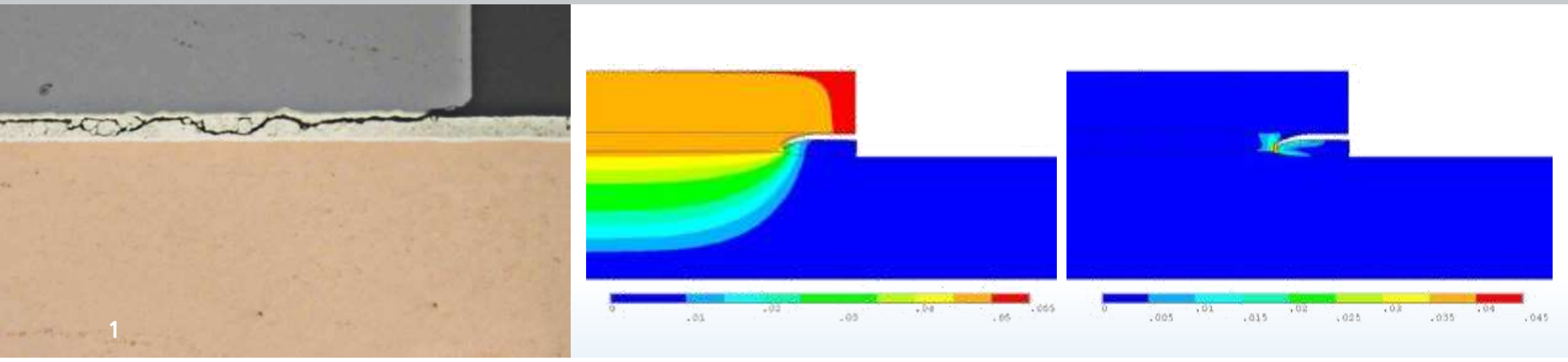
Fraunhofer

IISB

FRAUNHOFER INSTITUTE FOR INTEGRATED SYSTEMS AND DEVICE TECHNOLOGY



1 *Crack propagation in sintered die-attachment layer. Left: Experiment, Center: Simulated deformation field, Right: Simulated stress field.*

LIFETIME PREDICTION

FOR POWER ELECTRONICS ASSEMBLIES

Lifetime & Reliability Considerations during Product Development

One essential goal of the design process of an electronic product is to create a robust and reliable design that meets the demands from field operation. Typical measurement values, the number of failures per operation time and their distribution are evaluated. By the use of accelerated aging tests together with numerical simulations, it is possible to get access to these quantities and to predict the lifetime of a product for different load cases.

A typical lifetime prediction analysis involves the following steps:

Mission Profile, Use Cases ➡ Power Loss Profile ➡ Thermal Profile ➡ Load Analysis ➡ Lifetime Model ➡ Lifetime Prediction

We support our customers during each step in order to avoid over-engineering, increase power density and enhance the competitiveness of your products.

Application and Research

- Development of lifetime estimation strategies (experimental and theoretical).
- Statistical methods according to industrial standards and guidelines.
- Numerical and analytical modeling of physical degradation mechanisms.
- Objectives: Electronic systems, subsystems and components (e.g. converter, power modules, semiconductors, capacitors, inductors, etc.).

Fraunhofer IISB

Schottkystraße 10

91058 Erlangen

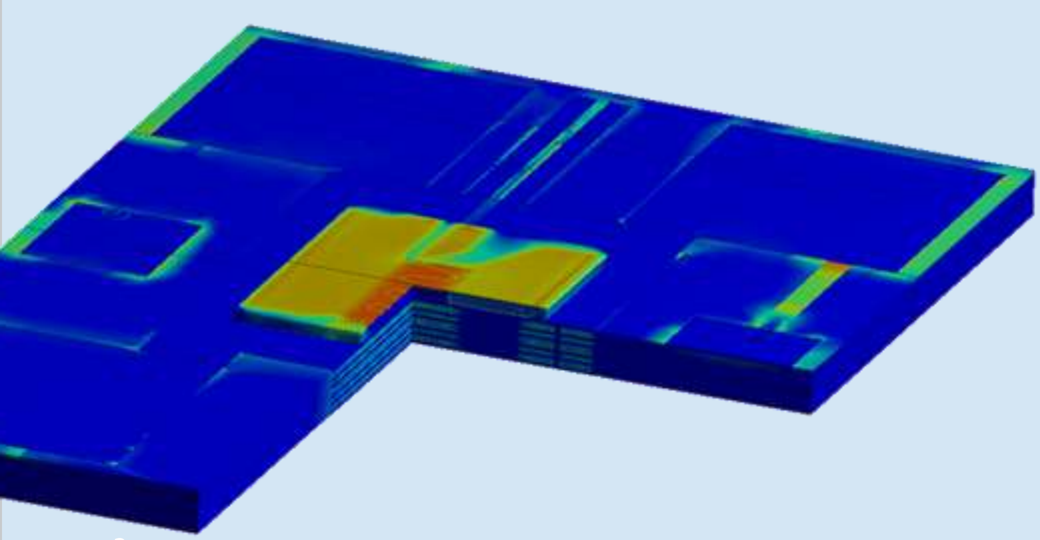
Contact:

