for small flat panel displays and as lighr source ("***OLED***")

- So we have quite a number of semiconductors that we can buy *right now* as part of a product or component. And before *you* are going to earn serious money as Materials Scientist and Engineer, there will be more, for almost sure.
- Once more we come to the crucial point: A semiconductor material in the form of a powder in a bottle (what you get when you buy it as "chemical") is almost always useless for us (exception: **TiO_2**). We must have two sets of additional properties that ensure that we can use the materials for "*semiconductor technology*"
  - There must be a market for the component or product (it must be better or cheaper than the competition). **Ge**, as an example, did not really meet this point for the last **45** years or so.
  - It must have the properties needed (e.g. be very perfect single crystal) *and* processes must exist to turn it into the component or product envisioned. This point, if enlarged upon, will turn into a long list of requirements.
- Both point together provide for a threshold that most semiconductors cannot pass. It is the (demanding) job of Materials Scientists and Engineers like *you* to make more semiconductors ***pliable*** for technical uses.