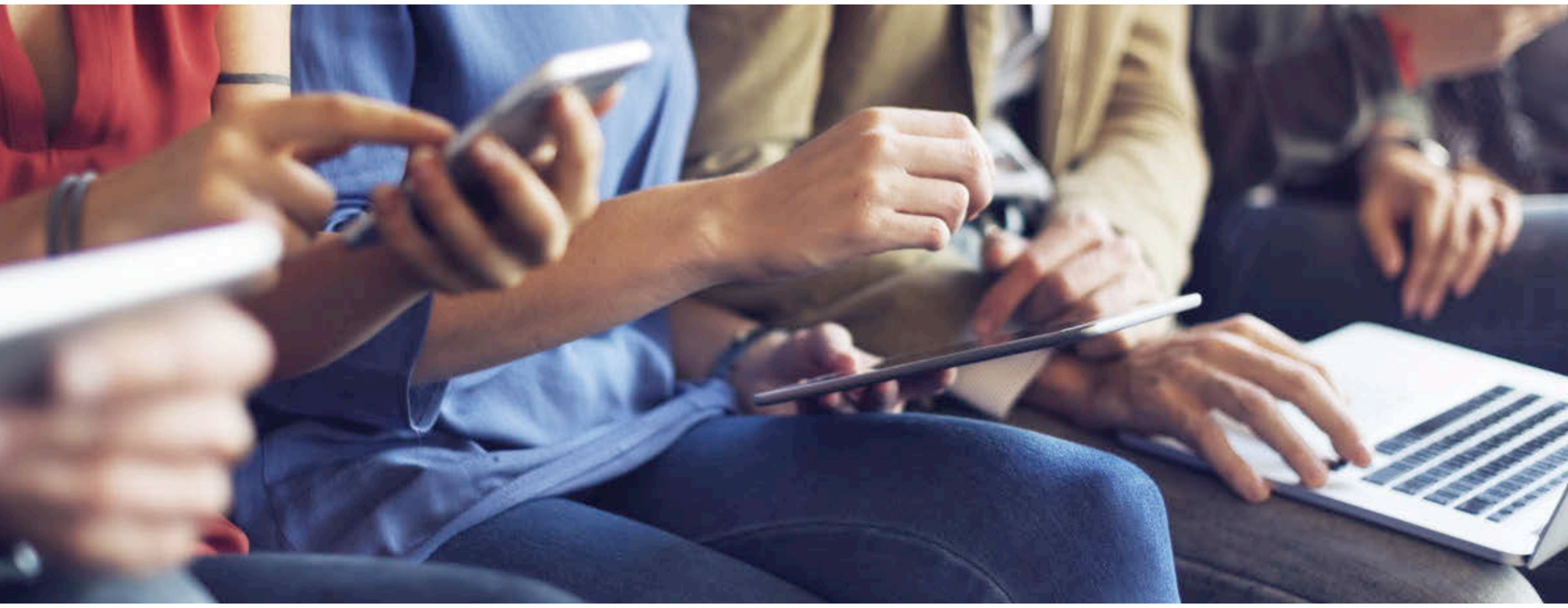

# Replacing silicon

While silicon still dominates the market, both GaN and SiC are now being considered for low-voltage applications. New Electronics investigates

In a world with mobiles, laptops and tablets the demand for low-voltage power adaptors has never been greater. In fact, according to UnitedSiC President and CEO, Dr J. Christopher Dries, there are over 300 million low-voltage chargers being used in the market today, and each one includes a flyback converter.

With such a great reliance on these devices, power conversion has never been so important, so designers are looking to boost efficiency, avoiding the conversion losses which come from using traditional switching circuits used in power converters.

Right now, the low voltage charger market is dominated by silicon and has been for decades.

"Silicon dominates the market and if we are going to be serious about increasing efficiency we need to reduce the thermal output of these devices," explains Aly Mashaly, Manager Power Systems, ROHM Semiconductor Europe.

"It used to be the case that if you left a laptop on for a few hours it became extremely hot, today we have seen a marked improvement due to the increased efficiency of the electronics. However, as devices become more power hungry so there's a need to improve the efficiency of low-voltage adaptors – it's a growing trend we need to address."

"At present, the low-voltage adaptor is well served by silicon powered by MOSFETs," says Dr Dries, who goes on to explain that it's an affordable solution because consumers aren't willing to spend a lot of money on a phone charger. But equally, he argues, people are always looking to improve efficiency, in particular in terms of size and weight.

"After all, don't we all want our charging time to go down, the weight of the charger to be less and the cost to be reasonable?"

**"Alot of SiC companies are focused on the high-end power market. We saw an opportunity to take our devices into the low power segment."**
Dr. J Dries

To help push this forward, UnitedSiC is developing a silicon carbide alternative which it believes can compete with and outperform its more affordable counterpart.

