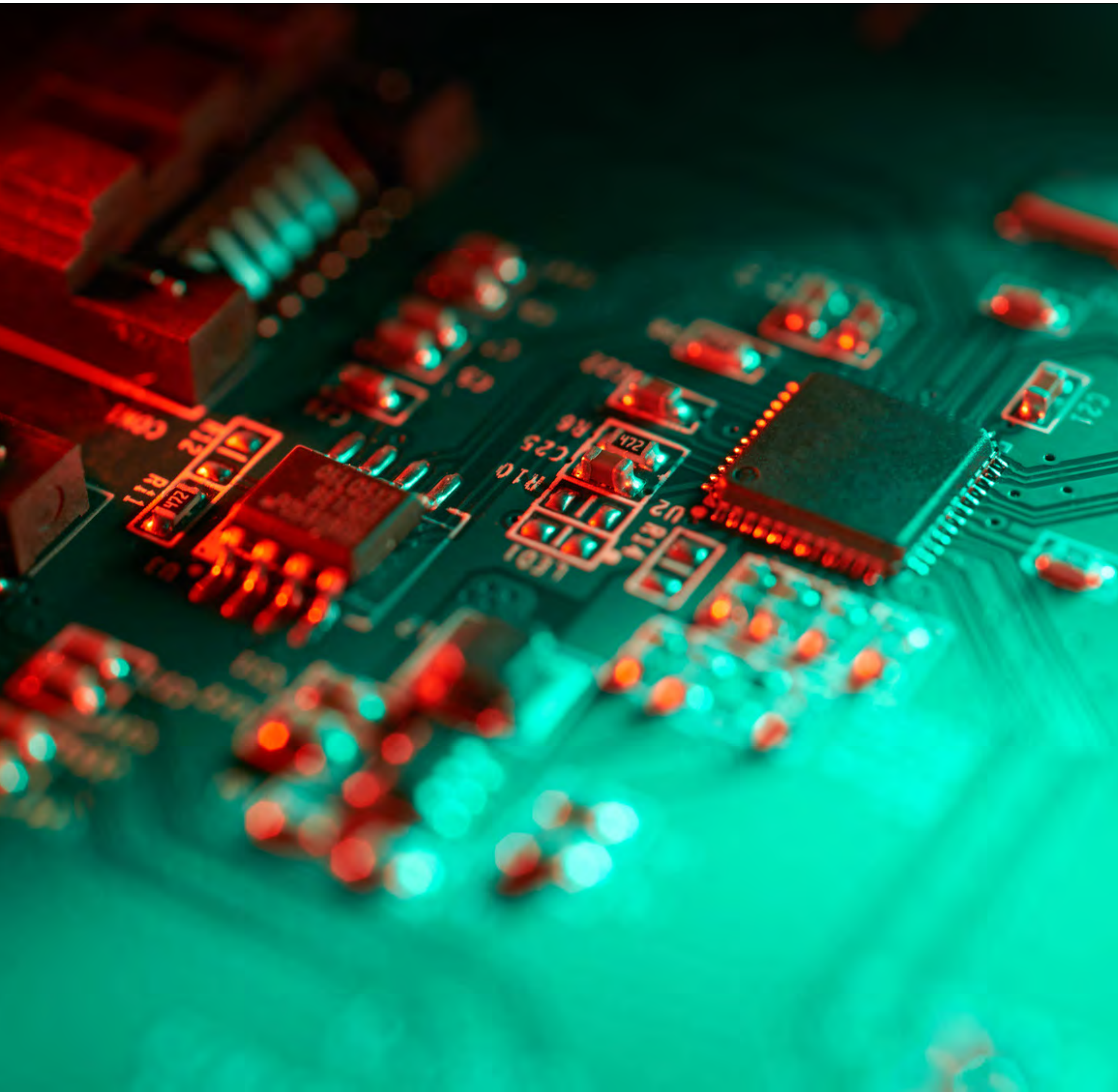
WILL SIC BE THE GAME CHANGER IN THE ELECTRIC VEHICULE INDUSTRY?



EDITO

A worldwide shortage of semiconductors is paralysing various sectors – especially the automotive industry. But the electronic component supply chain was already known to be weak before this was highlighted by the pandemic. So, all industry actors are now mobilising to deal with growing demand for semiconductors and to support the general roll-out of the electric vehicle. The goal? To secure a supply of semiconductors, especially SiC, which is essential for electromobility.

