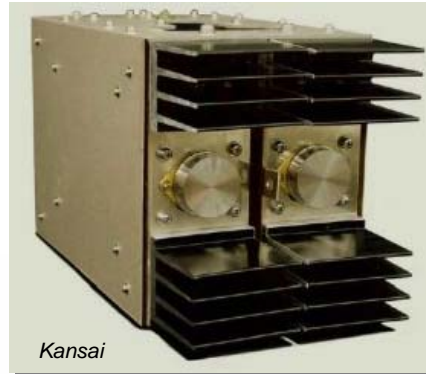


PowerSiC

Silicon carbide devices for power electronics market:
status & forecasts

2006 edition



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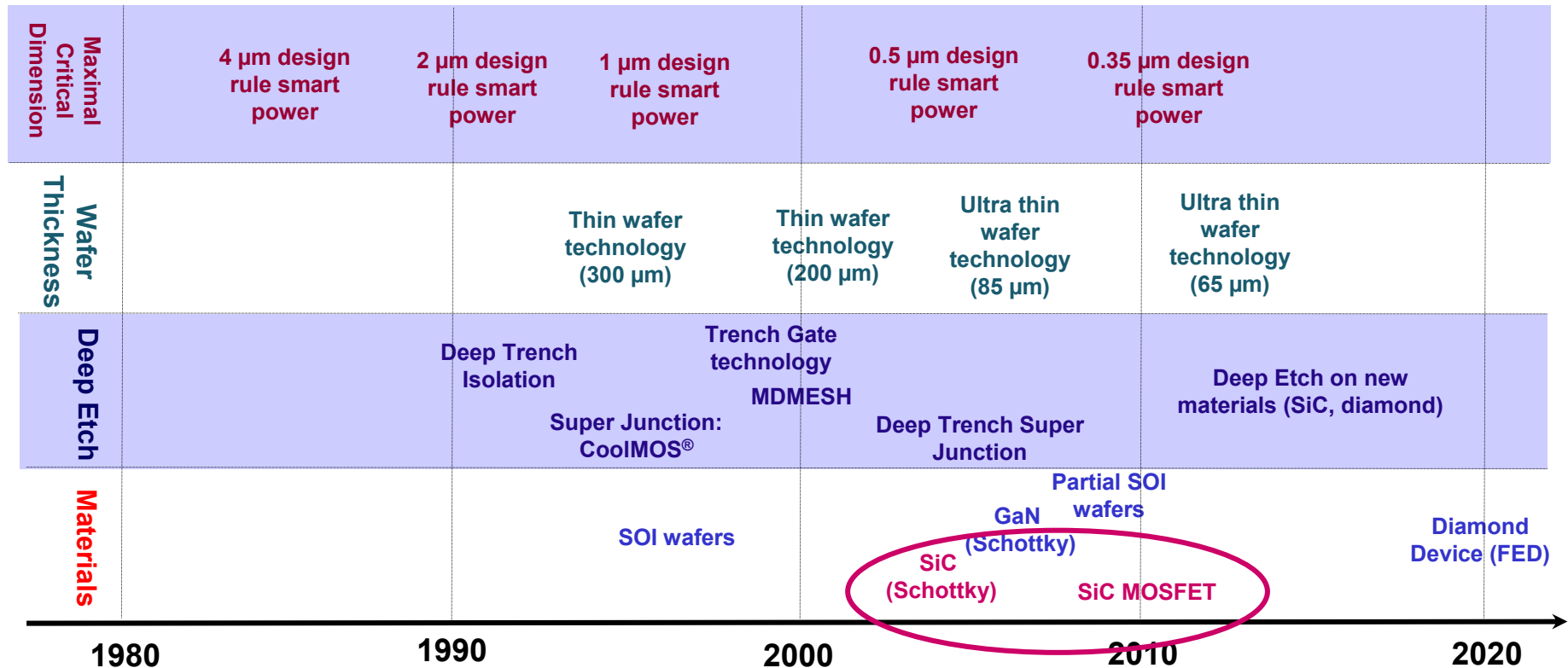
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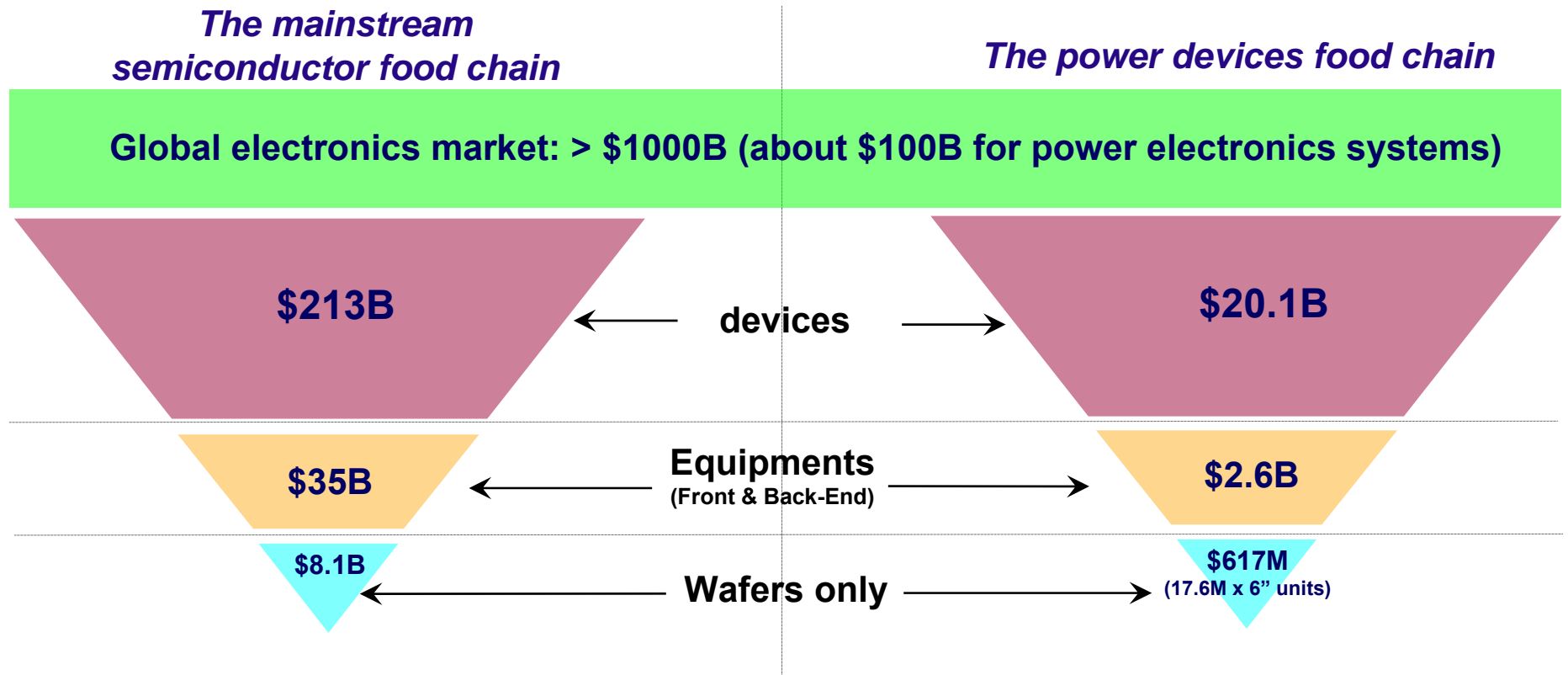
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Executive summary

