



THERMAL
PROCESSING

Development and Evaluation of Equipment Enhancements for Transient Liquid Phase Bonding (TLPB) and Sintering

V. Rangelov, S. Altenbockum

J. Kleff, C. Weber, H. Oppermann, K. D. Lang

15. June 2017

Automotive 2017, Torino, Italy

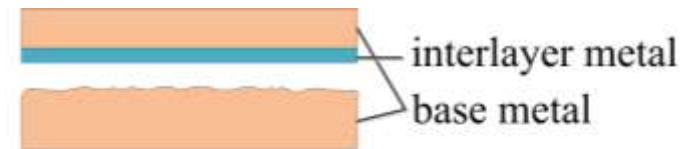
Outline

- Introduction to TLPB
- Motivation
- Introduction to bonding equipment
- Equipment and process evaluation
 - Silver sintering
 - Transient Liquid Phase Bonding (TLPB)

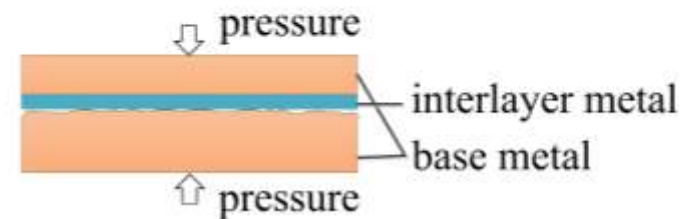
Introduction to TLPB

- Process stages of Transient Liquid Phase Bonding:

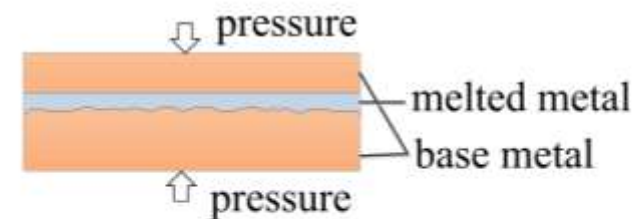
1. Stage: Interlayer preparation



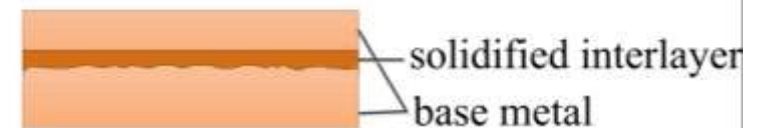
2. Stage: Interlayer melting and dissolution



3. Stage: Isothermal solidification



4. Stage: Homogenization



Motivation

- Requirements on bonding equipment:
 - pressure uniformity
 - temperature uniformity
 - accuracy of position
 - flexible heat and pressure profile
 - inert and reducing atmosphere
 - complex topography
 - processing of multiple substrates