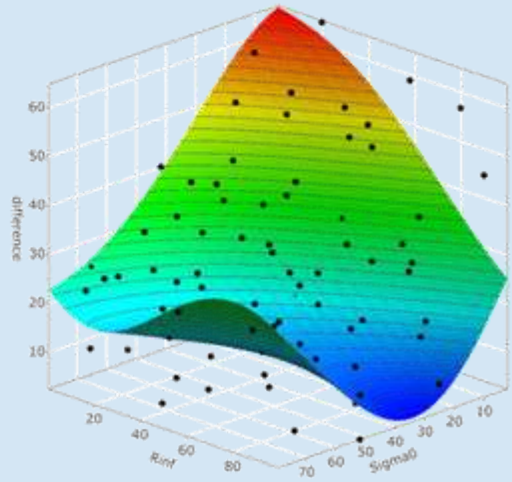
Andreas Schletz

Phone +49 (0)9131 761 187

andreas.schletz@iisb.fraunhofer.de

www.iisb.fraunhofer.de





Example: Lifetime Analysis of Electronic Power Module

1 Mission Profile

- Use cases, e.g. drive cycles
- Operating data, e.g. V and I vs. time

2 Power Loss Profile

- Electrical simulations
- Empirical mathematical relations

3 Temperature Profile

- 3D-transient thermal Finite-Element-Analysis (FEA)
- 1D-modeling by electro-thermal analogue circuits

4 Load Analysis

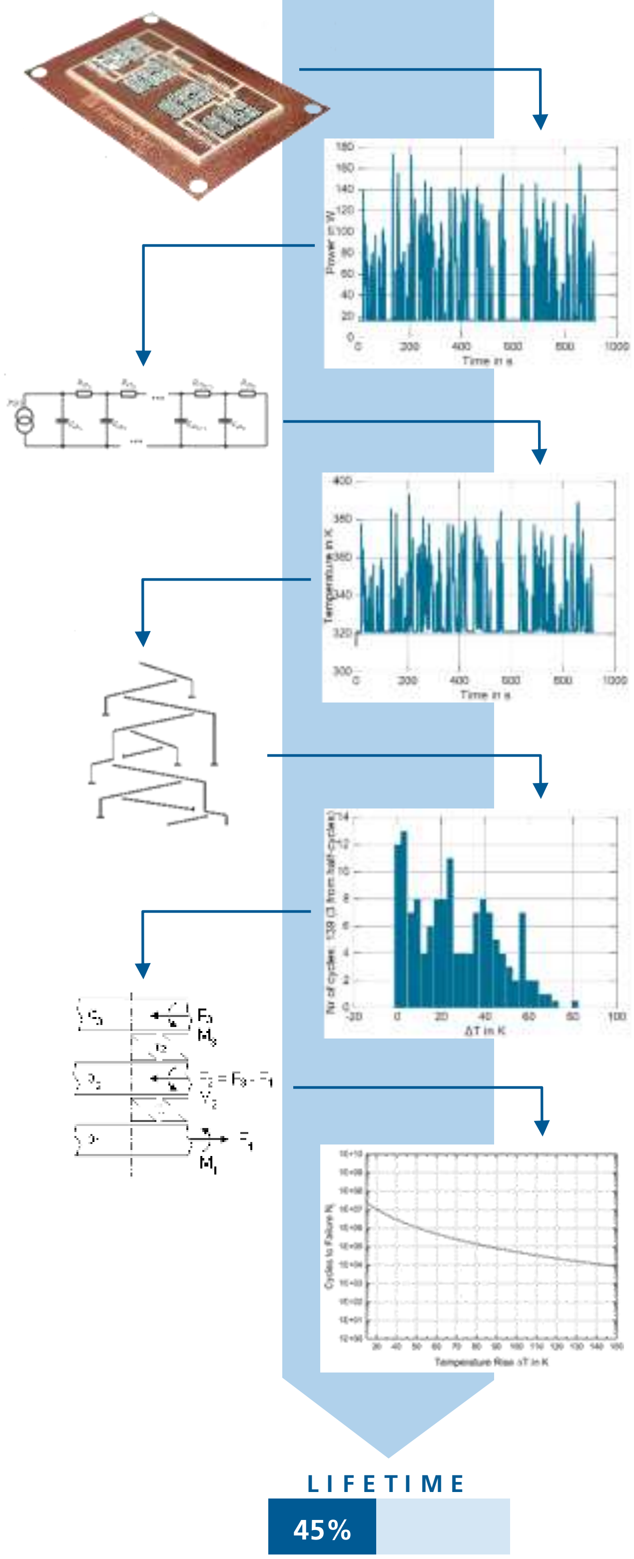
- Constant, variable, block and random loads
- Extraction of closed hysteresis loops from load signal by use of counting algorithms as input for lifetime model

5 Lifetime Model

- Determination of system response and damage variables
  - Accelerated ageing tests (e.g. power cycling, thermal cycling, shock and storage tests, etc.)
  - Non-linear transient finite-element-analysis
- Modeling of damage evolution
  - Empirical, by observable variables, e.g. temperature swing, heating voltage, thermal resistance
  - Physical, by internal variables, e.g. inelastic strain, plastic strain energy density, damage variables (CDM)

6 Prediction of Lifetime

- Accumulation of damage per load increment
- Calculation of predicted lifetime



Left: Finite-Element-Analysis of GaN-on-PCB-package.
Right: Response surface from parameter sensitivity analysis.