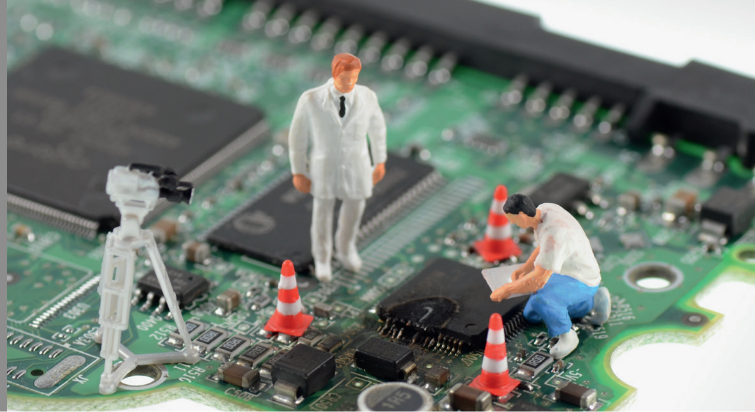


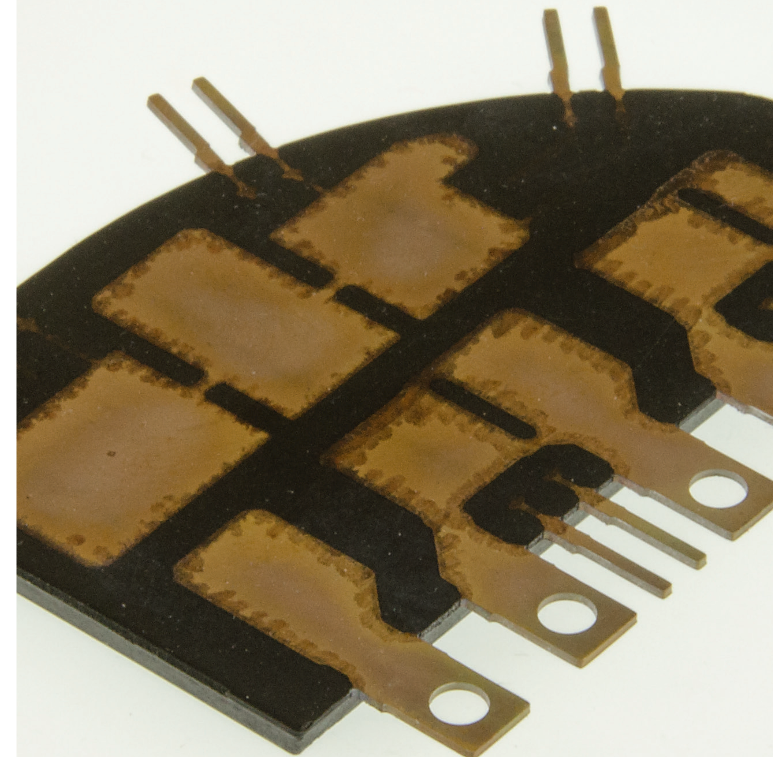
Fraunhofer

IZM

FRAUNHOFER INSTITUTE FOR RELIABILITY AND MICROINTEGRATION IZM

# STRESS-MEASUREMENT FOR MICROSYSTEMS

**CMOS Stress-Measurement-System quantifies loads during production and operation**



## OUR SERVICE

### ELECTRONICS CONDITION MONITORING LAB

- Excitation vibration tests for electronic modules (sinus, white noise, shock), combined with humidity and temperature stresses
- Contactless vibration testing for design optimization, weakness analysis, and fault detection
- HALT testing to establish failure limits for temperature, extreme temperature variation, and vibration
- Level drop tester for shock tests and continuous monitoring of max acceleration, impulse duration, and impulse characteristics

### POWERLAB FOR POWER ELECTRONICS

- Active and passive load alternation tests for power semiconductors in a range of form factors and technologies
- Calibration of the barrier layer temperature and monitoring of parameters for every sample
- Thermographic monitoring during active testing

### THERMAL AND ENVIRONMENTAL ANALYSIS LAB

- Heat flow optimization for heat sinks and thermal distributors via wind tunnel or dynamic fluid simulation
- Component and system analysis to establish surface temperatures and thermal resistance
- Identification of the thermal resistance and heat conductivity of Thermal Interface Materials