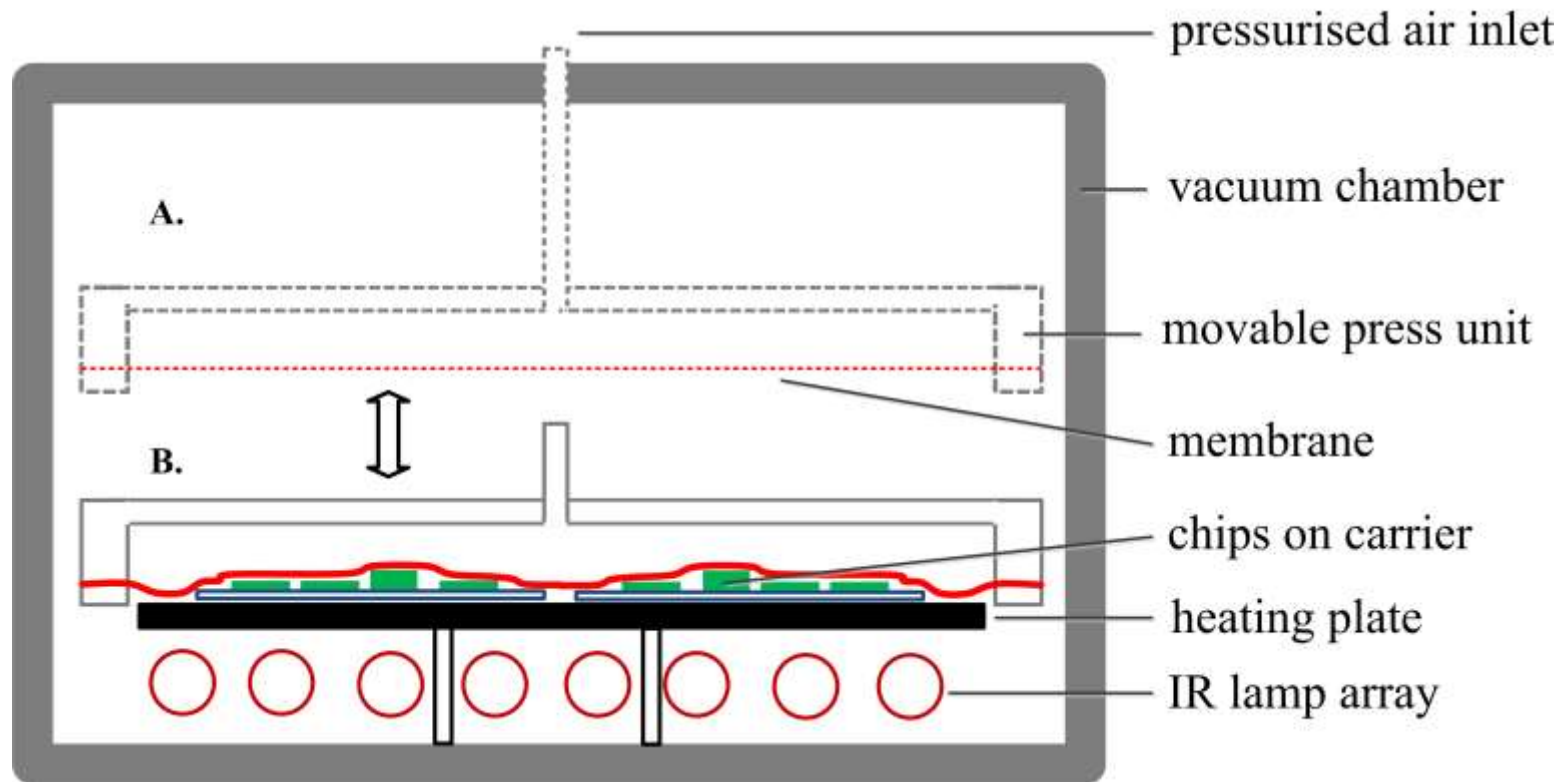


SRO-7xx

⇒ **new approach combining vacuum reflow soldering system with press unit**

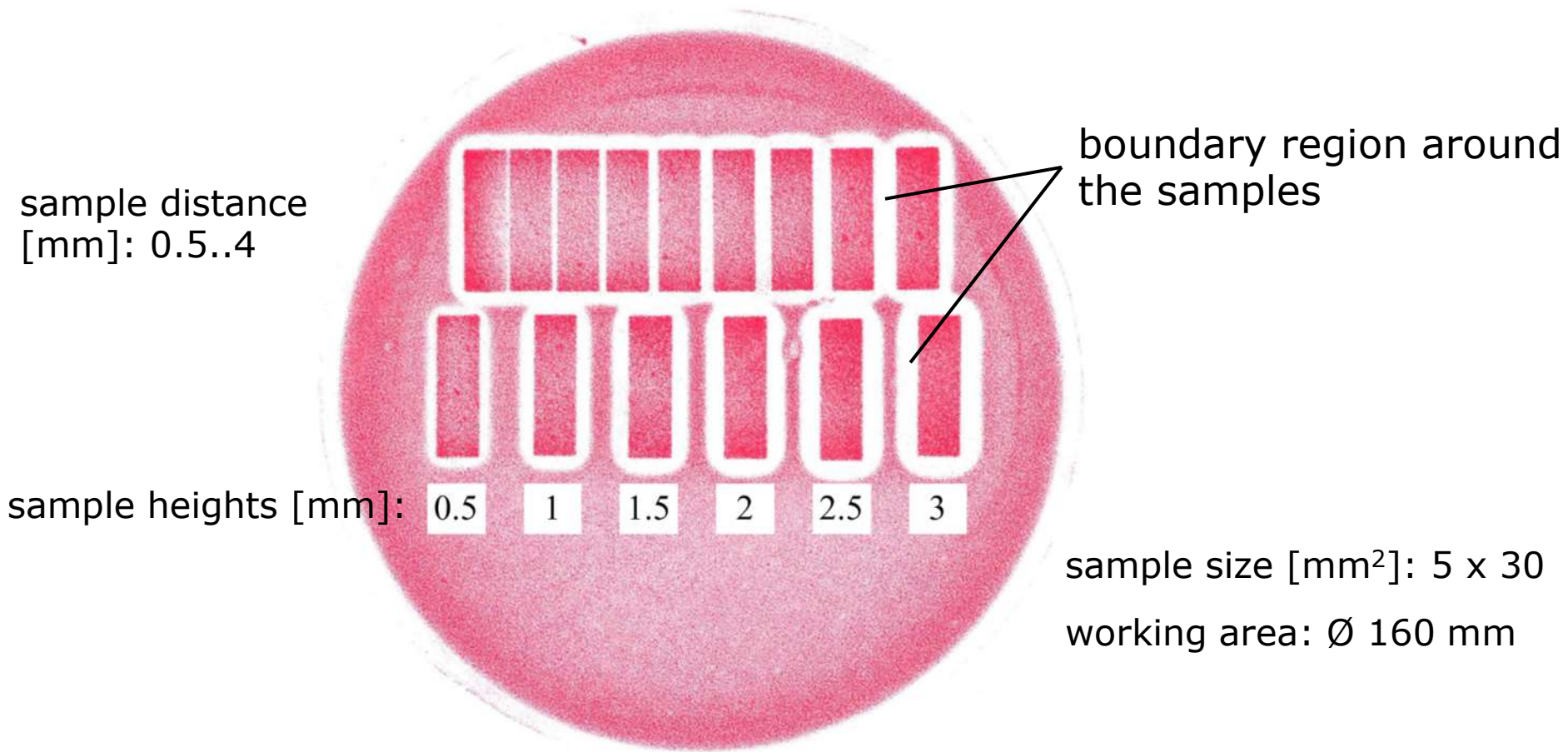
Introduction to bonding equipment