Emerging technologies roadmap for Power Devices production: SiC as a key trend for future power electronics

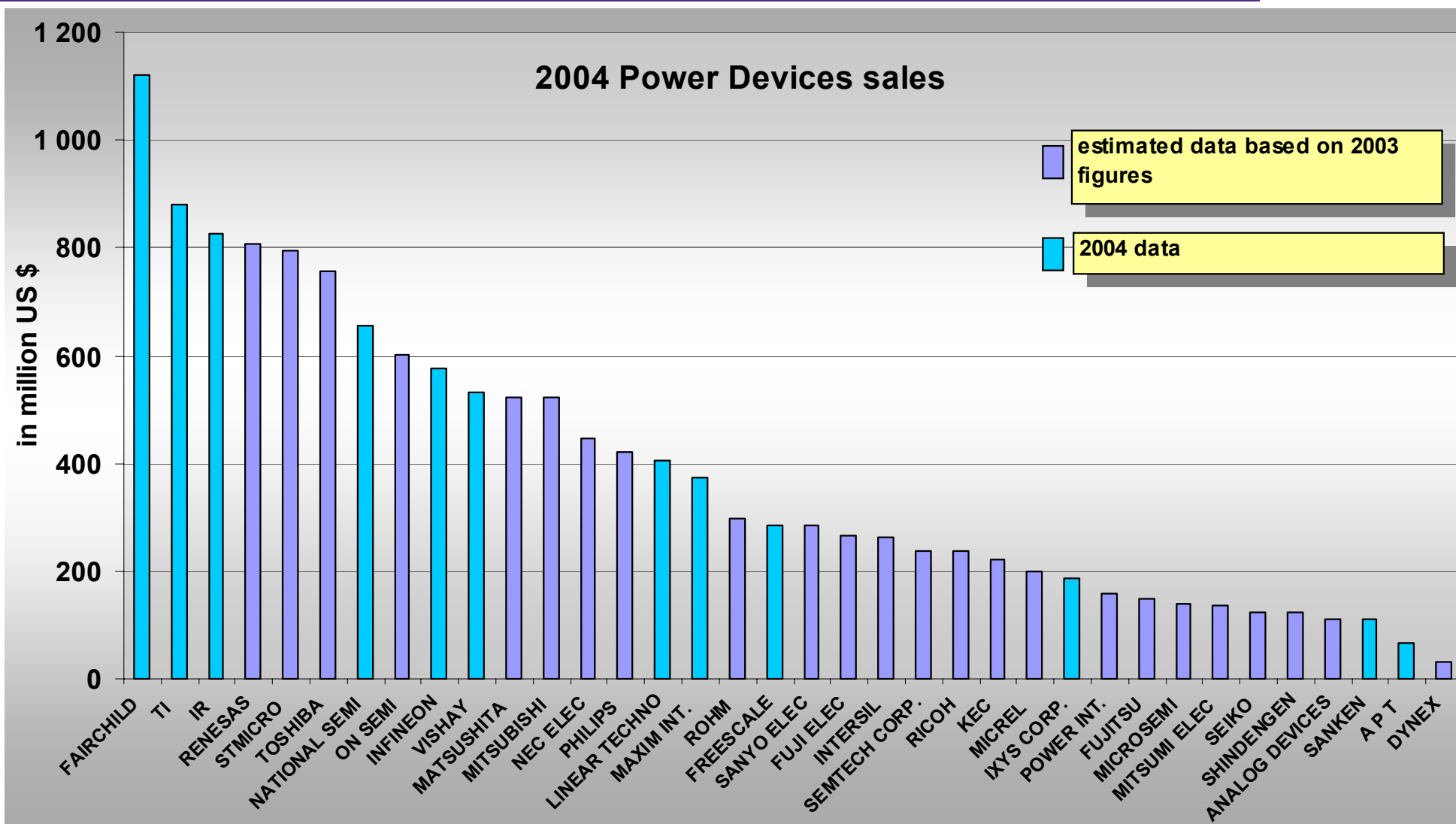


Comparison with mainstream SC market: in 2005, Power Devices is accounting for ~10%



