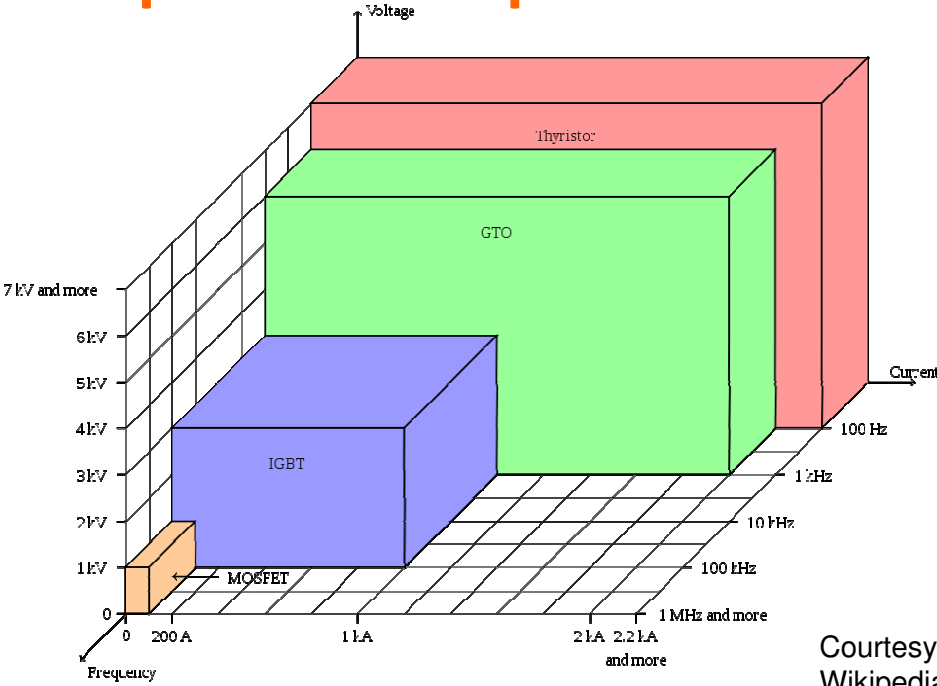


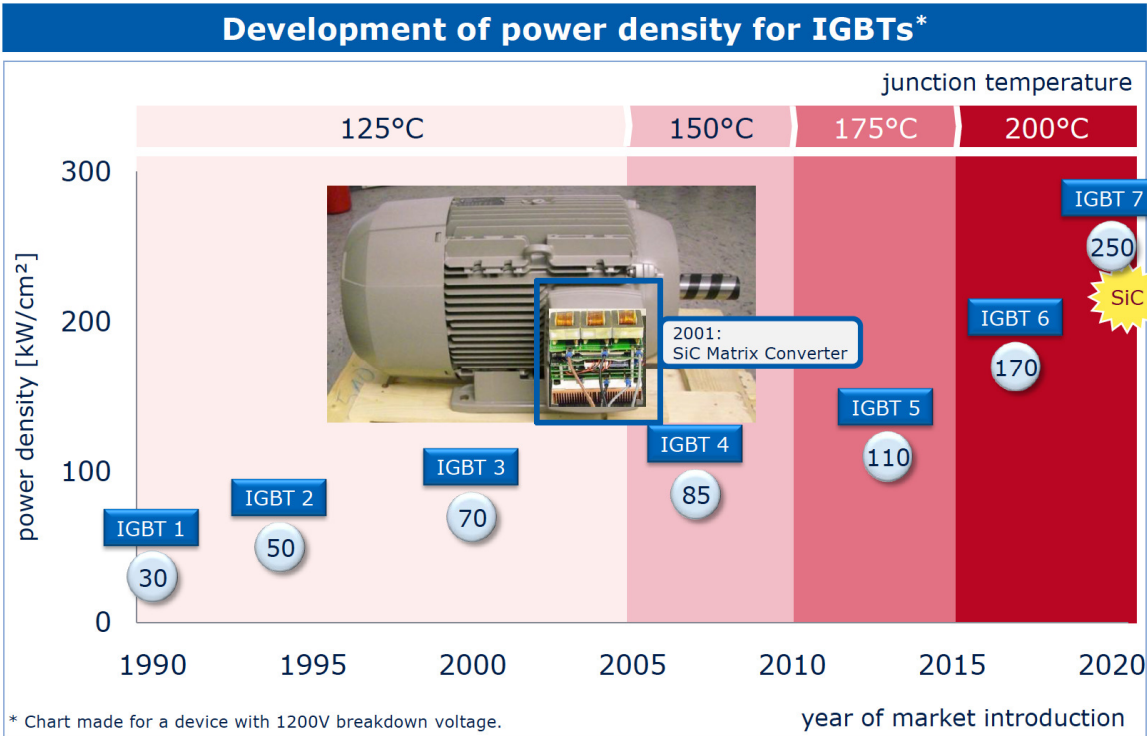
Capabilities of power devices



Courtesy of Wikipedia (Cyril)

Progress in IGBTs

Courtesy of Infineon 2011



Evolution of power semiconductor devices

Active devices are a large fraction of the total system cost → actual design try to minimize the number of active devices used and their maximum ratings (cost)

Progress in Power devices DRIVE changes in circuit choices and market adoption.