Basic idea: Isostatic press using an elastomer membrane



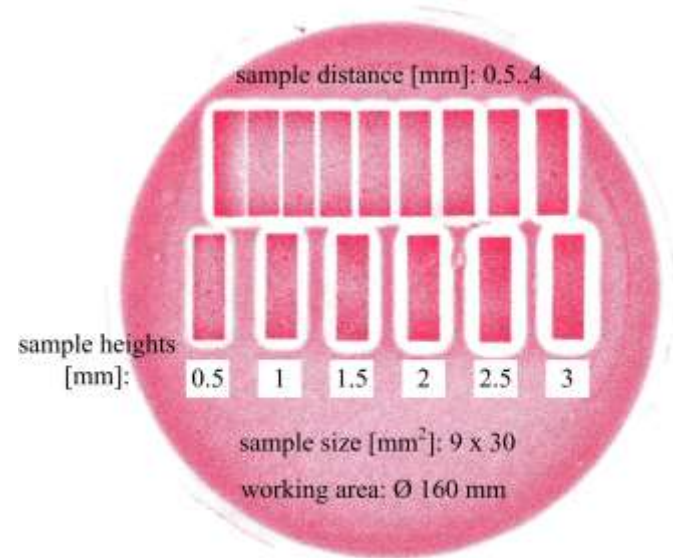
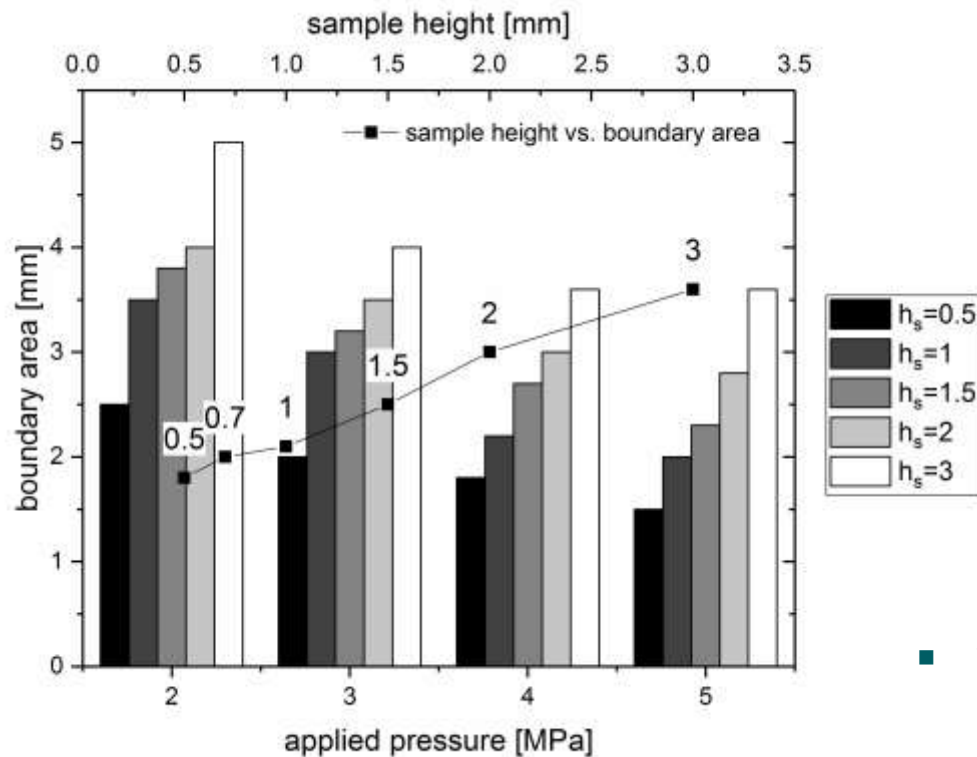
Evaluation of bonding equipment

