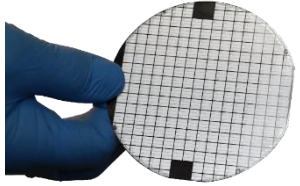
Microsemi

a Microchip company



Productization of 3.3 kV & 700 V Silicon Carbide MOSFETs

Objectives: Proposed efforts would focus on commercialization of advanced 700 V SiC MOSFETs that can compete with Si superjunction products and 3.3 kV MOSFETs, including reliability assessments and production scale-up. Build state-of-the-art reference designs to gain adoption in auto and industrial markets.

Major Milestones: 700 V – Advanced designs and fabrication of high yielding 700 V FETs, 3.3 kV – Optimize design and process for commercialization, complete fundamental reliability tests, prove ruggedness by R-UIS, R-Surge, Build resonant converters demonstrating the efficacy of using WBG in high performance industrial applications.

Project Metrics / Deliverables

- 100 bare-die or packaged 700 V MOSFETs with advanced designs
- 100 bare-die market-ready 3.3 kV MOSFETs with completed reliability studies.

WBG Technology Impact

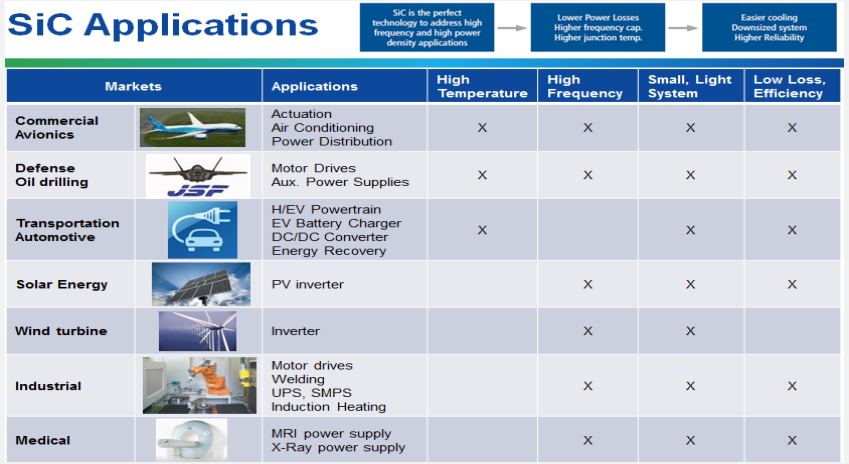
1. WBG Benefits: Inherently faster switching operates at higher frequencies while generating lower power losses, for higher efficiency. High ruggedness provides pathway for WBG to enter mission-critical applications such as T&D and traction.

2. Markets: Automotive, Transmission & Distribution, High Power Traction, High Performance Industrial, Aerospace & Defense.

3. Commercialization: 12 months.

4. Market Penetration: Superjunction Si devices (<=650 V) comprise a significant portion of the power semiconductor market is ripe for displacement if the economics of WBG work out. HV SiC devices replacing current Si IGBT solutions require ≥2 kV. The HV market consisting primarily of the 3.3 kV-based solutions could make up 20% of the total market by 2021.

Proposed BP5



SiC Applications

SiC is the perfect technology to address high frequency and high power density applications → Lower Power Losses Higher frequency cap. Higher junction temp. → Easier cooling Downsized system Higher Reliability

Markets	Applications	High Temperature	High Frequency	Small, Light System	Low Loss, Efficiency
Commercial Avionics	Actuation Air Conditioning Power Distribution	x	x	x	x
Defense Oil drilling	Motor Drives Aux. Power Supplies	x	x	x	x
Transportation Automotive	H/EV Powertrain EV Battery Charger DC/DC Converter Energy Recovery	x		x	x
Solar Energy	PV inverter		x	x	x
Wind turbine	Inverter		x	x	
Industrial	Motor drives Welding UPS, SMPS Induction Heating		x	x	x
Medical	MRI power supply X-Ray power supply		x	x	x

Contact

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Additional Impacts

1. Impact on Cost Effectiveness: (a) Using 6” fab that shares several tools with a larger-volume Si line can drastically decrease cost per amp, (b) as market penetration increases, cost of substrates is expected to drop substantially, (c) a commercial foundry would reduce extrinsic defects, improving yield and cost, (d) R&D cycles can be reduced, which directly lowers costs.

2. Jobs: 4 fulltime equivalents; potential of assembly and fab work benefits.

3. US Competitiveness: Major players in SiC are based outside of the US, a potential risk that could affect mission-critical applications such as Aerospace and Defense. Semiconductor fabrication is also rapidly moving outside of the US and threatens to stall innovation. Microsemi is working towards keeping both the design and fabrication of WBG technology in the US.