Examples:

- power MOSFETs → switched-mode power supplies
- IGBT → Energy efficient motor drives with inverters

Next

New materials: SiC, GaN → Class D audio amplifier, inverter for motion control – AC-DC and DC-DC power supply

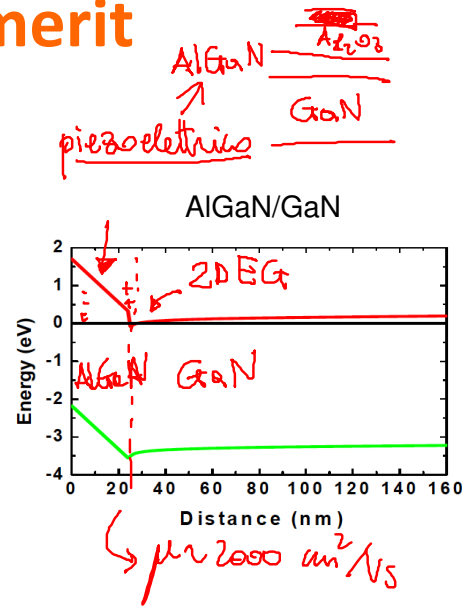
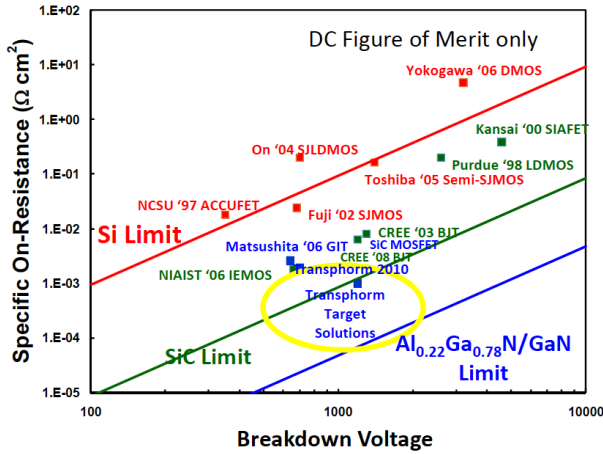
Alternative semiconductors

	Si	GaAs	SiC	GaN
Bandgap at Room T (eV)	1.12	1.43	2.2-3	3.4
Thermal conductivity (W/(cm K))	1.5	0.5	5	1.3
Max Temp. (C)	150	300	600-1000	400
Max Electric Field (V/m)	3e5	4e5	4e6	3e6
Saturation velocity (cm/s)	1e7	2e7	2.5e7	2.5e7

$$n_i^2 = N_A N_D e^{-E_g/kT}$$

600
600

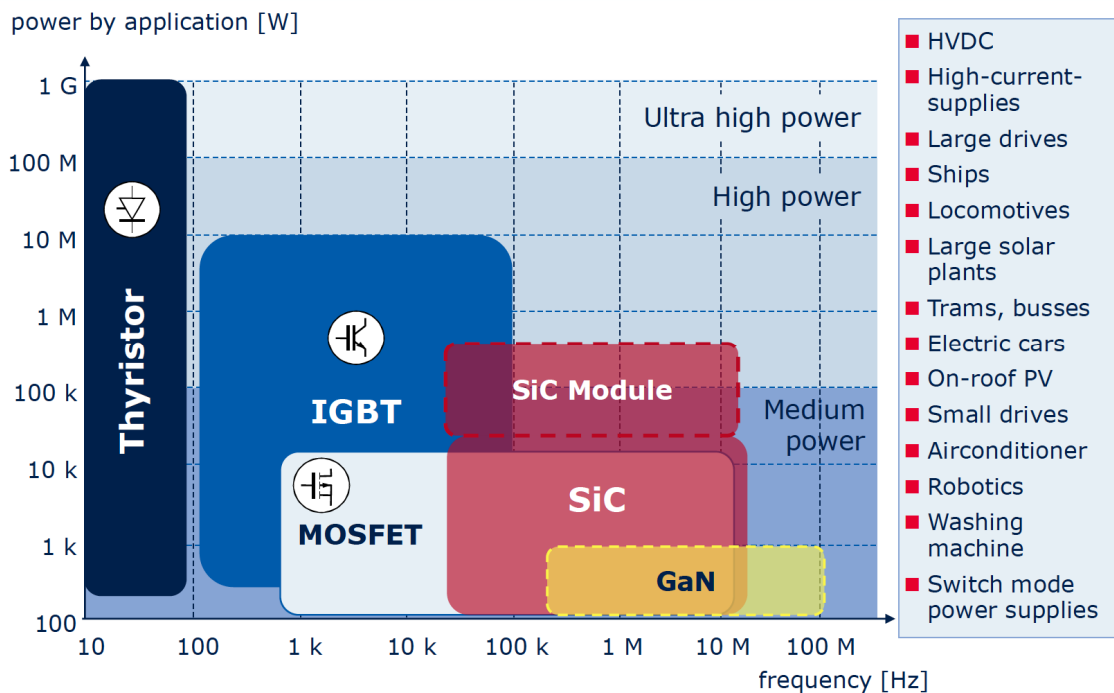
GaN and SiC have better DC figures of merit