- Pressure distribution study



Evaluation of bonding equipment

- Dependence on sample height and applied pressure

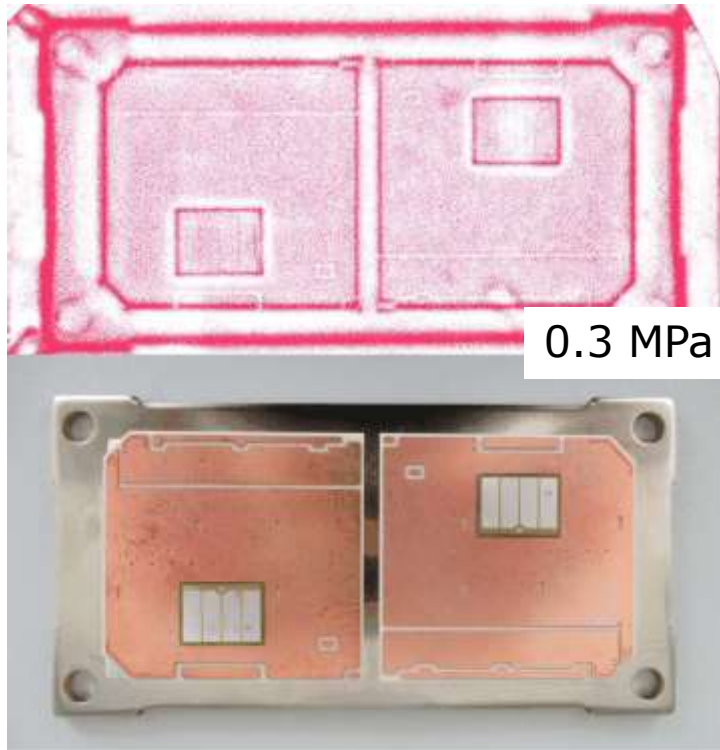


- very slight influence on sample distance and height
- operation within a wide design diversity possible

