

Semiconductor Technology from A to Z

Compound Semiconductors

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Applications & System Comparison

E-Mobility: SiC Dominates the Traction Inverter

The traction inverter is the power electronics component that most directly determines an electric vehicle's range and efficiency. SiC MOSFETs have become the standard here over Si IGBTs, because their lower switching losses allow higher switching frequencies – this shrinks passive components (inductors, capacitors) and typically raises efficiency by 3 to 5 percentage points over the drive cycle. In 800 V system architectures, which are increasingly becoming standard, the SiC advantage grows even further, since the higher breakdown field strength matters most at higher voltage classes.

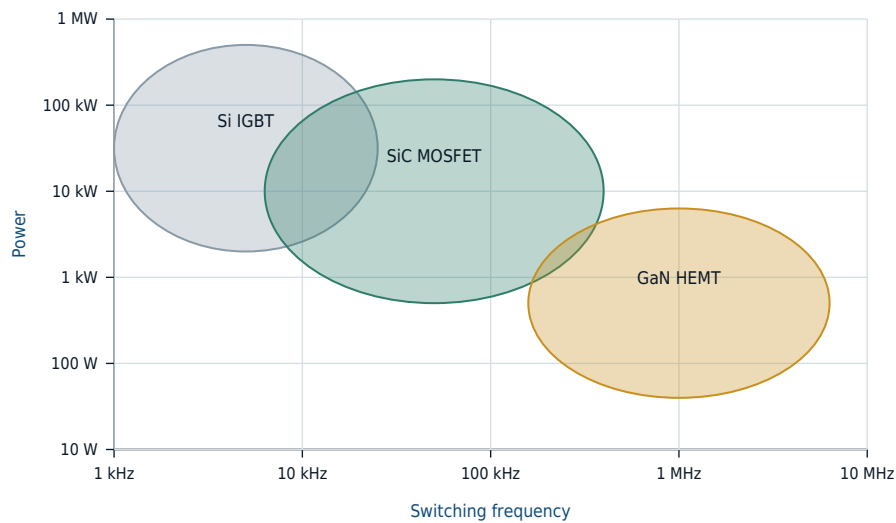
Fast-Charging Infrastructure and Power Supplies: GaN Excels at High Frequency

For applications with medium voltages (48 V to a few hundred volts) and a need for a compact form factor, GaN plays to its strengths: chargers for laptops and smartphones use the high switching frequency of GaN HEMTs to drastically shrink transformers and filter components – a 65 W USB-C charger today fits into a housing that, just a few years ago, was needed for a third of the power. DC fast chargers for electric vehicles are also increasingly adopting GaN in their front-end AC/DC stages.

Efficiency and Switching Frequency Comparison

Roughly speaking: Si IGBTs remain the most cost-effective option today for low switching frequencies (below 20 kHz) at very high power levels. SiC MOSFETs dominate the medium-to-high power range with frequencies reaching into the hundreds of kHz. GaN HEMTs unlock MHz frequencies at lower to medium power levels, where form factor is the dominant design driver.

Efficiency and Frequency Ranges Compared
Typical application ranges of Si IGBT, SiC MOSFET and GaN HEMT



Si IGBTs dominate low frequencies at very high power levels.
SiC MOSFETs cover the medium-to-high power range.
GaN HEMTs unlock MHz frequencies at lower to medium power levels.

Cost Trends and Outlook

Despite their clear technical advantages, SiC and GaN devices remain more expensive than comparable Si solutions – driven mainly by substrate costs and lower manufacturing volumes. That price gap, however, is shrinking steadily: 200 mm SiC substrates and larger GaN-on-Si wafers lower per-unit costs, while rising volumes in e-mobility and consumer electronics create economies of scale. For many applications, the break-even point over the system's lifetime (lower cooling costs, smaller form factor, higher efficiency) has already been reached today, even though the raw component price is still higher.