Fraunhofer IISB

Fraunhofer Institute for Integrated Systems and Device Technology IISB

For Power Electronics Packaging Materials

Material Characterization

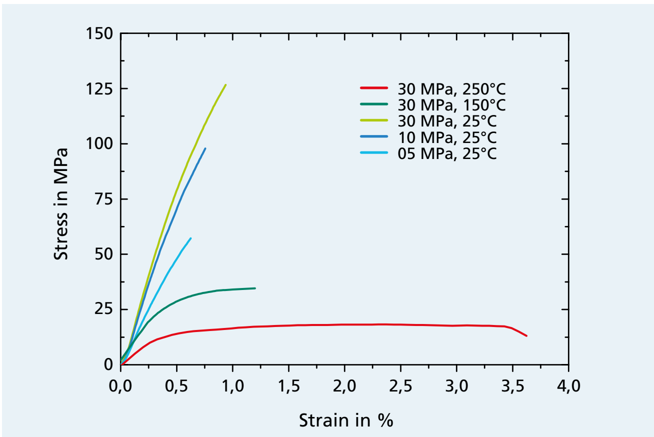
Sample preparation for simultaneous thermal analysis at the NETZSCH STA 449 F3 Jupiter © Fraunhofer IISB

Why material charaterization?

- Analyze thermal and mechanical material properties
- Reveal best material combination for specific application
- Find adequate parameters for processing of solder- and sintering-layers, casting compounds, base plates, housings, terminals, interconnections, windings, dielectrics
- Improve lifetime and reliability of packaging concepts
- Reduce development time and costs

Research and applications

- Temperature-dependent characterization of mechanical properties including creep-, fatigue-, fracture-, and failure-investigations
- Material property mapping by spatially resolved nanoindentation at small scales
- Application examples: intermetallic phases, die-attaches, bond wires, phase boundaries and spatial property gradients
- Thermal analysis of materials: specific heat of semiconductors, die-attaches, solder pastes (evaporation of fluxes, melting temperature, solidification behavior), sintering pastes (drying and sintering time, temperature, and atmosphere), substrates, TIMs



Mechanical behavior of silver-sintered dog bone in tensile test at different test temperatures and sintering pressures © Fraunhofer IISB

Micro scale thick silver-sintered dog bone immediately before hot tensile test © Fraunhofer IISB

	Unaxial Testing	Nanodentation	STA
Specimen	Rectangular cross section from sheets to bulk materials	Thin layer, multi layers, bulk materials	Liquid or solid objects
Temperature	RT to 300 °C	RT to 500 °C	190
Atmosphere	N_2, AR, Air	N_2, AR, Air	N_2, AR, Air, O_2

Assembly of test specimens

- Soldering: all kind of solders (lead-free, lead, gold, etc.)
- Silver-sintering: representative specimens for tensile tests and nanoindentation
- Wire ultrasonic bonding and resistance welding
- Polishing, etching, micro machining

Nanoindentation

Local, global and gradients in mechanical material parameters:

- Temperature dependent
- Elastic modulus, hardness, creep parameters
- 3D-Mapping of material properties
- Quantitative scratch and wear testing
- According to test standard ISO 14577

Tensile and compression testing

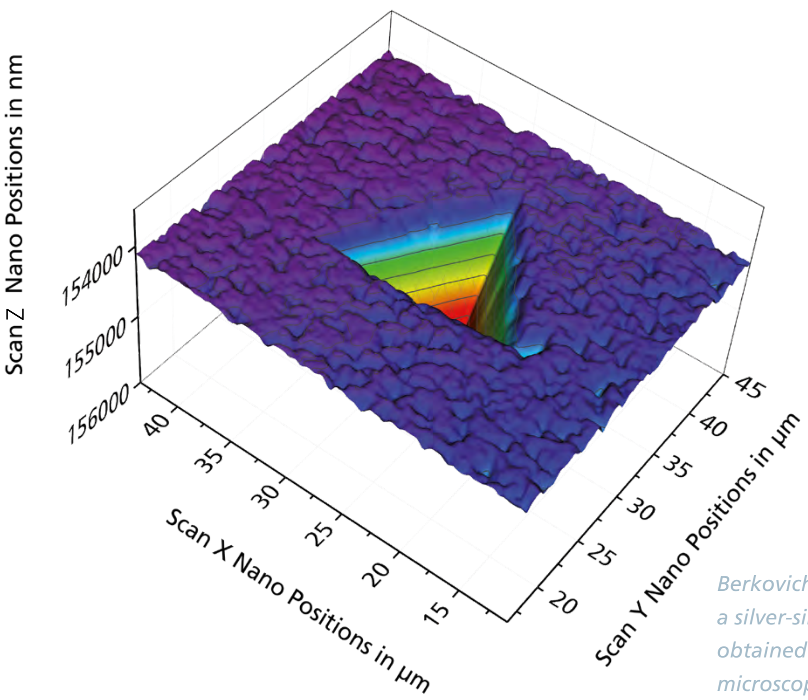
Global mechanical material parameters:

- Temperature dependent
- Elastic properties, tensile-, compressive-, yield-, creep- and fatigue-strength
- Different strain rates for time-dependent material behavior
- Stress-strain curves for nonlinear FEM
- Special data for material models, e.g., Ramberg-Osgood, Anand, Garofalo

Simultaneous thermal analysis STA

Thermal material parameters:

- Characteristic temperatures (sintering, melting, formation of intermetallics, decomposition, oxidation, glass transition)
- Temperature dependent specific heat capacity measurements
- Analyse of peak areas in dependence of mass change
- Kinetics of reactions, for instance oxidation and sintering
- Evaluation of mass change steps, for instance leakage of organics and debinding



Berkovich nanoindent on a silver-sintered bond line obtained by nanomechanical microscopy © Fraunhofer IISB

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