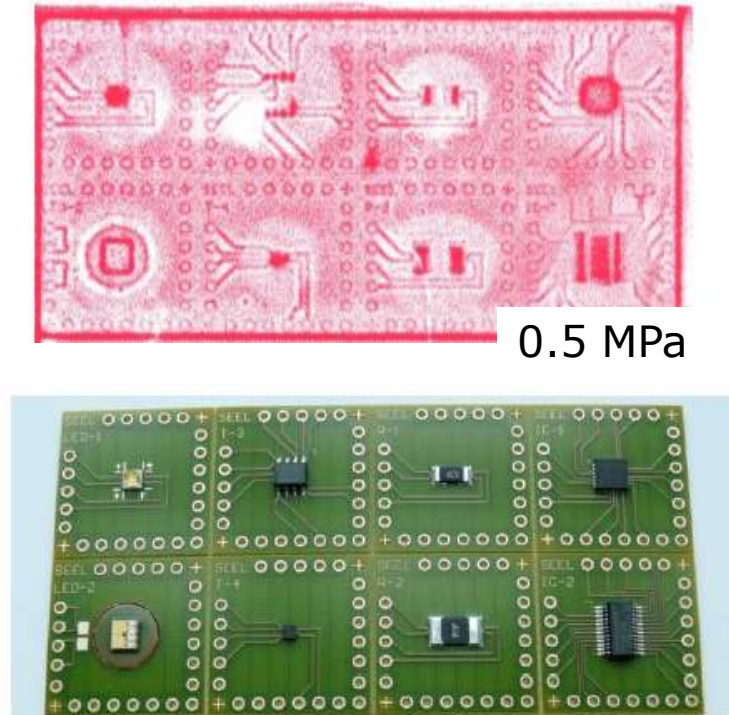
Evaluation of bonding equipment

- Processing of complex topographies

Dummy power module



FR4 demo board

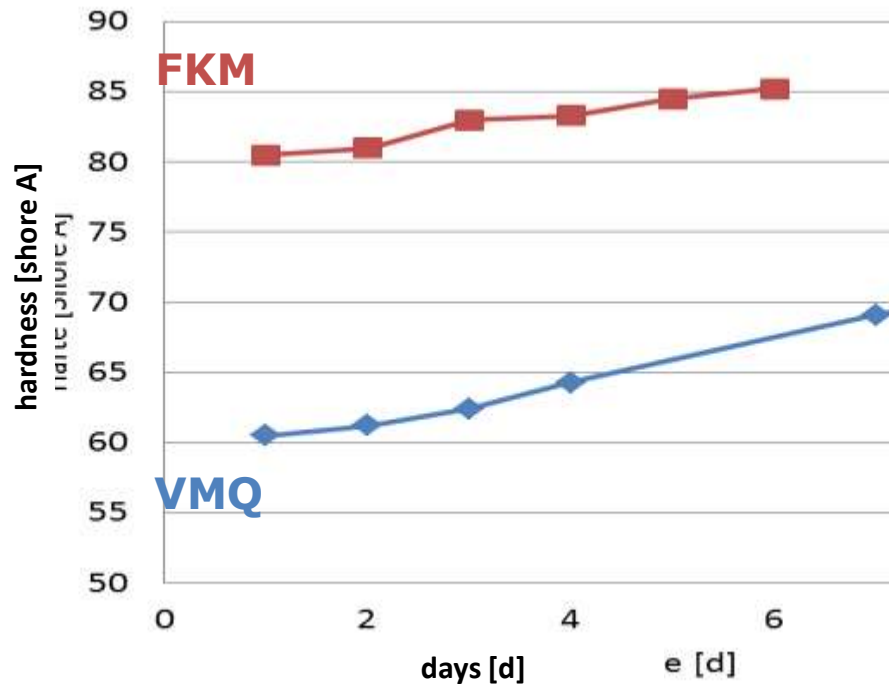


- no need of tooling
- simultaneous bonding of a batch of assemblies

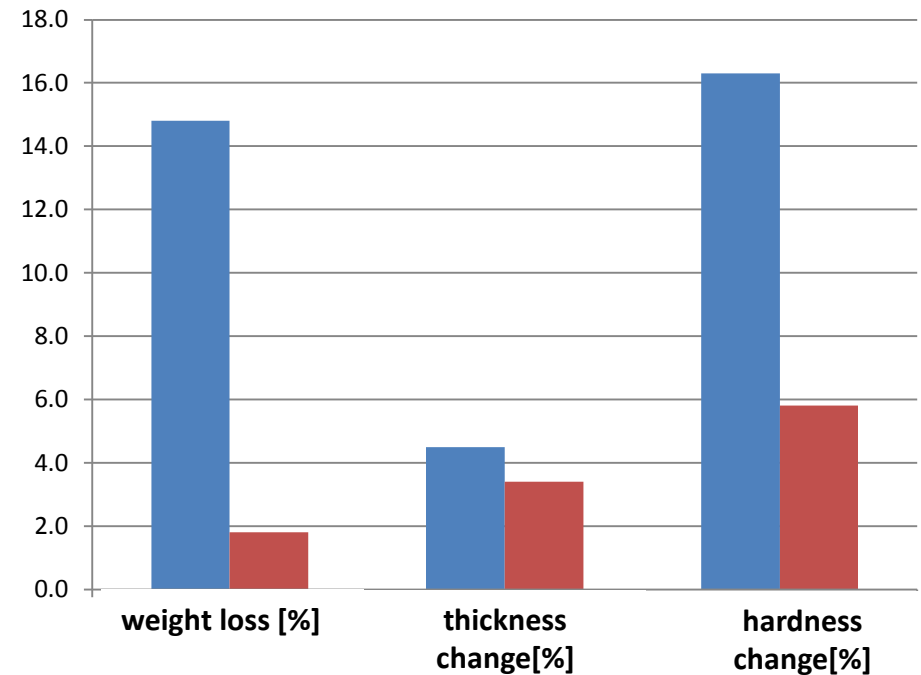
Evaluation of bonding equipment

