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Fraunhofer Institute for Integrated Systems and Device Technology IISB

Advanced cooling technologies

Highly-Integrated SiC Power Module on Ceramic Heat Sink

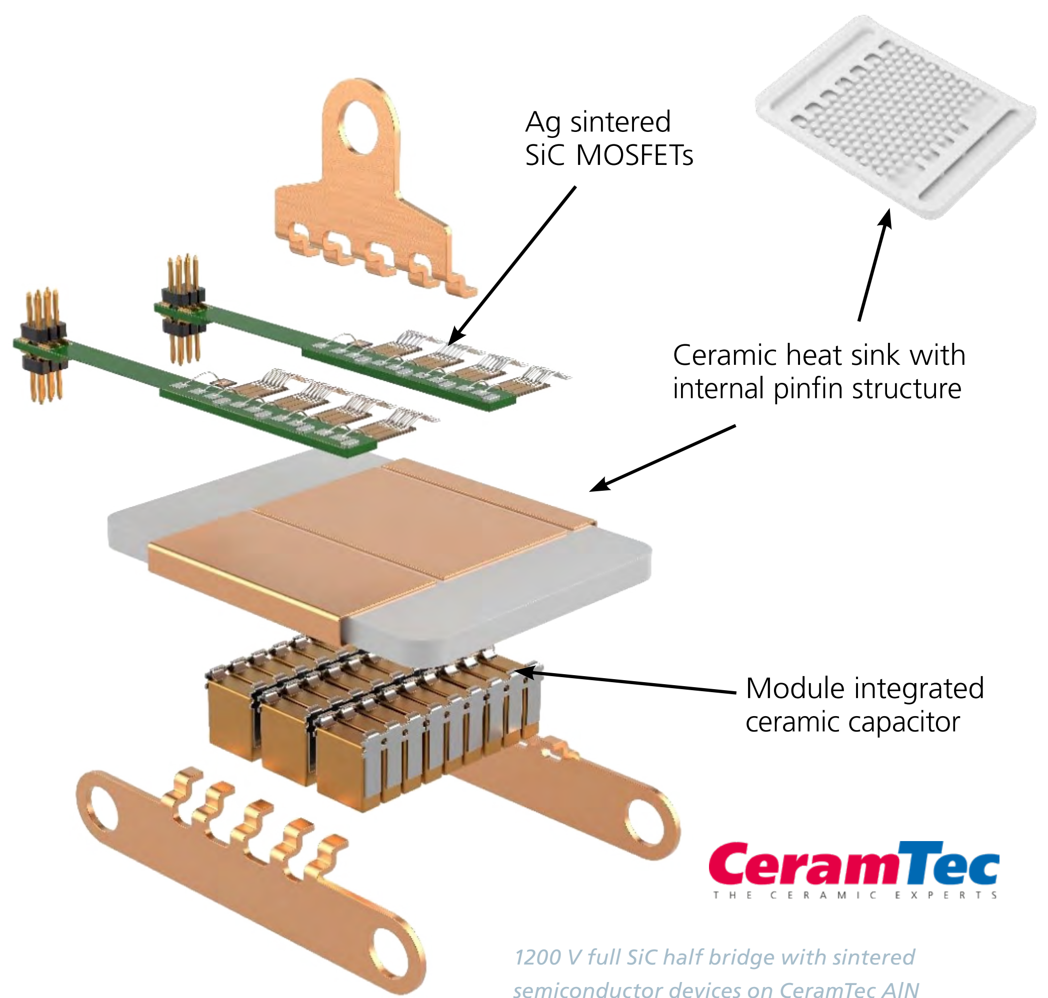
1200 V full SiC half bridge with sintered semiconductor devices on CeramTec AlN ceramic heat sink © Thomas Richter / Fraunhofer IISB

Power module design

- 1200 V SiC half bridge power module based on CeramTec AlN heat sink
- Ceramic heat sink – Integration of cooler and ceramic substrate
- Direct sintering of SiC chips on metallized ceramic heat sink
- Double sided use of ceramic heat sink – Integrated ceramic capacitors on back side for easy system application
- Scalable and flexible design

Key features

- Low thermal resistance ($R_{th}' = 0.15$ Kcm²/W)
- Low stray inductance
- Very low weight and small size (cooler weight = ~10 g)



1200 V full SiC half bridge with sintered semiconductor devices on CeramTec AlN ceramic heat sink © CeramTec

Fraunhofer IISB - Your Partner in Power Modules

Concepts and Engineering

Design of custom-specific power modules:

- High Power
  - Double-sided cooling
  - High parallelization
  - Reliable interconnection technologies for high thermal cycling capability
- High Performance
  - Fast-switching SiC and GaN
  - Integrated RC-snubber
- Application specific
  - Power modules on ceramic substrates, IMS,...
  - Innovative cooling
  - 3D-integrated design

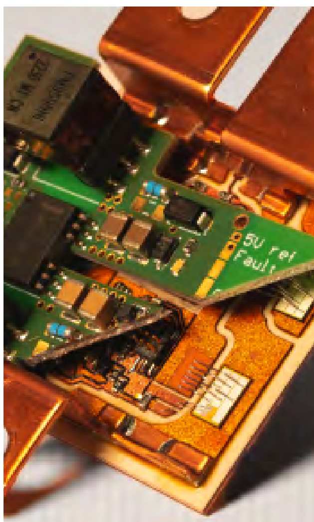
Characterization and Modelling

- Electrical performance analyses
  - Switching behavior, switching and static losses
- Extraction of parasitic elements
  - Inductances in commutation loops, current density estimation and capacitive coupling
- Thermal and thermo-mechanical analyses
  - By simulation and measurement
- Modelling setup
  - For virtual switching cell prototypes and thermal networks

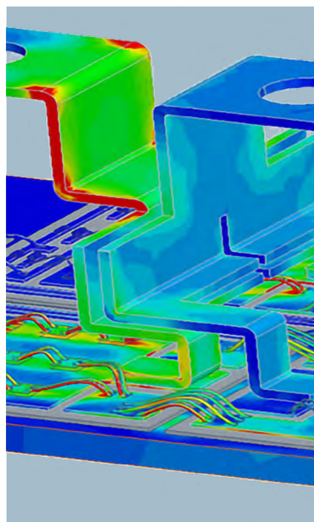
Prototyping

Manufacturing of custom-specific prototypes with newest packaging technologies including tests under clean room standards:

- Manufacturing of custom-specific power modules
- Packaging technologies
  - For top and bottom side chip contact (sintering, soldering, wire bonding, direct bond,…)
  - Encapsulation and coating
- Subtractive and additive manufacturing processes
- Tests
  - Electrical and thermal characterization
  - Destructive and non-destructive analyses of die attach
  - Lifetime testing and reliability



Engineering: vGaN-ready power module with integrated gate driver stage © Elisabeth Iglhaut / Fraunhofer IISB



Characterization: analysis of current distribution and power loop inductance © Fraunhofer IISB

Prototyping: power module manufacturing in IISB's own AIT-cleanroom © Anja Grabinger / Fraunhofer IISB

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