SiC Semiconductors: enabling efficient power electronic systems for Smart Cities and Green Transport

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Date 4th June 2015
Agenda

- SiC Power Market
- Growth segments/activity
- Continental Initiatives
- Raytheon’s capability

Battery Monitoring Systems
Power Switch Nodes
Power Modules
Power Convertors
Power Semiconductor Foundry
SiC Power Market – Yole Oct 14

SiC device market size split by applicative markets (M$)

Source: Yole Oct 2014
Growth Segments

Next Generation Power Semiconductors

- SiC (silicon carbide)
- GaN (gallium nitride)

Physical properties superior to Si

- Low Loss
- High-Speed Switching
- High Breakdown Voltage (small size, large capacity)
- High Operating Temperature

Fig. 1 & 8 from Material science and device physics in SiC technology for high-voltage power devices

Total energy availability is approximately 40% (Average of 10 power companies, actual values for Fiscal 2004)
* From the website of Oseka Gas Co., Ltd.

Approximately 60% of electricity is lost through exhaust heat!

SiC can significantly reduce energy lost through electric conversions

Full-scale popularization of SiC power devices has conserve approximately 30 TWh (equivalent to 3 to 4 nuclear power plants) of energy per year just in Japan!

According to estimates of Engineering Advancement Association of Japan

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Key Issues being addressed to accelerate adoption

Reliability: especially on trench MOSFET’s
Yield > 80%: Stabilised processes, wafer quality
Cost (2-3x acceptability): Today 10x
Packaging: integration into system solution high in value chain
Commercial availability of power device design skills....UK???
Continental Initiatives

- Power America
- Europe
- Japan

The Ministry of Economy, Trade and Industry (METI) decided to start the "New Material Power Semiconductor Device Project Toward Achieving a Low Carbon Society" (budget for FY 2010: 2 billion yen) this year. This is a major project for green innovation promotion.

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Developing advanced manufacturing processes to enable cost-competitive, large-scale production of wide bandgap semiconductor-based power electronics, which allow electronic systems to be smaller, faster and more efficient than power electronics made from silicon.

Wide Bandgap materials cut electricity losses during charging by 66%.

Wide Bandgap materials enable higher-efficiency, variable-speed drives. Motor systems use 69% of electricity consumed in U.S. manufacturing.
Raytheon’s Capability

- Device Manufacturing experience
- Product development
- Improving yield and reliability
SiC Capability

Raytheon’s SiC Foundry

- Cleanroom size: 1250sqm
- Cleanroom grade 100
- Number of employees: 560/60
- Quality standards: ISO 9001, ISO 16949
- Open for Development or Production

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Device Experience

Customer requirements

Power Semiconductor (e.g. Schottky Diode, MOSFET, PiN, BJT, JFET)

Entry points

- Device structure and design existing on CAD (The CAD-to-Fab route)
- Initial process work already performed in lab (The Lab-to-Fab route)
- A process flow already exists (Fab-to-Fab route)

Underpinned by:

- Raytheon supplied process modules
- Raytheon’s processing experience
- Raytheon’s customisable processing steps
- Raytheon’s wafer fabrication equipment
adjective: reliable
consistently good in quality or performance; able to be trusted.
SiC Foundry for Power Devices

- Complete device supply chain management
- Delivering lower cost SiC devices through expertise and economies of scale
- Experience of SiC SBD, JFET, BJT, MOSFET, PiN devices
- Working across start-ups and production scale providers of SiC devices
- A flexible fab: transfer whole-device process-flows, short loops & single stage
- Partnerships with SiC device producers, integrators, designers & OEM’s
- Close links with UK and US academia and technology funding agencies
Market is predicted to grow by +20% CAGR

Key segments serving Green Transportation & Smart Cities PE requirements

Differentiated devices developed

Focus on reliability, adoption and cost reduction

New global initiatives to address strategic challenges/objectives

Raytheon can play a part
  Differentiated products
  Lower costs for production
  System optimised devices
  Stabilised process
  Accelerated time to market for power devices
Thank you!

- Find out more
- www.raytheon.co.uk/semiconductors