- membrane material: FKM vs. VMQ based elastomers

continuous operation at 300°C



aging after 8 days at 300°C



Evaluation of bonding equipment

- maintaining of the alignment accuracy

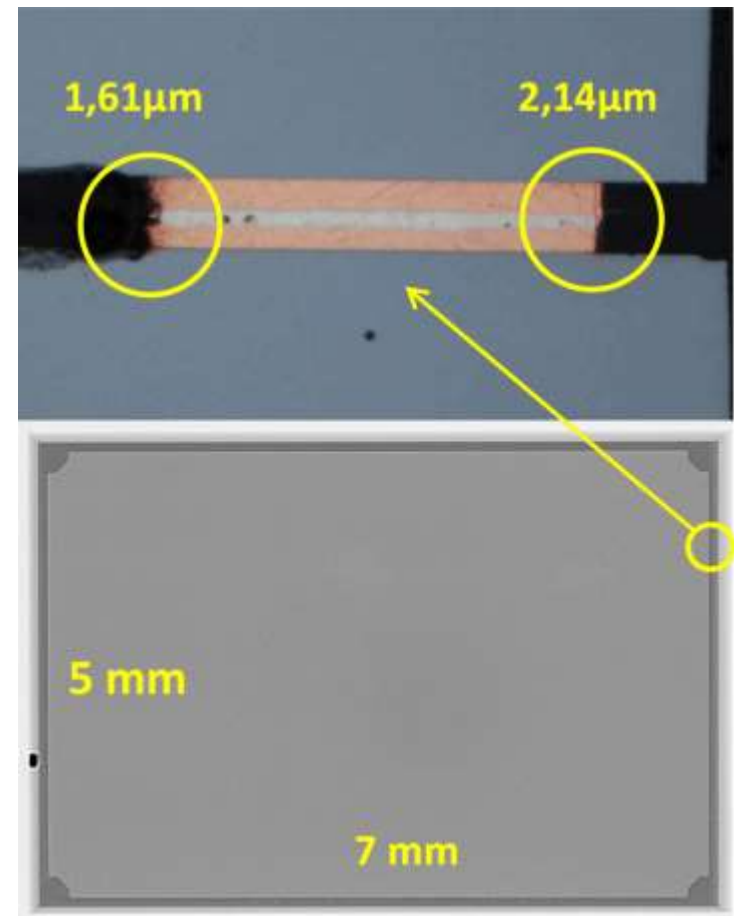


alignment after FC-bonder

**alignment after process run
in bonding oven**

Evaluation of bonding equipment

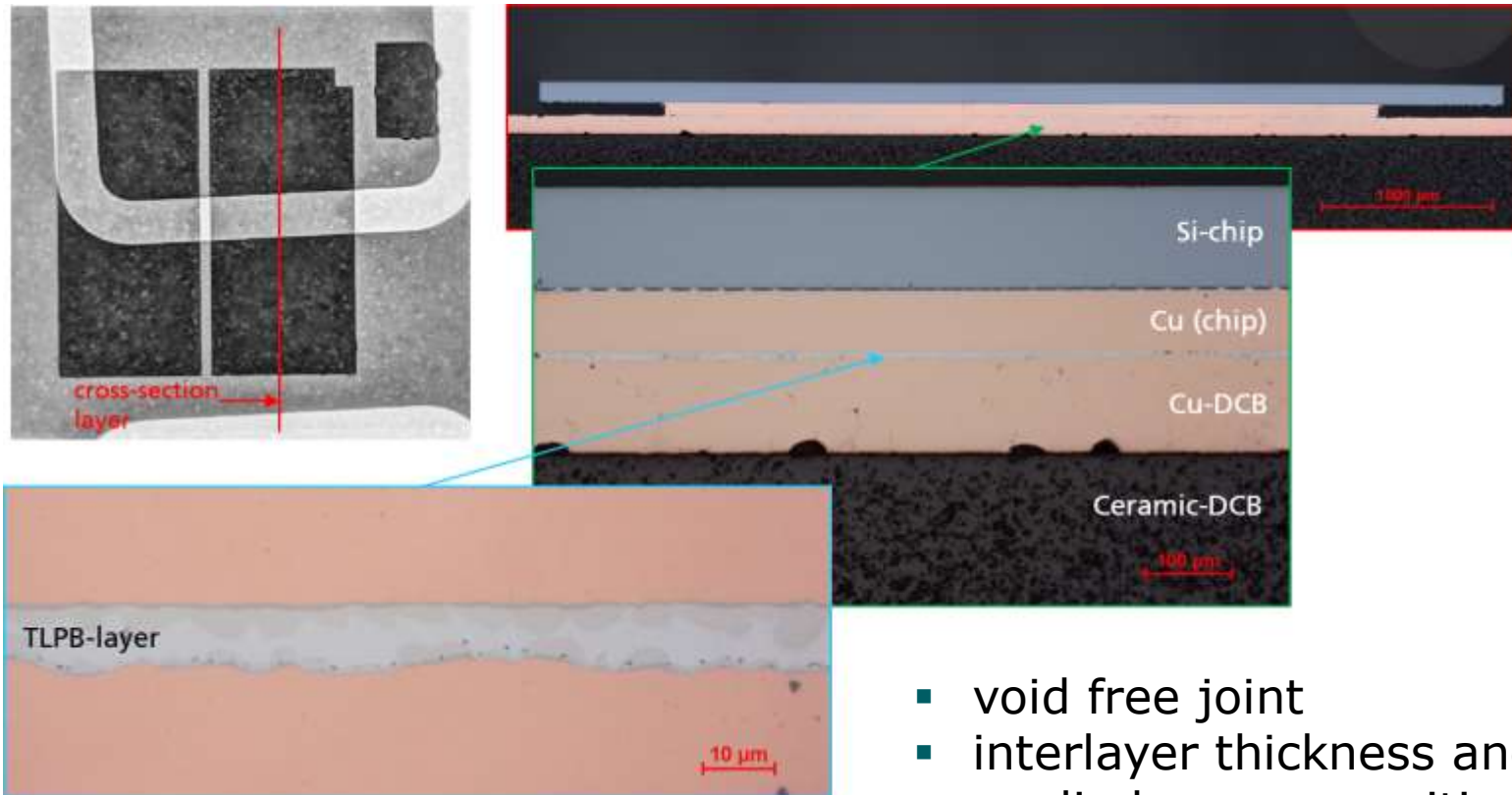
