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Inverter Market Drives Advances In Power Component Technologies And Sales

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Because of continued strong interest in green energy, power electronics is experiencing significant growth. According to a recent study conducted by our firm (see the reference), the demand for power inverters in green applications such as electric vehicles (EVs), hybrid electric vehicles (HEVs) and renewable energy systems is increasing rapidly. This rising demand for inverters is also spurring growth in sales of numerous electronic components as well as innovations that improve their performance.

Starting from a total market size of almost $44 billion in 2012, based on our estimates, the inverter market should reach more than $55 billion in sales by 2016. This growth will be largely driven by a high compound annual growth rate (CAGR) for applications such as EVs and HEVs and renewable energy. We project that overall shipments of inverters for every power range should reach a total of almost 28 million units in four years' time.

As a consequence of the growing inverter sales, the market for semiconductor power modules—mostly driven by IGBT modules—is also rising rapidly to new levels. In 2012, the power module market will hit $1.64 billion thanks to EV and HEV applications having a CAGR of 29% from 2011 to 2016.

Power modules will also be notable for their role in the introduction of wide-bandgap semiconductor materials. Indeed, requirements such as form-factor reduction, higher efficiency, greater reliability and lower weight will push compound semiconductors into the power modules. Our firm forecasts a market size of $150 million for these semiconductor devices by 2016 with a fast ramp up in adoption starting in 2014.

Last but not least, the inverter market will fuel demands for other electronic products. Specifically, passive components and connectivity solutions such as power connectors and busbars will represent another huge market. In this area, we expect to see the adoption of new passive components like supercapacitors and developments around connectors as well as power signal and communication features. The general growth trend of power electronics will also drive sales of more standard components such as resistors. Overall, our firm estimates that the market for passive and connectivity components should reach $2.7 billion in 2016.

Impact of Semiconductor Developments

The evolution of semiconductor devices is at the heart of all developments in inverter technology. These developments, mostly geared toward improving a device's electrical performance also have an impact on other aspects of module and inverter design including power packaging, system size reduction, efficiency, and passive and connectivity solutions.

However, according to our findings, silicon carbide (SiC) and gallium nitride (GaN) based switches are not ready yet to penetrate the market in high volume. Indeed, these technologies still need further improvements and cost reduction. Consequently, we believe that mass adoption will not come before 2015 (see the figure below.)

But even after this milestone is achieved, compound semiconductors will still compete with silicon-based technologies such as (fast) IGBTs and superjunction MOSFETs, specially driven by new inverter architectures (like neutral-point clamped (NPC)) that are implemented at the power module level.

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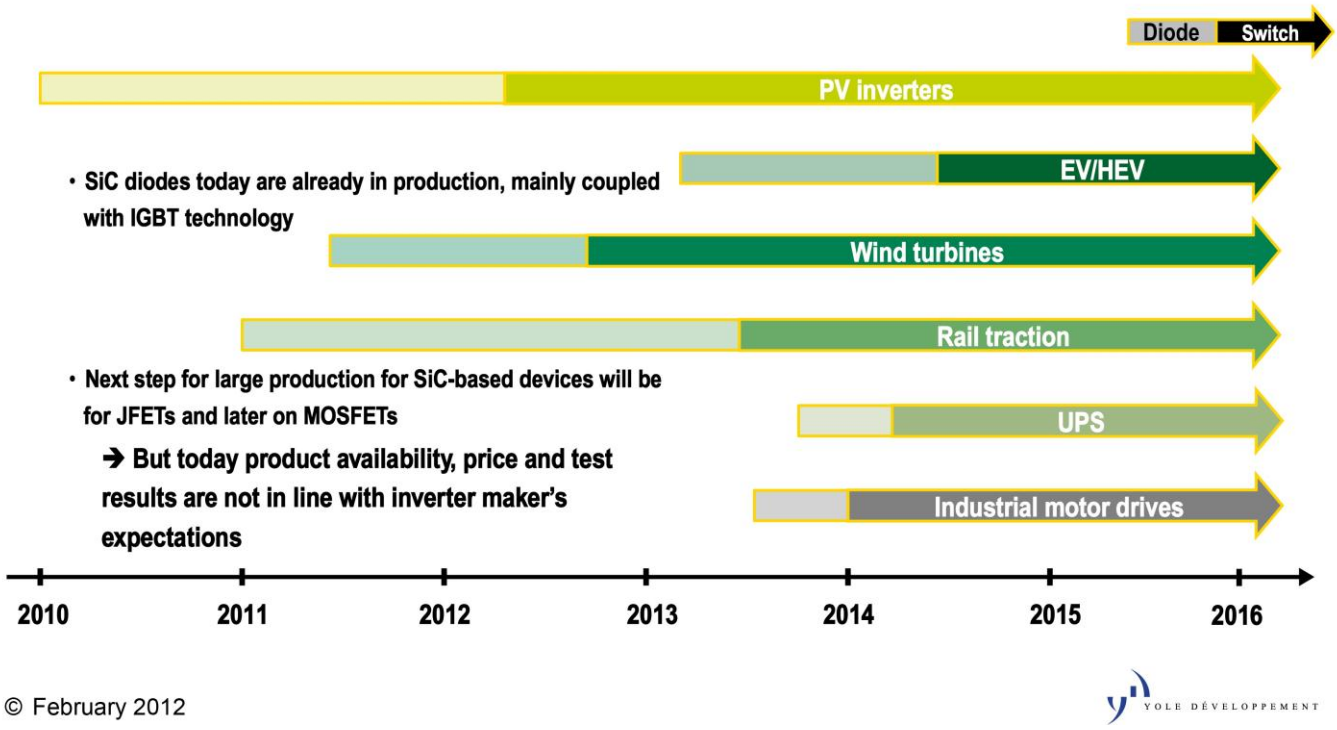

