

9.1.3 Summary to: 9.1 Optoelectronics - General Concerns

Optoelectronics has *two* basic branches:

1. Light in \Rightarrow electrical signal out:
 - **Optical sensors** as single elements
 - "CCD" chips in "megapixel" matrices.
2. Electricity in \Rightarrow light out; in two paradigmatic versions:
 - **LED's**
 - **Laser diodes**

Here we only look at the second branch.

- The semiconductors of choice are mostly the **III-V's**, usually in single-crystalline perfect thin films.
- The present day (**2008**) range of wavelength covers the **IR** to near **UV**.
- Indirect semiconductors like **GaP** can be used too, if some "tricks" are used.

	Wavelength (nm)	Typical Semiconductor
Infrared	880	GaAlAs/GaAs
Red	660 - 633	GaAlAs/GaAs
Orange to Yellow	612 - 585	AlGaInP GaAsP/GaP GaAsP/GaP
Green	555	GaP
Blue to Ultraviolet	470 - 395	GaN/SiC GaN/SiC InGaN/SiC

The **index of refraction** $n=(\epsilon)^{1/2}$ and thus the dielectric constant ϵ become important

- Semiconductors have a relatively large index of refraction at photon energies below the bandgap of $n \approx 3 - 4$.
- Diamond has the highest n in the visible region

The **thermal conductivity** becomes important because for generating light one needs **power** (which we avoided as much as possible for signal processing with **Si!**)

- Again, diamond has the highest thermal conductivity of all known materials - **5** times better than **Cu!**

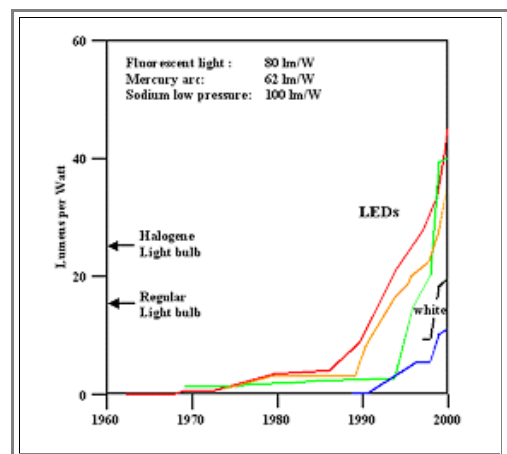
Typical Semiconductor	Dielectric constant	Thermal conductivity [W/cm · K]
Si	11.9	1.5
GaAs	13.1	0,45
GaP	11.1	1.1
GaN	8.9	1.3
SiC	10	5
C (Diamond)	5.8	22

LED's come as cheap little "indicator" lights and recently also as replacement for "light bulbs".

- Intense white light from **LED's** becomes possible, Advantages: High efficiencies and long life time
- The key was the "taming" of the **GaN** material system for blue and **UV LED's**.

LED's based on organic semiconductors (**OLED**) are rapidly appearing in **OLED** based displays.

- **Advantage:** High efficiencies because of active light generation.
- **Problem:** Product life time; sensitivity to air.



Semiconductor "Diode" **Lasers** are high-power" **LED's** plus "mirrors"

- **Advantage:** Small and cheap.
- **Problems:** Low power, "Quality".

Enabling technology for
CD / DVD / Blue ray / ...
memory technologies!

Exercise 9.1-1
All Quick Questions to 9.1