

High-Temperature, Wirebondless, Ultracompact Wide Bandgap Power Semiconductor Modules

For space and commercial power systems

Silicon carbide (SiC) and other wide bandgap semiconductors offer great promise of high power rating, high operating temperature, simple thermal management, and ultrahigh power density for both space and commercial power electronic systems. However, this great potential is seriously limited by the lack of reliable high-temperature device packaging technology.

This Phase II project developed an ultracompact hybrid power module packaging technology based on the use of double lead frames and direct lead frame-to-chip transient liquid phase (TLP) bonding that allows device operation up to 450 °C. The new power module will have a very small form factor with 3–5X reduction in size and weight from the prior art, and it will be capable of operating from 450 °C to –125 °C. This technology will have a profound impact on power electronics and energy conversion technologies and help to conserve energy and the environment as well as reduce the nation's dependence on fossil fuels.

Applications

NASA

- ▶ Wide operating temperature power semiconductors for space power systems and science missions:
 - Spacecraft orbiting Earth, Venus, Europa, and Titan
 - Lunar Quest Program

Commercial

- ▶ Power electronics, along with computer and microprocessor technology:
 - Automobiles, electric utilities, pollution controls, communications, computer systems, consumer electronics, and factory automation
- ▶ Hybrid electric vehicles
- ▶ Renewable energy conversion
- ▶ Power supplies



Phase II Objective

- ▶ Develop an ultracompact hybrid power module packaging technology based on the use of double lead frames and direct lead frame-to-chip TLP bonding

Benefits

- ▶ Device operation up to 450 °C
- ▶ Very high current-carrying capability
- ▶ Low package parasitic impedance
- ▶ Low thermomechanical stress at high temperatures
- ▶ Double-side cooling
- ▶ Modularity for easy system-level integration

Firm Contact

Advanced Power Electronics Corp. (ApECOR)
John Elmes
jelmes@apecor.com
3259 Progress Drive, Suite A
Orlando, FL 32826–2930
Phone: 407–275–1174

Proposal Number: 09-2 S3.05-8550