Status of the SiC power devices market

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Abstract

SiC devices business is not yet the most exiting money-maker activity. It is not explicitly published neither by Cree nor Infineon, but we estimate the SiC-based power electronic devices 2006 sales should have generated something around $15 million revenues.

Key Words: Silicon carbide, MOSFET, market, Schottky diode

The only product commercially available is Schottky diode (SBD), now reaching 1200V and 20A range. This component is targeting numerous possible applications (Fig.1) but is mostly used in high-end PFC (Power Factor Corrector) systems where it brings some impressive added values like better power conversion efficiency (Cree proved +50% improvement on losses), circuit board size shrinking, RF oscillations avoidance and removal of numerous passive discretes.

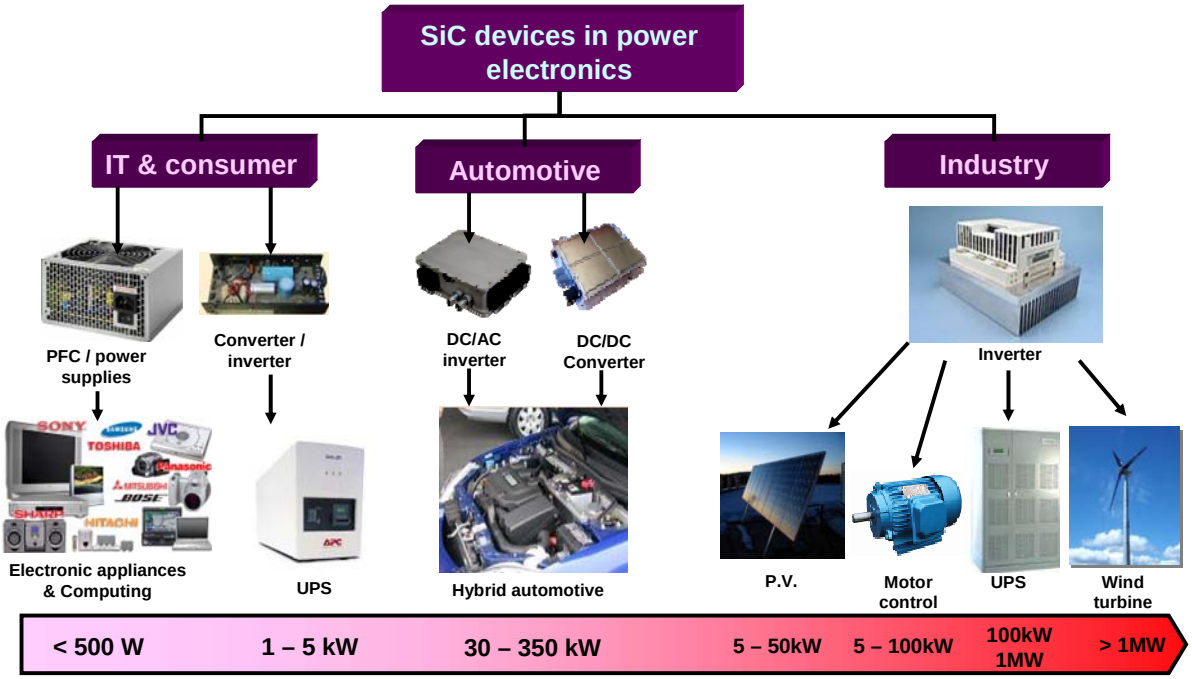

Figure 1: Possible applicative fields for SiC power devices

Theoretically, SiC can be considered as the dream technology to replace silicon-based circuits in the PFC systems. Moreover, we are talking here about a total accessible market of more than 2.2 billion PFC units in 2007 exhibiting a +12% CAGR (Source: Darnell

Group). The TOP 3 PFC manufacturers (Delta Electronics, Astec Power / Emerson and Lite-on Technology) are generating more than $4.2B revenues.

So, why that tiny $15M sales for SiC devices? First reason is certainly linked to the technology implementation: It is not a chip-to-chip replacement. PFC circuits have to be redesigned to handle and catch the added value of the SiC Schottky diodes. Secondly, from an economical point-of-view, PFC market is heavily price-pressurized and introduction of a new technology is a possible risk that some companies are hesitating to take. Finally SiC Schottky diode market price itself is a limiting factor.

SiC Schottky diode (SBD) cost breakdown is significant to illustrate this last point (Fig.2). To summarise, material bill accounts for ~75% of the device cost (based on current 3" wafers production), which is fundamentally different from the silicon-based technology where material is no more than 10%. The introduction of 4" material should help to make this ratio decreasing. 4" production has already been launched at Cree and Infineon may complete the 3"to 4" transition in 2008.

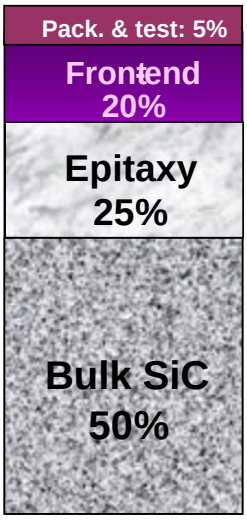

Fig. 2: SiC SBD cost breakdown

The current market price of SiC Schottky diode is oscillating somewhere between $0.30/Amp and $0.40/Amp depending of the voltage and the lot size. According to both SiC device makers and PFC manufacturers, it seems that a price level of $0.20/Amp would give a favourable feedback for the technology penetration. First estimations of 4"-based SiC manufacturing cost lets us think that this threshold should be beat by 2008. This goes with production yield improvement, adapted SiC wafers price level ($0.15/mm^2 would be highly appreciated…) and fabs capacity increase.

Conclusion

It is now clear that the relative stagnation of SiC power device market is partially due to a lake of a reliable transistor technology. PFC business is the only one driving SiC device sales and perspectives for higher market penetration is mainly linked to the device cost decreasing. Others applications are requesting a complete SiC switching cell (diode and transistor).

MOSFET has been largely investigated by major SiC R&D teams, but it seems more and more certain that JFET or BJT technologies may be released first on the market place. Big names are confessing to face unsolved issues with MOSFET so maybe truth is out there, out from oxides….

Acronyms:

BJT: Bipolar Junction Transistor
CAGR: Compound Annual Growth Rate
JFET: Junction Field Effect Transistor
MOSFET: Metal-Oxide Field Effect Transistor
PFC: Power Factor Corrector
SBD: Schottky Barrier Diode
SiC: Silicon Carbide