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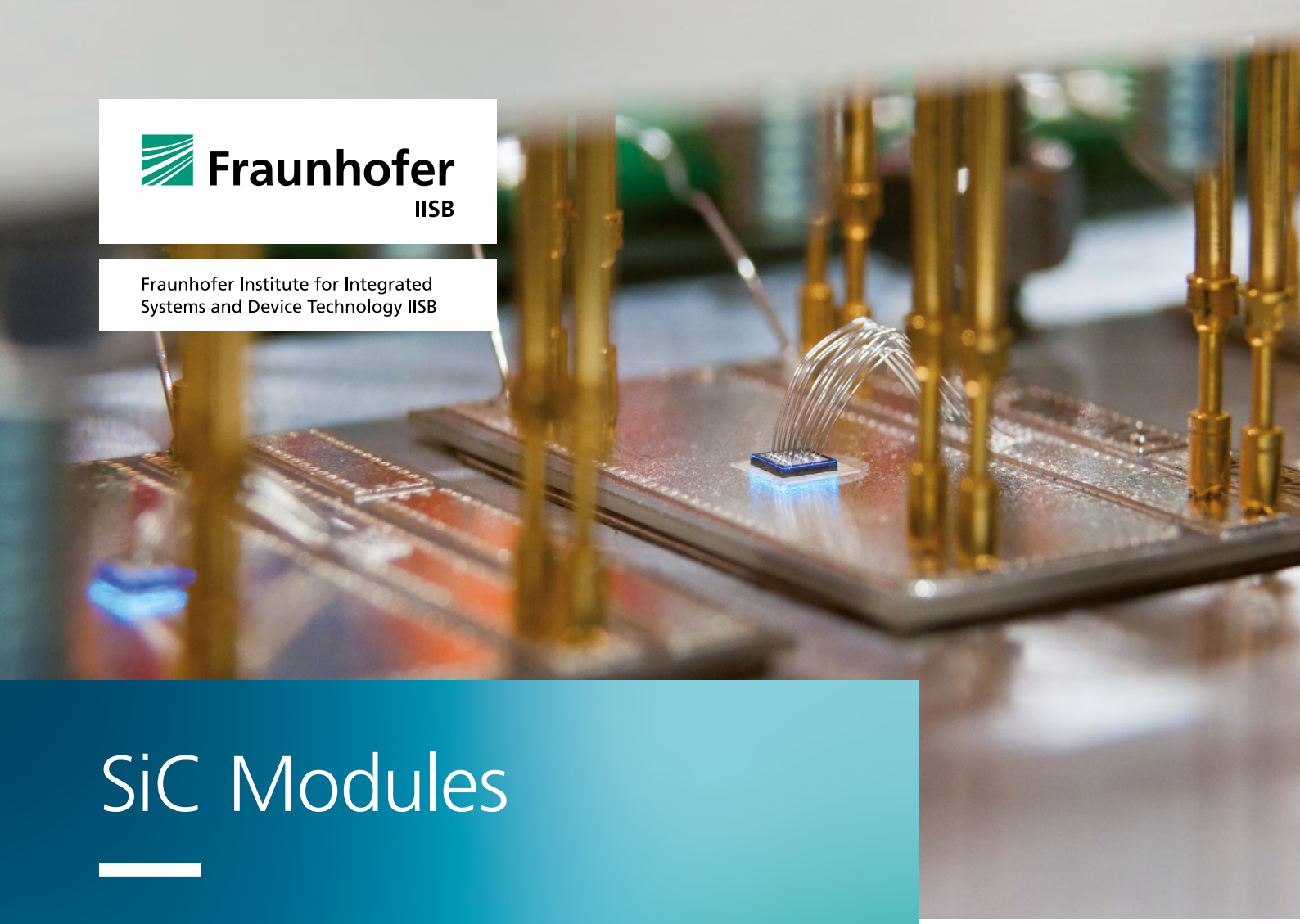
Fraunhofer Institute for Integrated Systems and Device Technology IISB



SiC Modules

Die Attach Technologies & Reliability

From Chip to Power - Research, Development, and Prototyping from one Source

Advanced SiC module concepts turned into prototypes with verified electrical static and dynamic characteristics, thermal performance and tested lifetime. Fraunhofer IISB supports you in the development of new materials, die attach, electrical interconnects, cooling and mechatronic subsystems using state-of-the-art simulation, design and assembly tools.