Figure. Roadmap of SiC-based device integration in power electronics applications. (Source: Inverter Technology Trends & Market Expectations report, February 2012, Yole Développement.)

Power Packaging Turns To New Materials

Today, semiconductor manufacturers, power module makers and system integrators are looking for several improvements in power semiconductor products. These include more-reliable interconnections, materials that withstand higher working temperatures, and ways to remove or reduce the size of cooling systems. Indeed, due to the higher switching frequencies and higher amounts of heat coming from external sources (motors, high ambient temperatures) semiconductor dies are getting closer to the heat dissipation system as the materials between the dies and heatsinks become thinner and thinner.

This also means die-attach materials are being investigated in order to maintain a strong connection between the direct bonded copper (DBC) substrate and the semiconductor device. Copper wire bonds or aluminum ribbon bonds are preferred to standard aluminum technologies (which still represent 90% of the market), since they also support harsh working conditions. Another track for interconnection is foil-based solutions, which enable reduction in a power module's volume, higher reliability in the face of vibration, connection of surface mount devices (SMDs) or other devices on top of the module and adoption of double-sided cooling systems.

Of course, all of these efforts to improve packaging and interconnections are intended to to support the application of new semiconductor materials such as SiC and GaN. But this same work is also conducted to satisfy the current application requirements—even when those applications are not currently suitable for the new semiconductors.

For example, today, some cost-driven applications such as motor drives and UPSs are not ready to implement the new types of modules based on wide bandgap semiconductors because their added cost has too great an impact on the overall system. In other words, the new modules are currently too expensive for use in motor drives and UPSs. However, these same applications are expected to benefit from the improvements in packaging and interconnects described above and therefore they also help drive R&D efforts in power packaging. In parallel, applications such as photovoltaic (PV) inverters, trains and electric and hybrid vehicles are the key drivers for power packaging research.

Out of the standard material suppliers for the electronics industry, three types of power electronics companies are likely to work on R&D for power packaging:

- Semiconductor device and module makers, such as Infineon, Toshiba or Mitsubishi

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- Power module makers like Semikron, GE Global Research or Starpower
- Inverter manufacturers like DENSO, Yaskawa, Alstom or BYD.

Supply Chain Evolution Varies By Region

Power electronics now implies working with a broad spectrum of knowledge and know-how: mechanical, electrical, semiconductor, fluidics, hydraulics, and connectors. Therefore, developments can be complicated and final products can be expensive.

As a consequence, our team has observed and analyzed two main trends in the power electronics industry, which depend on the players' locations.

Japanese and Chinese companies in this industry, especially the system makers, tend to go downstream and master the manufacturing processes of each subsystem and component. In the case of Japanese suppliers, this tendency is mostly driven by cost reduction and absorption of intermediary margins. Meanwhile, Chinese vendors tend to go this route because they want to access the technology and show some proof of quality.

On the other hand, players in the European Union and United States are more diversified. Among these companies, growth through the acquisition of other firms with new competencies (such as Mersen, Rogers or Power Integration) or high-end R&D and prototyping services (like APEI, Primes, IMEC, GE Global Research) is becoming more common.

Reference

Inverter Technology Trends & Market Expectations, February 2012, Yole Développement.

About The Authors

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