## GET IN CONTACT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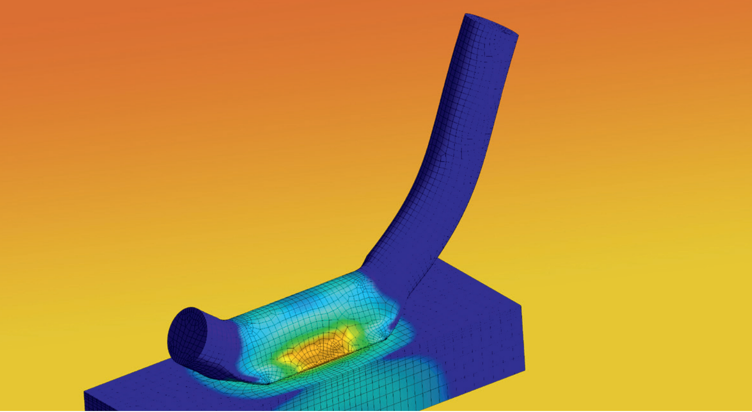

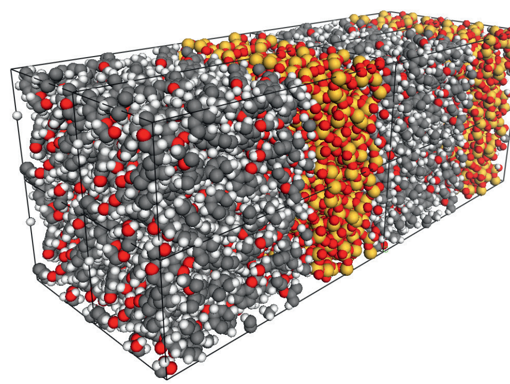

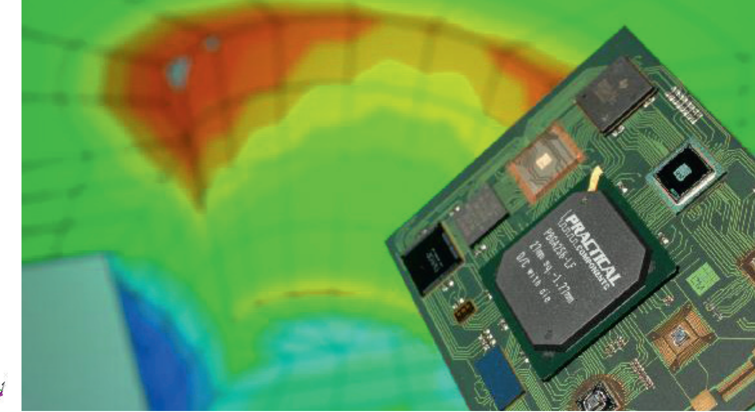


## PROBLEM

Assembling and packaging processes in micro system technology need a high degree of process know-how in order to minimize negative mechani-cal stress effects on micro elec-tronic sensors and systems.

MEMS-sensors or multi chip modules are exposed to high thermal and thermo mechani-cal loads during interconnec-tion and packaging phases and during operation time. Result-ing mechanical forces acting on the sytems can cause changes in component feature and functionality.

## SOLUTION

The Fraunhofer IZM provides the service of stress-measure-ment for applications in development, assembly and quality management using a calibrated stress measuring sys-tem, which was optimized within the BMBF funded pro-ject "iForceSens".
The test chip will replace the micro system or other elec-tronic parts and will pass through the same production and testing steps as the system under inspection, re-cording all emerging stress actions.
On basis of the CMOS tech-nology, piezoresistive struc-tures detect shear stress, tem-perature and the two normal stress components on the chip surface.
The resulting under-standing of the failure mechanism sup-plies important indicators for product- and process optimization.

## CHARACTERISTICS

- **Stress distribution** ($\tau_{xy}$, $\sigma_{xx}$, $\sigma_{yy}$) **and temperature** measurement integrated on one silicon chip
- **Four chip variants** with dimensions of: 1.1x1.1 mm², 1.7x1.7 mm², 1.7x2.8 mm², 1.9x3.5 mm² chip thickness: 10 µm to 725 µm (backside chip thinning)
- **Four electrical connections** per chip (multiplexer): wire bonding: AlSiCu - metallization
  flip chip: UBM-metallization possible
- Stress resolution
  - in-duced difference stress: +/- 1.2%
  - induced shear stress: +/- 4.5%
  - single normal stress components:+/- 13% of total stress
- Time resolution: 50 ms for single cell readout
- Pitch of measuring cells: 260 µm
- Lateral interpolated space resolution: 50 µm
- Operation temperature: -40°C … +180°C

## APPLICATION FIELD

- **Processes of assembly and interconnection**
  Die- / wire bonding, flip chip-assembly / underfilling / glob top, transfer molding, injection molding
  Optimization of encapsulation processes: concerning minimal induced stress and thermal stress postcuring.
- **Stress measurement at final assembly**
  MID, chip on board, embedding thinned chips in PCB…
- **Quality and reliability tests**
  detailed insight in stress changes and correlation with failure mechanism (delamination, cracks, moisturized swelling…)

## ADDITIONAL SERVICE

- Assembly and interconnection technology
- Encapsulation technology: transfer molding, injection molding, hotmelt, vaccum casting
- Qualification- and reliability tests
- Failure analysis: X-ray, ultrasonics, metallography, SEM
- Thermo- mechanical simulation
- Simulation and analysis of encapsulation process