Ranking of power devices manufacturers

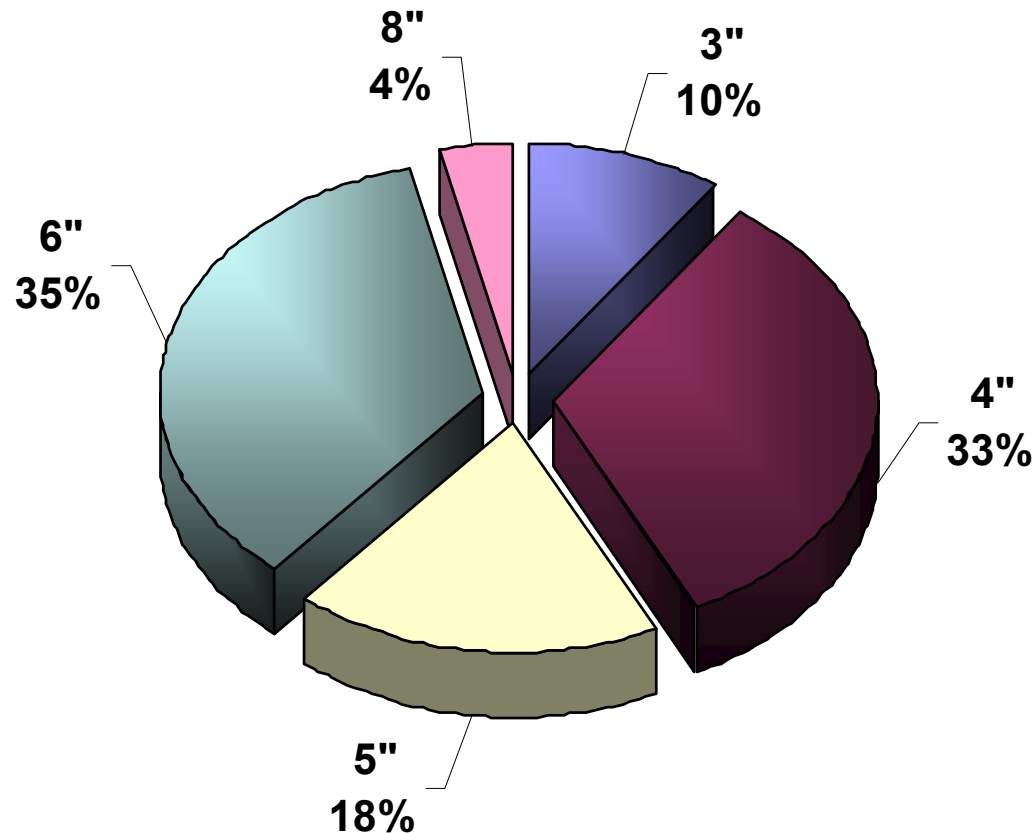
2004 ranking based on sales



Wafers size

(Source: DataFab / World Fab Watch)

- 4" and 6" wafers are mainly used and no move to 300 mm is forecasted (statistics made on 82 power devices fabs)



SiC diodes and transistors

Main targeted applications and specs



Power Supplies
PFC

SiC diodes

SiC trans.

Targeted specs
for a single chip

800 volts
1 - 10 Amp
200 - 300 kHz

2006 status
SiC diodes
in prod.

2006 status
SiC MOSFET
still in dev.



Inverters & converters
Automotive, solar & wind power

SiC diodes

SiC trans.

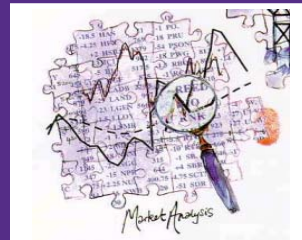
Targeted specs
for a single chip

1200 volts
100 Amp
200 - 300 kHz

2006 status
SiC diodes in prod.
Avail.: 1200V / 10 A
Demo: 1200V / 75 A

2006 status
SiC MOSFET
still in dev.

Process cost per square units for different SiC components

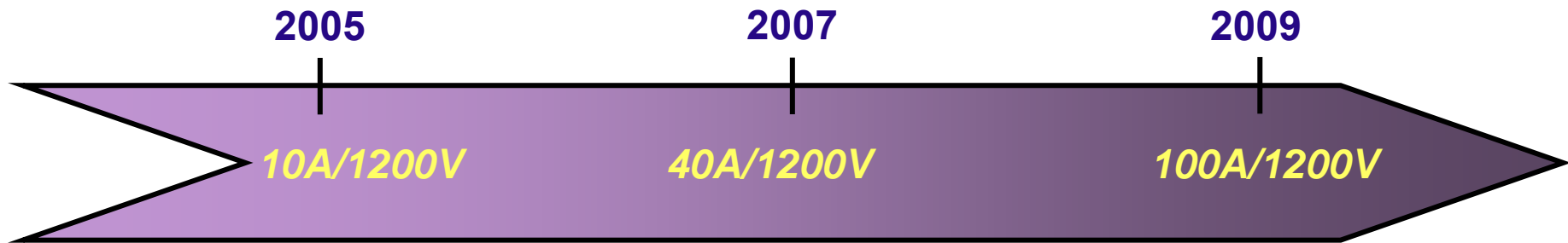


	2", 4H SiC row substrate	Electronics "Schottky"	Electronics "MOSFET"	MEMS (Incl. packaging)
Cost / surface	0.2 – 0.5 \$/mm ²	0.6 – 1 \$/mm ²	1.6 – 2.7 \$/mm ²	0.8 – 3 \$/mm ²

Depending on the volumes

SiC Schottky diodes

Devices specs roadmap (R&D)

