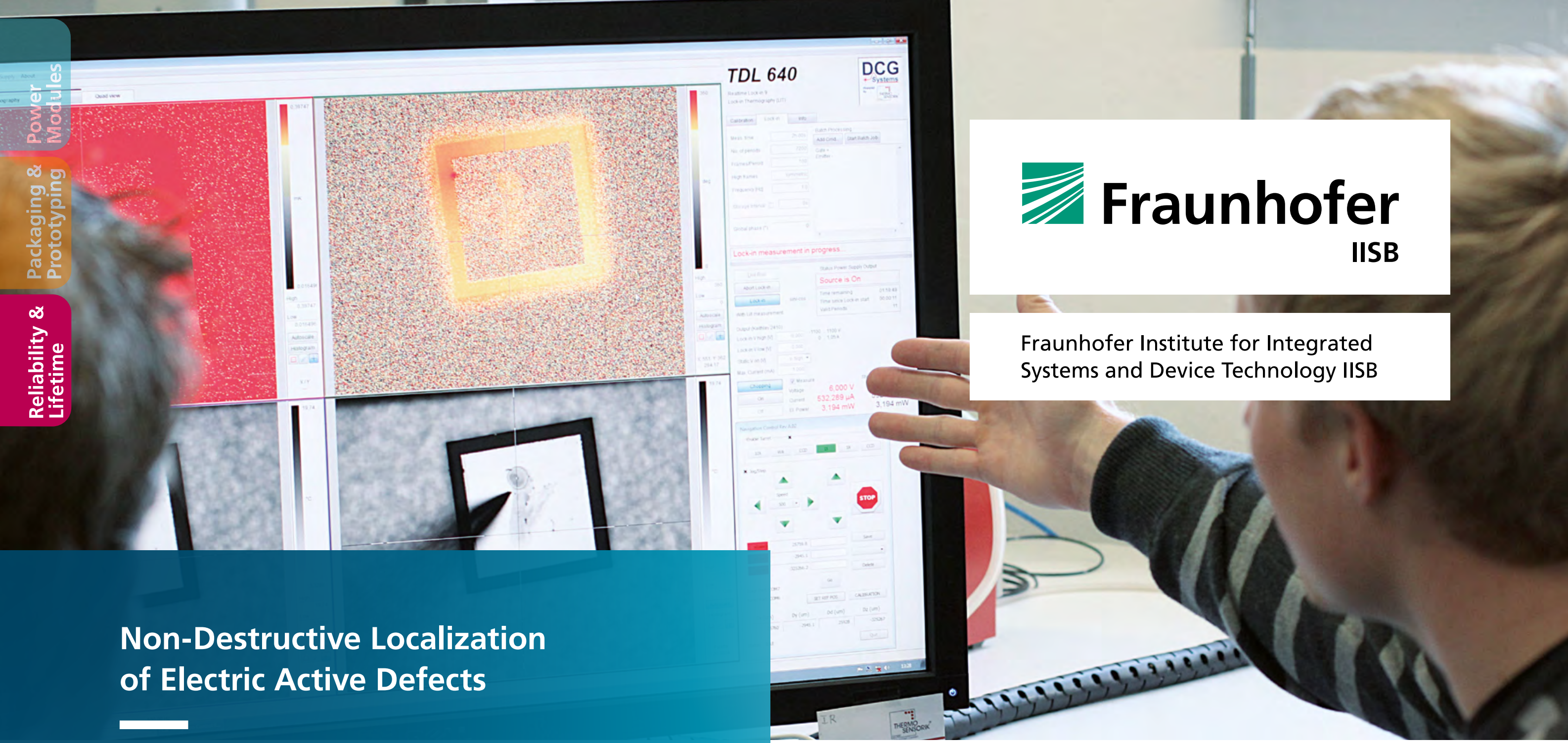


Fraunhofer IISB

Fraunhofer Institute for Integrated Systems and Device Technology IISB

Lock-In-Thermography in action © Fraunhofer IISB

Non-Destructive Localization of Electric Active Defects

Lock-In-Thermography

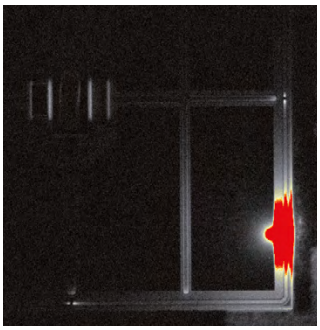
Description of Lock-In-Thermography analysis

- Detection of failed power electronic devices such as IGBTs, MOSFETs, diodes, and resistors
- Analysis of short circuits, ESD defects, oxide damages, edge termination defects, avalanche break down, whiskers, and electrical conductive contamination
- High sensitivity for hot spot detection with a heat dissipation in the µW range
- 2D/3D defect localization for further destructive analysis to identify the failure mechanism

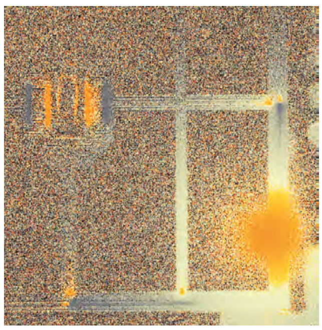
Optical microscopy of IGBT © Thomas Götz / Fraunhofer IISB