- lateral displacement after permanent bonding well below $3\ \mu\text{m}$
- samples transfer manageable
- use of temporal adhesives possible



Cross-section and x-ray image of an encapsulated silicon package for MEMS applications

Process evaluation - TLPB

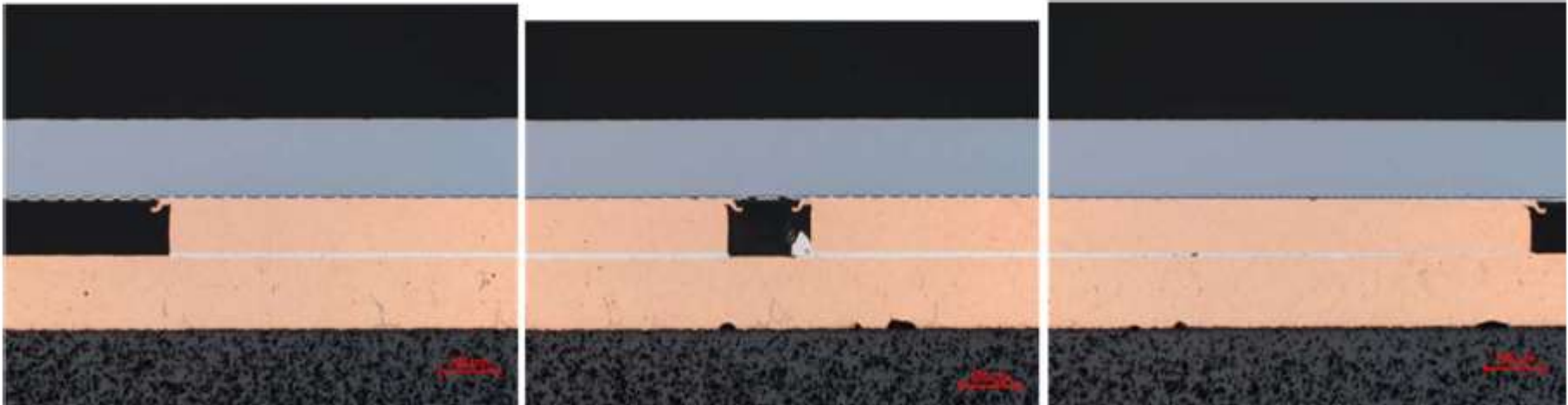
- Transient Liquid Phase Bonding for power devices (Sn-Cu)



