9.1.3 Summary to: 9.1 Optoelectronics - General Concerns

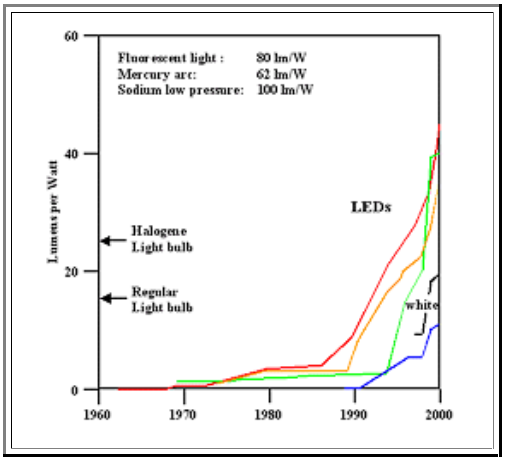
- Optoelectronics has *two* basic branches:
  - **1.** Light in ⇒ electrical signal out:
    - **Optical sensors** as single elements
    - "**CCD**" chips in "megapixel" matrices.
  - **2.** Electricity in ⇒ light out; in two paradigmatic versions:
    - **LED's**
    - **Laser** diodes
- Here we only 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