Advantages & benefits

- Solutions from the system or application point of view
- In-depth experience in power module research and development
- Complete process line from chip to package and from package to lifetime model
- From idea to prototype within a short time, always ready for any challenge
- Innovative solutions and fast response time
- Projects from small scale to complete technology investigations and transfer

SiC merged PiN schottky diodes emitting blue light during power cycling test.
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Features

- Conceptional investigations for SiC power modules
- Joining technology research like, e.g., silver sintering
- Various characterization equipment and know-how
- Wide lifetime testing capabilities like, e.g., power cycling
- Diverse analyzing of failure mechanisms like, e.g., µ-scale chip crack
- Lifetime modeling of power modules like, e.g., physics of failure method

Module assembly and die attach technologies

Module design

- Conceptional investigations
- Design for electrical, thermal, mechanical, and lifetime constraints
- Electrical and thermal simulations

Manufacturing and packaging, including advanced joining technologies

- Soldering for standard and high-temperature applications (vapor-phase vacuum soldering system / formic-acid-activated IR vacuum reflow)
- Silver sintering with enhanced automatic die placer and servopress
  (single and double sided / multichip power modules)
- Wire bonding of different materials and diameters with automatic bonders

Characterization

- Dynamic switching / static device performance
- High speed imaging / infrared imaging
- Thermal resistance (R_{th}) / impedance (Z_{th}) measurement

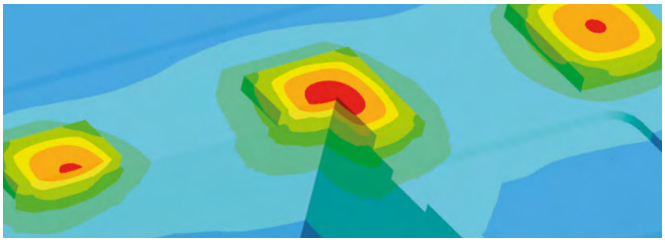
Reliability and failure analysis

Accelerated aging

- Passive temperature cycling via air in single-chamber or two-chamber shock oven from -80 °C to +300 °C (TST)
- Passive temperature cycling tests for liquid cooled power electronic systems from -25 °C to +120 °C
- Active power cycling with up to 40 devices in one test and a wide range of parameter sets (PC_{min}, PC_{sec})
- Environmental tests for power modules and passive components (like H3TRB and others) with temperature, humidity, AC and DC voltage and dynamic switching

Analysis of failure mechanisms and modeling

- Package decapsulation / removal of soft gel
- Scanning Acoustic Microscopy (SAM), high-resolution topography (micro-CT), Scanning Electron Microscopy (SEM)
- Focused Ion Beam (FIB) with elementary analysis (EDX)
- Lock-in thermography (LIT)
- Partial discharge
- Electro-thermo-mechanical simulation of power modules including reliability prediction (Digital Twin)
- Physical and empirical lifetime modeling for, e.g., gate oxide reliability and electromigration



Simulated temperature distribution in SiC power module consisting of 96 SiC PiN diodes.
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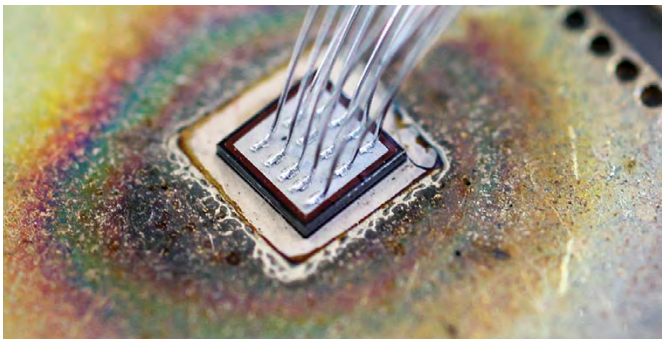

Silver-sintered SiC device on insulating substrate operated at high temperature.
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Contact

Dr. Juergen Leib
Group Manager
Testing and Reliability
Tel. +49 9131 761-615
juergen.leib@iisb.fraunhofer.de

Fraunhofer IISB
Schottkystrasse 10
91058 Erlangen, Germany
www.iisb.fraunhofer.de

Dr. Hubert Rauh
Group Manager
Advanced Power Modules
Tel. +49 9131 761-141
hubert.rauh@iisb.fraunhofer.de

Fraunhofer IISB
Schottkystrasse 10
91058 Erlangen, Germany
www.iisb.fraunhofer.de