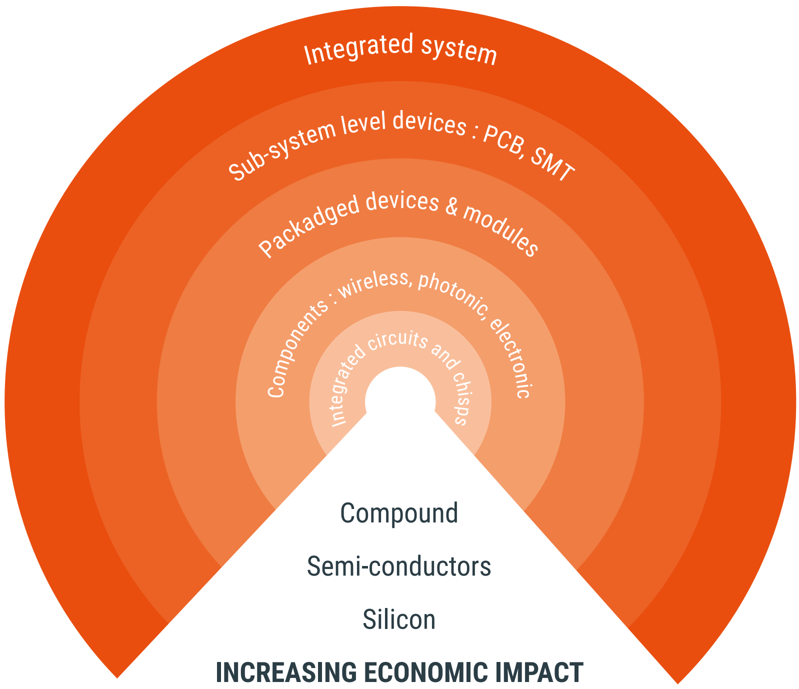
Under pressure: the semiconductor supply chain

An enormous **92% of businesses** that use semiconductors state that they have been **impacted by the shortage**. This figure, provided by a Morgan Stanley survey, shows just how weak the supply chain is. This problem has been highlighted by the pandemic, which has both increased demand for semiconductors (especially for microcomputers, needed for remote working[1]) and put a halt to production and shipment of these materials.

Covid-19 has revealed a problem already well-known in industry to the general public: the centralisation of electronic component manufacturing. Back in the 1970s, almost all production took place in the USA, whereas now, **80% of semiconductor production** is in Asia, particularly Taiwan. The Taiwan Semiconductor Manufacturing Company (TSMC) alone was responsible for over half of worldwide semiconductor production in 2020. This quasi-monopoly makes the market vulnerable to the vagaries of global demand.

In parallel, **demand for semiconductors is growing exponentially**, as more and more sectors need them in a society undergoing a real 'digital transformation', characterised by the rapid rise of new technologies like AI, the Internet of Things, robotics, etc.

Technology powered by Semiconductors



Source : VanEck

Semi-conductor manufacturing: a high-risk endeavour!

As the research and production cycle is long and expensive, semiconductor manufacturing poses a real financial risk. Furthermore, the delay between the research phase and the market launch leads to an industrial risk: will the chips reach the market at the right time in terms of the global context and demand? An even more shocking issue is the effect of the weather on production, as the process requires a lot of water. Indeed, TSMC uses 156,000 tonnes of water per day to make its chips, so it has been badly hurt by recent droughts in Taiwan.

Vehicle manufacturers among the worst affected

Naturally, the shortage has had an impact on a host of different industries, but especially vehicle manufacturers[3], which require a lot of electronic chips.

Renault estimates that around 500,000 vehicles were not made in 2021 due to this shortage[4]. Ford, meanwhile, has indicated that the effects of this crisis will still be felt in 2022[5]. Of course, electric and hybrid vehicles have also been hit hard: Hyundai is struggling to manufacture the Ioniq 5, its electric crossover, due to a lack of chips for its battery modules[6].

In total, the automotive industry's loss of earnings caused by the chip shortage could reach 210 billion dollars in 2021, according to the Alix Partners consulting firm[7].

What about Silicon Carbide?

Though silicon is currently the most widely used semiconductor, for the most demanding uses, manufacturers are turning to germanium, gallium arsenide and silicon carbide.