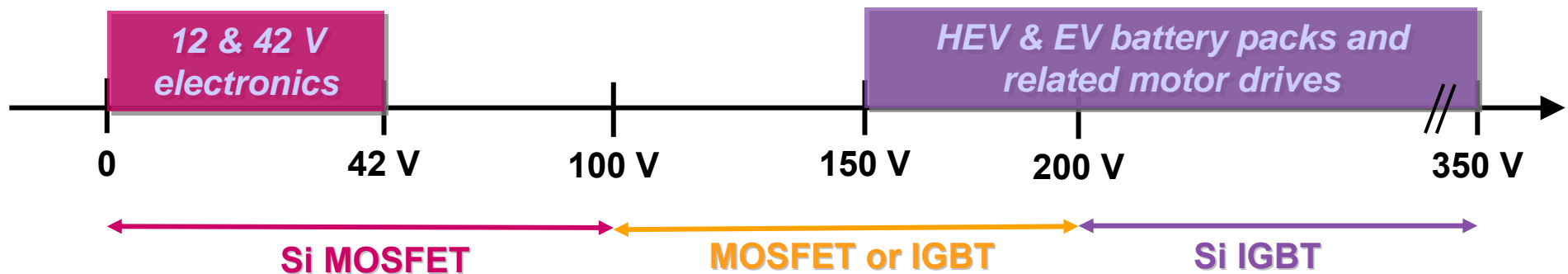


- Roadmap is given for single chip device, at R&D level.
- This evolution is linked to the improvement of useable area, and so to micropipes density
- A 100A diode will need about 10x10 mm² micropipe-free active area. 1200 V breakdown voltage requires about 12-15 μm epilayer thickness.
- It's now all a question of material ! and cost....

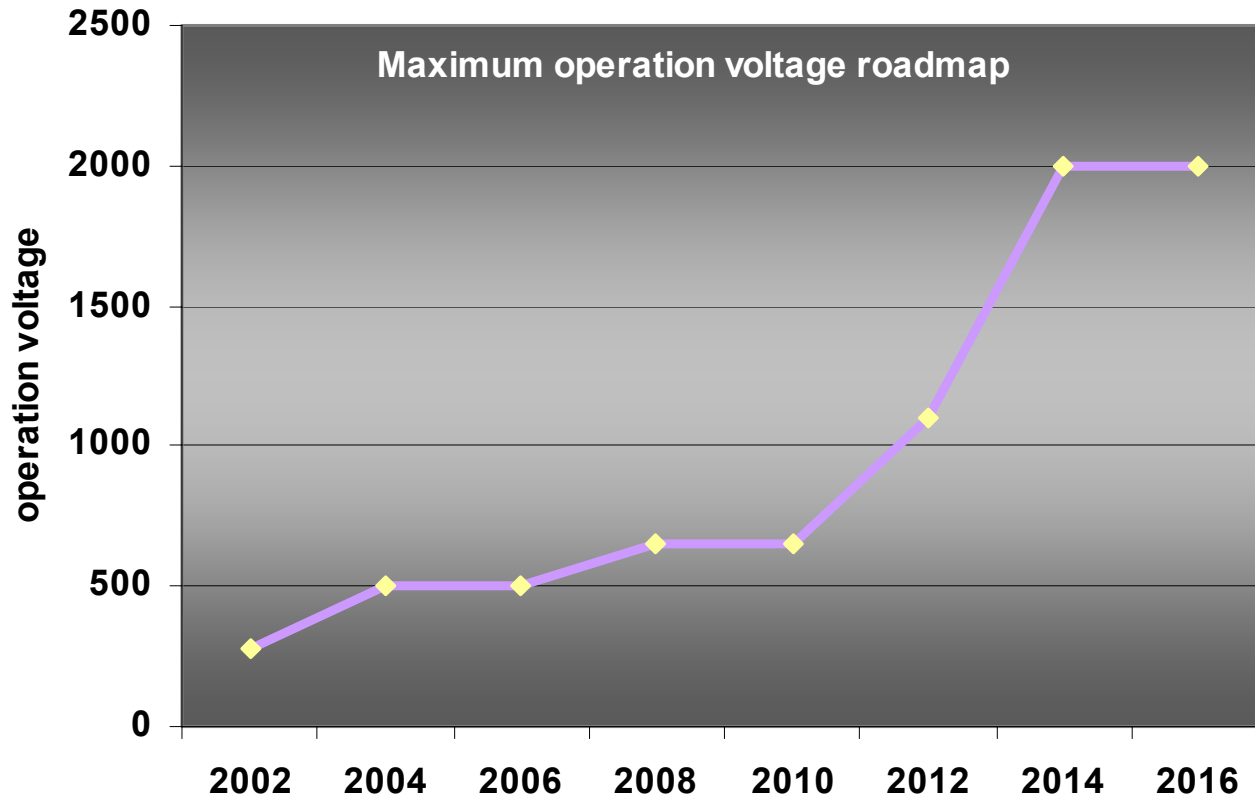
Automotive Application: Current technologies in use



