Defense-Wide Manufacturing Science & Technology (DMS&T) Program

Silicon Carbide (SiC) High Efficiency Power Switches

PROBLEM / OBJECTIVE

Power loads continue to rise on all military platforms. Mission capability on current and future platforms is driven by effective use of electric power. Limited space is available to provide power without compromising mission payload allocation.

Silicon carbide (SiC) based converters provide greater power density and finer control than silicon based converters, however, yield is too low and cost is too high.

APPROACH / BENEFITS

Objectives

- Improve yield, cost, and maturity.
- Enable new class of power electronics that allows flexible new architectures at higher voltages, higher frequencies, less volume and weight, higher temperatures, higher efficiency (reduced fuel consumption), and better power quality.

Approach

- Increase throughput and decrease cost of SiC power devices through enhanced material growth and high-yield device fabrication processes.
- Increase wafer/epi-layer diameter from 4” to 6“.
- Increase voltage and current/power ratings by 2-3 X.
- Reduce cost of power die by 3-10 X depending on type of power die. Estimated power die savings plus fuel cost savings of 2% for 1000 combat vehicles = $389M over 10 years.
- Ensure rapid feed-back from power device processes to starting material processes.
- Cost share with industry for new manufacturing processes and relevant fabrication line.

- Focus on increased efficiency and temperature for size reduction and fuel economy.

SiC Power Switches

Expected Benefits and Warfighter Impact

- Applications: Ground Combat Vehicle (GCV), DDG-51 Flight III, F-35, F-22, and other aircraft
- Enhanced mission capability (mobility, survivability, lethality), performance, range, duration, and reliability (less maintenance down-time)
- Silicon carbide (SiC) based converters reduce volume by at least 30% and weight by at least 50%.
- SiC based converters reduce the risk of deploying Air & Missile Defense Radar (AMDR) onto future naval platforms.
- Reduced cooling requirements, increased efficiency (3X) at high voltage and higher operating temperatures.
- Easier to integrate onto military ground vehicles than silicon based systems and provide significant improvements in fuel economy and mobility performance.
- Improved power quality, enhanced reliability, and reduced weight & volume, leading to reduced ship installation cost. A shipboard radar system power conditioning substation can be reduced in weight by 89% (31,500 lb) and in volume by 70% (348 cubic ft).

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