Silicon carbide is especially attractive in terms of performance and durability: advantages that are particularly important for the production of electric vehicles. The batteries in these vehicles contain power converters, which transform direct current into alternating current. These converters, which have historically used silicon semiconductors, are now using SiC, as it offers:

- a higher **switching frequency** and less power loss (capped at 2%, compared to an average of 5–6% for silicon);
- reduced **size**; and
- **resistance to higher temperatures** (up to 250°C), thus granting more flexibility in the design process, as SiC components are less demanding in terms of cooling needs.

Specifically, for an electric vehicle, this translates as a lighter weight, a 20% lower TCO, better battery life, faster charging, and more.

Currently, SiC is more expensive to produce. But it remains irreplaceable for high-power electronics. Demand is high from battery manufacturers, and increased production should lead to lower prices. Even the manufacturing process itself is evolving: the first wafers made measured 2 inches across, which has increased to 6, and will probably reach 8 inches soon (compared to 12 for silicon).

Despite rapidly growing needs (especially in industries such as electromobility and renewable energy), SiC semiconductors are not in as short supply as Si components. This increase in demand was identified and planned for (rather than sudden and unforeseen), so the pandemic has not compromised SiC production. Nonetheless, the fact remains that, to support the electric vehicle boom, production capacity for SiC semiconductors needs to be expanded. And the supply of SiC must be secured, following the lessons learnt from the current Si component crisis.

Did you know ?

AT THE 2030 HORIZON, 80% of electrical energy will be converted in some way (vs 15% today)

THE GOAL

To improve the energy conversion efficiency

- Less energy consumption
- Less energy loss

FOR HIGH-POWER APPLICATIONS

- Diode, transistor
- Power module

At the heart of converters:

semiconductors, made from Si or SiC

BENEFITS OF SIC

- **Less energy loss**
- **Works at higher temperatures**
- **Better heat dissipation**
- **Smaller / light weight**

Securing the SiC supply chain

'The semiconductor situation is going to take a long time to fix', says Gina Raimondo, the US Secretary of Commerce[8]. At the root is a dependence on Asia deemed 'unacceptable'[9] by the CEO of Intel. A 'more balanced' semiconductor supply chain needs to be built, and all countries are getting involved.

Manufacturers are expanding their production capacity. States and international organisations are mobilising. China, for example, is aiming to achieve self-sufficiency by improving its chip design and production capacity. The USA, meanwhile, has asked TSMC to build a chip factory (with a budget of 12 billion dollars) on American soil. Then there is the European Union, which is considering building a cutting-edge chip factory (at a cost of 30 billion dollars) to reduce its dependence on Asian industry[10].

The SiC supply chain is also being shaped by manufacturers, so as to avoid the vulnerability experienced by its Si counterpart: each manufacturer is looking to guarantee a more local production source. So, across the pond, General Motors has signed a strategic agreement with Wolfspeed, in order to support its 'Assurance of Supply' programme and the construction of a new factory (the biggest in the world[11]).

In Europe, a common initiative has emerged, led by German company Bosch. The project, known as Transform[12], seeks to develop SiC technologies and, above all, to build a complete, competitive value chain in Europe. Transform has a project budget of 89 million euros and brings together key players in the SiC value chain in Germany, France, Italy, Austria, Sweden, Spain and the Czech Republic. It also includes manufacturers (Aixtron, Danfoss, EV Group, Mersen, Premo, Saint-Gobain, Semikron, Soitec, STMicroelectronics, Valeo-Siemens Automotive, etc.) and academic institutions (Universities of Brno and Seville, CEA Leti, Fraunhofer IISB, etc.). So, European vehicle manufacturers can rest easy: efforts are being made to secure the component supply chain.

Mersen, a global leader in the manufacturing of high temperature materials dedicated to the SiC production growth, secures its supply chain.

Mersen produces and develops high performance materials such as isostatic graphite and purified carbon insulation for the production of high quality SiC. Reaching a temperature of 2400°C, this process requires a precise temperature control and materials capable to cope with an agressive environment. Mersen solutions allow manufacturers to achieve large-scale industrial production, with reliability similar to that of silicon production.

To help to curb the shortage problem, Mersen is building an international supply chain. Its goal is to be able to maintain a very high standard of quality across large volumes, thus supporting the growth of electromobility.

Read more :

- 3 challenges semiconductors will face in the next decade
- How & why is SiC transforming the semiconductor industry?
- Silicium vs SIC: what's next for industrial engineering?

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