Special features

- Measurement voltage from mV up to 10 kV
- Decapsulation of mold compounds and silicone gels
- Chemical removal of chip topside metallization and contacts, for instance bond wires and ribbons out of different materials
- Follow-up investigations such as cross-sections, scanning electron microscopy, and micro sections with focused ion beam
- Interpretation of test results and failure mechanisms
- Consultancy on the different investigated failure modes, for instance chip damage due to improper bond wire process parameters



Lock-In-Thermography amplitude of IGBT © Thomas Götz / Fraunhofer IISB



Lock-In-Thermography phase of IGBT © Thomas Götz / Fraunhofer IISB

Analysis principle

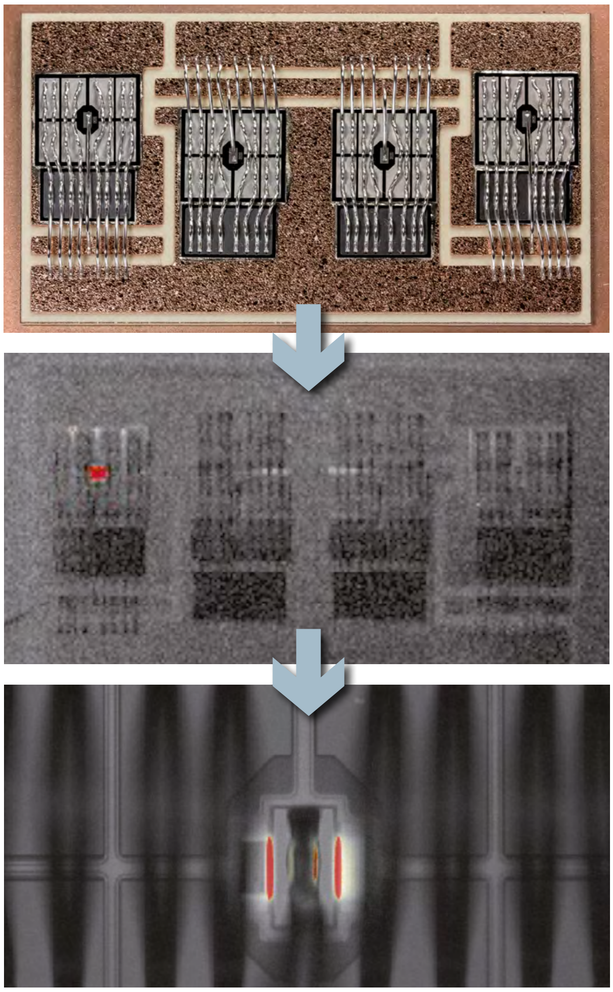
- The device under test is pulsed with the rectangular voltage by arbitrary Lock-In-Frequency (typical: 1 Hz to 25 Hz)
- Electrical defects dissipate thermal power
- Thermal power heats up the surface
- Measurement of infrared signal with infrared camera
- Acquisition of amplitude image as well as resulting time dependent step response (phase image)

Advantages

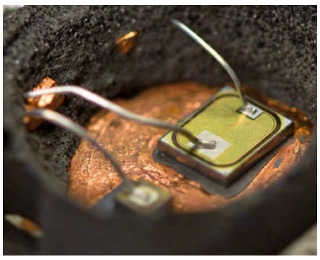
- Differential measurement principle
- Best suited for different emission coefficients of the device surface materials
- No influence of the ambient (temperature, reflections)
- Three different zoom lenses to investigate structures from complete power module to single IGBT cells

Application example

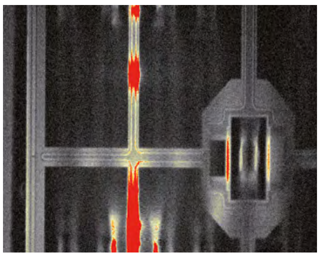
- After fabrication, a power module failed the final electrical quality test, for instance gate-emitter leakage current
- Lock-In-Thermography helps to detect which semiconductor is responsible for the leakage current and determines the exact position of the defect on the device
- The next step is to remove the bond wires and aluminum metallization from the semiconductor, followed by a second Lock-In-Thermography analysis to determine the location of the defect in the microscale
- An additional step could be a focused ion beam investigation with scanning electron microscopy to determine the cause of failure, such as a damaged gate structure



From power module to a Lock-In overview to a Lock-In detail © Thomas Götz / Fraunhofer IISB

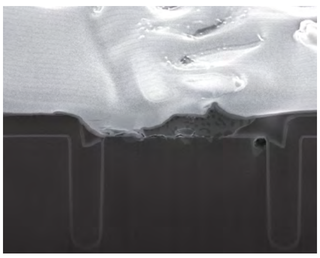


Demolded device © Fraunhofer IISB



Topography © Thomas Götz / Fraunhofer IISB

Cross-Section © Fraunhofer IISB



Focused ion beam © Fraunhofer IISB

Contact

Dr. Jürgen Leib
Testing and Reliability
Tel.: +49 9131 761 615
juergen.leib@
iisb.fraunhofer.de

Fraunhofer IISB
Schottkystr. 10
91058 Erlangen
Germany
www.iisb.fraunhofer.de

vCard Jürgen Leib