- $< 100 \text{ V dc}$: Power Si MOSFET ($f_{\text{max}} > 200\text{kHz}$)
- $> 200 \text{ V dc}$: Si IGBT ($f_{\text{max}} \sim 20\text{kHz}$)
- $100 - 200 \text{ V dc}$:
 - Low current apps: MOSFET
 - High current apps: IGBT
- Junction $T^\circ \sim 175^\circ\text{C}$ max.
- From 2 to 6 paralleled devices per switch to handle the current level ($\sim 300 \text{ A}$)



Roadmap for operation voltage in HEV



There is a clear trend to increase operation voltage from native battery pack 400V to 2kV through the use of boosters

New generations of HEV cars are planned to integrate boosters

According to Toyota the upper limit will reach 2kV. We forecast this value to be set 2010 and beyond.

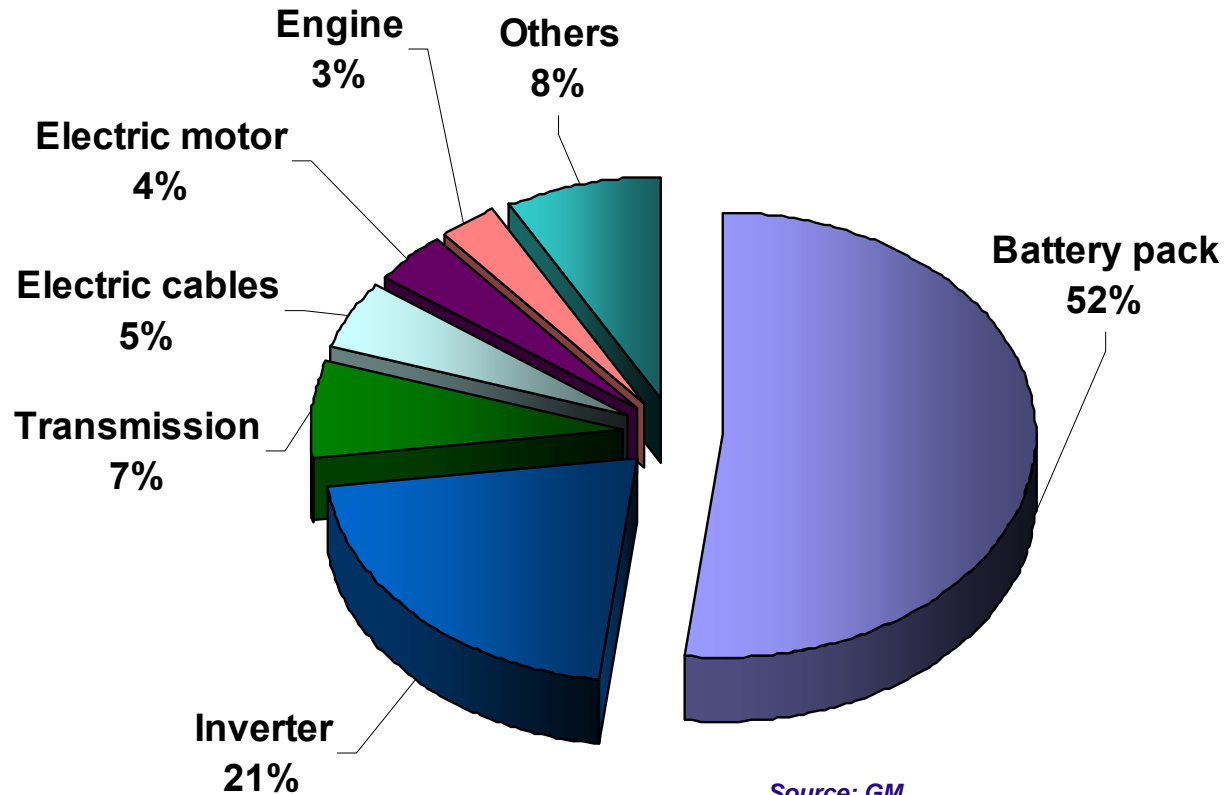
New Toyota RX400h is now running 650V operation voltage

SiC is already proposing 1200V devices (Schottky diodes)



Honda electric engine

Hybrid powertrain costs breakdown



GaN & Diamond electronics

Active layer thickness comparison