"A lot of silicon carbide or SiC companies are focused on the high-power market – that is anything from 600V and up, for example on-board car chargers," Dr Dries, explains. "We saw a market opportunity to take our SiC devices into the low-power segment with our SiC JFET solution. Virtually no one has done this. We enable people to spend just a little bit more than they would for silicon, but for that they get extraordinary levels of performance in terms of efficiency and operating frequency."

Its range of SiC JFET die is suitable for co-packaging with a controller IC with a built in low voltage MOSFET. This, Dr Dries said, will fabricate an extremely fast, cascode-based, 20-100W flyback product. It will also

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create a space-saving and efficient flyback power converter topology.

Ranging from 650V to 1700V, these normally-on SiC JFETs enable simplified start-up implementation with zero standby dissipation which makes them suitable for the large Flyback AC-DC applications market, including consumer adapters.

Controller IC manufacturers can benefit from the small die sizes with very low RDS(ON) and capacitances, according to Dr Dries. The normally-on JFET helps meet light and no-load dissipation regulations when coupled with a low Qg low voltage MOSFET integrated in the controller IC.

SiC cascodes are robust, due to the inherent capability of SiC JFETs when it comes to handling repeated avalanche and short circuits. Since the SiC JFET is in series with the LV MOSFET in the control IC, the source of the normally-on JFET rises to 12V before it turns off and the IC begins switching. This current path through the JFET can be used as a start-up supply for the controller IC. An auxiliary supply from the converter transformer is then gated-in when the converter starts running, with no further dissipation.

According to Dr Dries, a few companies are looking to accomplish the same feat with another wide bandgap material known as gallium nitride (GaN), because, like SiC, it offers higher frequencies with higher efficiency allowing for “more compact and better adaptors”. But so far only a few have had any success.

**GaN v SiC**

One of those companies is ROHM Semiconductor.

“We believe that GaN is the technology to watch,” says Mashaly. ”GaN is different to SiC because it conducts laterally which means it suits low-voltage applications better. We believe that GaN has a better efficiency than either silicon or SiC when it comes to low voltage applications.”


Above: The demand for low-power voltage adaptors has never been greater

Mashaly concedes that GaN is not currently widely used in the sector.

“We have seen some efforts in size reduction and efficiency, when it comes to GaN, but the market is at a very early stage. The industry is talking a lot about GaN, and interest is growing in terms of its benefits in the low-voltage space. However, I don’t see silicon disappearing and all three technologies (silicon, SiC and GaN) will be around in 20 years.”

If the market for GaN in flyback converters suddenly rockets, Dr Dries says he’s confident that UnitedSiC can “keep GaN at bay”. He points to the company’s cost structure and its efficient SiC ecosystem.

Compared to other SiC competitors, Dr Dries says that the company generates approximately twice the number of die per wafer at 1200V and almost 4x the number of die per wafer at 650V.

“It gives us a great cost and performance advantage while providing our customers with an additional feature set. We provide a standard gate drive that can be driven by an existing silicon solution, so a customer that has silicon in their design right now, can just take out that power set, drop in our device and get higher efficiency,” Dr Dries explains.

He continues: “If you contrast our devices with GaN, we generate 6x the die per wafer, so while SiC is more expensive than silicon and, per wafer, potentially more expensive than GaN, we offset that by the number of die per wafer that we generate.

**“GaN is different to SiC because it conducts laterally, which means it suits low voltage applications better.”**

Aly Mashaly

“The question for designers is ‘do I try and put GaN into this system which will cost more than silicon, or do I use UnitedSiC’s product and actually get more benefits?”

According to Mashaly, “GaN is around 10 years behind SiC. We have to reduce the cost of the material. We have low voltage devices like diodes and silicon MOSFETs and, in the near-future, we will start to introduce GaN devices into the low-voltage area.

“We are always looking for ways to reduce the cost of devices by removing components which aren’t necessary anymore. The size of the fan inside laptops has reduced significantly, and in the future, perhaps we can look at ways to remove the fan, reducing the material costs even further,” Mashaly contends. He continues, “That means that we can afford to use a slightly more expensive silicon alternative such as GaN and the cost of the product will still be lower than it was.”

Dr Dries acknowledges that the cost of SiC may be a problem, but he believes the performance benefits outweigh the cost and adds that he hopes that in the near-future UnitedSiC will sell at a price close to parity to silicon at 650V.

“We have succeeded in making a technology that is high-yielding and which uses a straight-forward process through the IP we have developed and patented over the years.

“The company announced, in March, a strategic investment from Analog Devices (ADI) and they’ve been a great partner. I believe that they’ll be the first of many analogue IC companies wanting to work with us.”

Whether GaN or SiC, the motivation for semiconductor companies to move to wideband gap materials is not because companies foresee a lack of demand for silicon in the future.

“Rather, it’s in response to different use cases,“ Mashaly suggests. “We are looking at greener energy, better efficiency, and that’s why we need to start exploring new materials.”