2.4 Other Semiconductors and Products

2.4.1 Germanium and SiC

Germanium

What do we need to know about **Ge**?

- There is only one thing to be aware of: **Ge** was the material for the very first transistors in the 60ties but has not been used for many years (with a few marginal exceptions) until 2000 and later. It is, however, experiencing a sort of "come back" now - but in a tricky way.

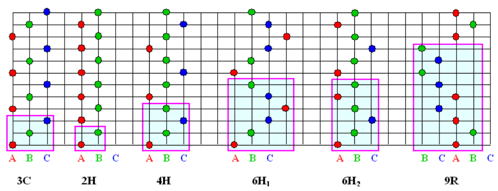
Just a short list of why **Ge** is of interest again:

- You can alloy it with **Si** - up to a point - and thus change the band gap, carrier mobilities and the lattice constant in potentially beneficial ways.
- You can use **Ge** single crystals as a substrates for growing certain layers better than on other substrates. This is enticing, e.g., for **GaAs** based space solar cells.
- You can use **Ge** single crystals for any uses where a low band gap is beneficial (detectors, sensors).

Silicon Carbide

What do we need to know about **SiC**?

- That it has quite interesting basic properties but is very difficult to produce as nearly perfect single crystal. The reason for that is that it comes in many different lattice types - the word is **polytypes** - meaning that there are many different stacking sequences of the **Si-C** base in a basically hexagonal lattice
- We will use a couple of pictures from a different Hyperscript at this point that illustrate what happens.



Polytypes of **SiC**

- All we do is to stack the building unit - **SiC** - in more tricky variants than the **fcc** and **hex** structure shown under "**3C**" and "**2H**"; the nomenclature used for **SiC**. Look up the original page for details, but you don't have to know this.
- What you should know is that **SiC** actually exists in all those polytypes (there are many more) and that given crystals may even be mixes of several polytypes.
- It is not easy at all to grow a good single **SiC** crystal in a defined polytype; unfortunately the properties depend on the polytype:

		4H-SiC	**6H-SiC**	**15R-SiC**	**3C-SiC**
Band Gap [eV]		3.265	3.023 3.03	2.986	2.390
Lattice Constant [Å]	**a**	3.08 3.073	3.08	3.08	4.36
	c	10.05	15.12	37.70	-
Effective Mass [m_c]	**m_e**	0.37	0.69	0.53 - 0.28	0.68 - 0.25
	m_h	0.94	0.92	-	-
Mobility (@ 300K) [cm^2/Vs]	**μ_e**	500	300	400	900
	μ_h	50	50	-	20

Thermal conductivity (RT) [W/cm · K]	3.0 - 3.8	3.0 - 3.8		

- You get the drift: **SiC** would be great for certain uses (high power, high speed, ...), but there are hardly any real products out there - despite major (usually military inspired) efforts.
  - We thus will not go into **SiC** much more but wait and see. Just one little innovation - a cheap way of making good single crystals of one polytype - would generate a new technology and a new market.
  - As a last use of **SiC** it should be mentioned that it often serves as substrate for producing thin layers of **GaN**..