Power Modules

Packaging & Prototyping

Reliability & Lifetime

Fraunhofer IISB

Fraunhofer Institute for Integrated Systems and Device Technology IISB

Analysis and discussion of sinter layers by optical microscopy © Fraunhofer IISB

Destructive and Non-Destructive Analysis for Power Electronics

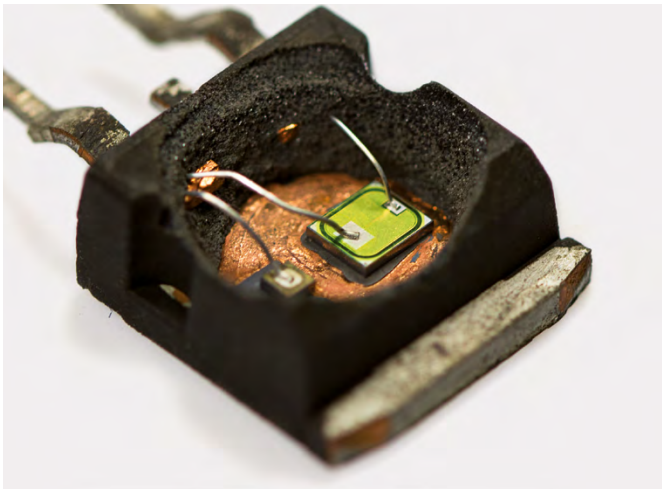
Failure Analysis of Electronic Devices and Systems

Fields of research and service

- Investigation of field returns
- Characterization of samples accompanying in-house and external lifetime tests such as active power cycling
- Analysis of new packaging concepts and joining technologies, for instance sinter technology versus soldering
- Competitive analysis of power electronic systems, modules and devices like power electronics of hybrid vehicles
- Physics of failure analysis, material characterization for parameterization of existing lifetime models or enhanced ones
- Interpretation of test results and failure mechanisms such as edge termination break down of semiconductor devices
- Consultancy on the different investigated failure modes, for instance chip damage due to improper bond wire process parameters

Analyzing methods

- Non-destructive techniques, for instance scanning acoustic microscopy
- Destructive techniques such as cross sections, focused ion beam or shear tests



Demolded IGBT and diode of an D2Pak device © Fraunhofer IISB

Non-Destructive analysis

- Micro-CT (X-Ray micro tomography)
- Scanning acoustic microscopy (investigation of voids, cracks, delamination)
- Partial discharge measurement for isolation quality investigations
- Ultra-violet imaging of discharge effects
- Infrared imaging, thermography for thermal resistance measurements
- Lock-In-Thermography for localizing of defects
- Eigen frequency measurement to determine cracks inside the material
- Static and dynamic electrical characterization

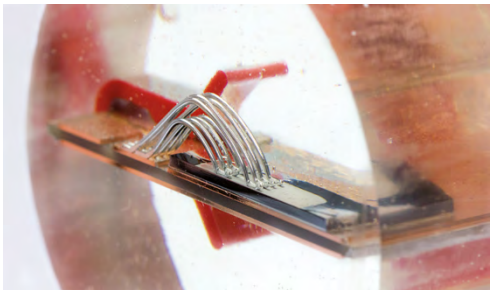
Destructive analysis

- Cross-sectioning
- Optical microscopy (magnification up to 5000x)
- Scanning electron microscopy (SEM)
- Element analysis (EDX, distribution and quantity)
- Focused ion beam (FIB)
- 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
- Nanoindentation, tensile tests under extended temperatures
- Shear, pull and peel tests

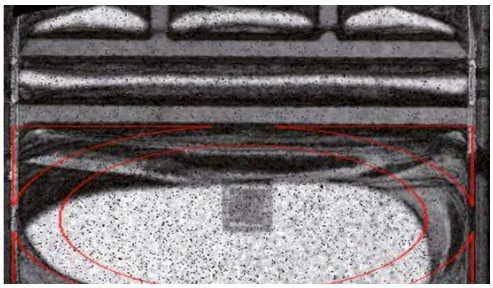
„Physics of Failure“ method

The „physics of failure“ method assists to get a better understanding of the reasons behind the symptom. Fraunhofer IISB helps to ask the right questions for the interpretation of failure analysis:

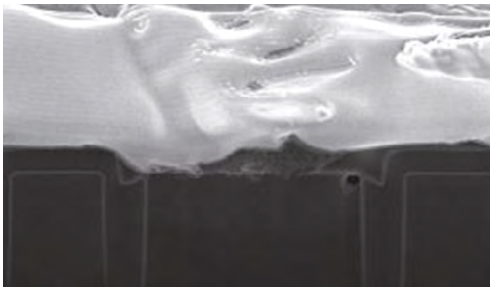
- **Failure mode:** What kind of failure effect? Short/ open circuit, heating, etc.
- **Failure cause:** What kind of process? Crack formation and growth, migration, corrosion, etc.
- **Failure mechanism:** What triggers the failure? Bond wires, solder layer, cooling, etc.
- **Failure model:** How can the failure be described? Mathematical or statistical model, FEM simulation, etc.



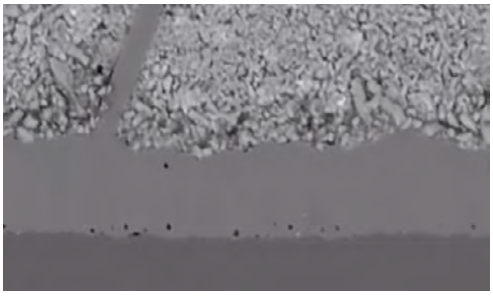
Cross section of IGBT power module
© Fraunhofer IISB



Scanning acoustic microscopy of an DBC substrate with conchoidal fracture © Fraunhofer IISB



Focused ion beam analysis of an IGBT
© Susanne Beuer / Fraunhofer IISB



Scanning electron microscopy
© Susanne Beuer / Fraunhofer IISB

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