Courtesy of Transphorm Inc.

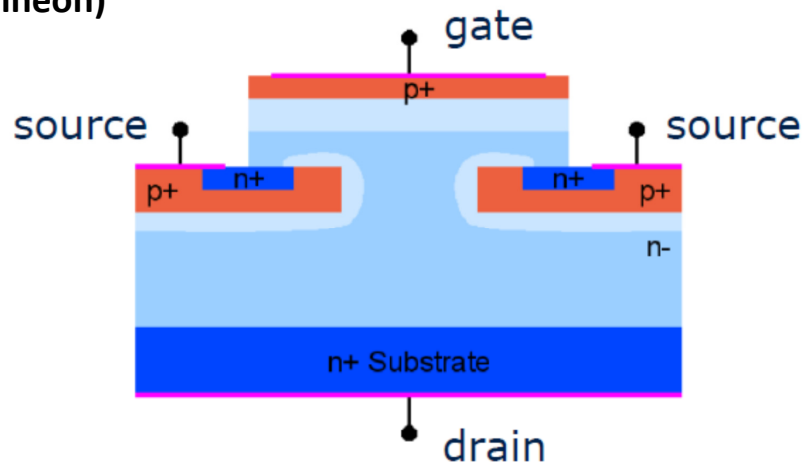
Power versus frequency

Courtesy of Infineon 2011



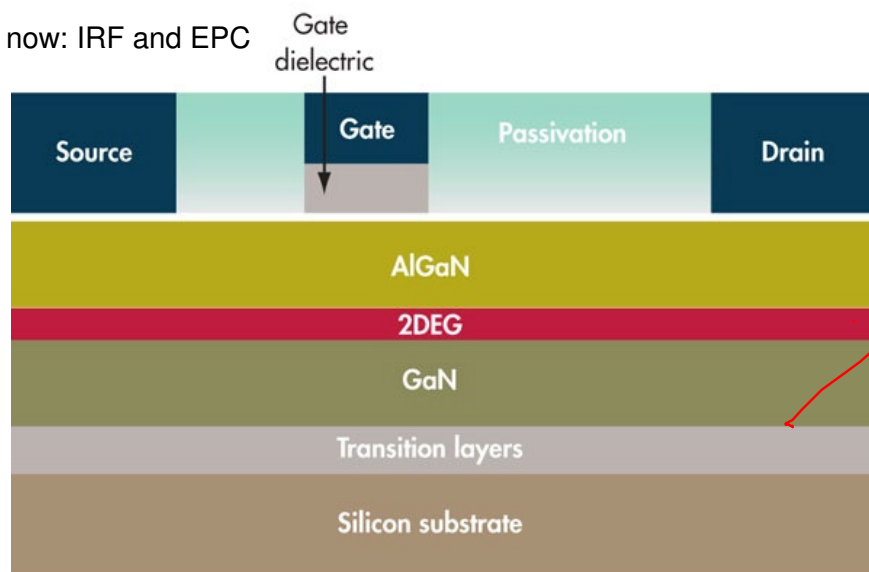
SiC

- SiC diodes, SiC JFETs, SiC MOSFETs
- **SiC JFET (Infineon)**



GaN-AlGaN MIS-HEMT

Only 2 producers now: IRF and EPC



- No pn junctions (only majority carriers)
- Lateral device (reduced capacitances, high fields in the upper layers)