- void free joint
- interlayer thickness and applied pressure critical
- process time to be adopted

Process evaluation - TLPB

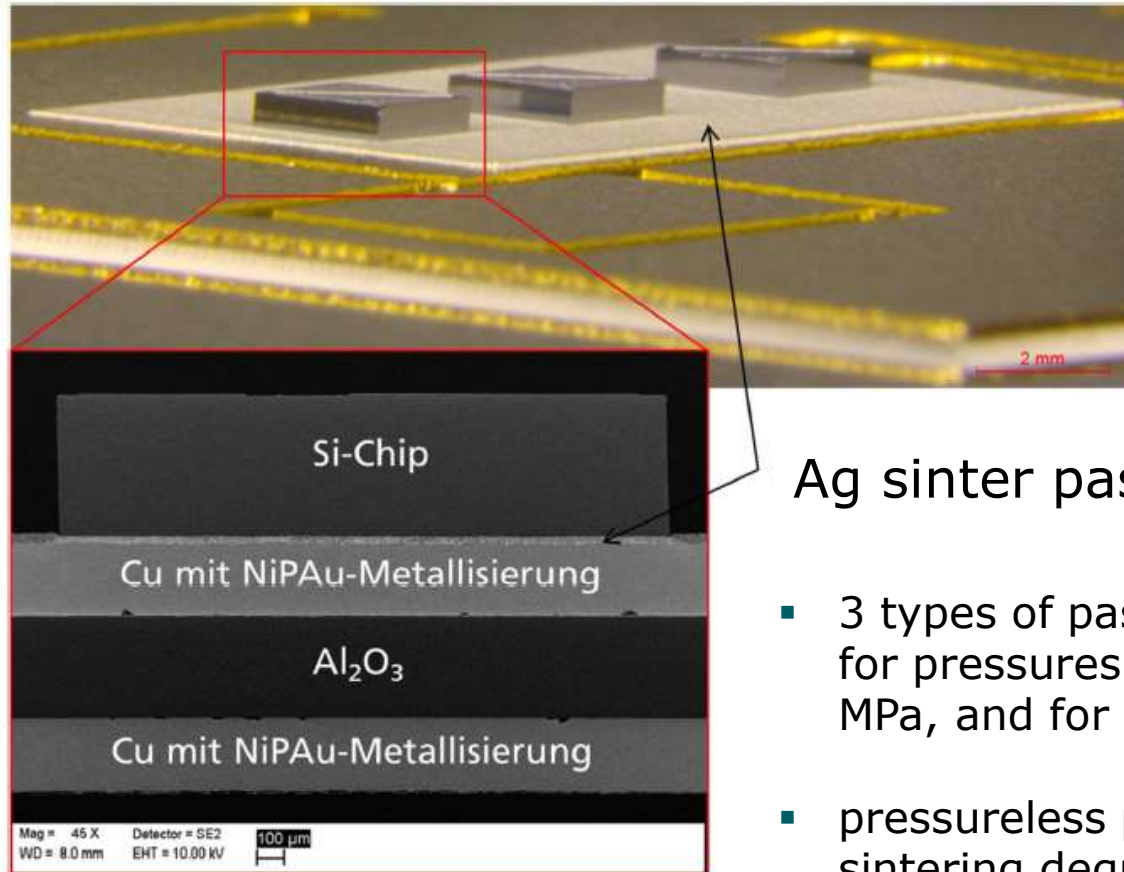
- Uniform TLPB joint across entire device



- oxide reduction over large area
- bending of device neutralised

Process evaluation – Ag sintering

- Low pressure silver sintering

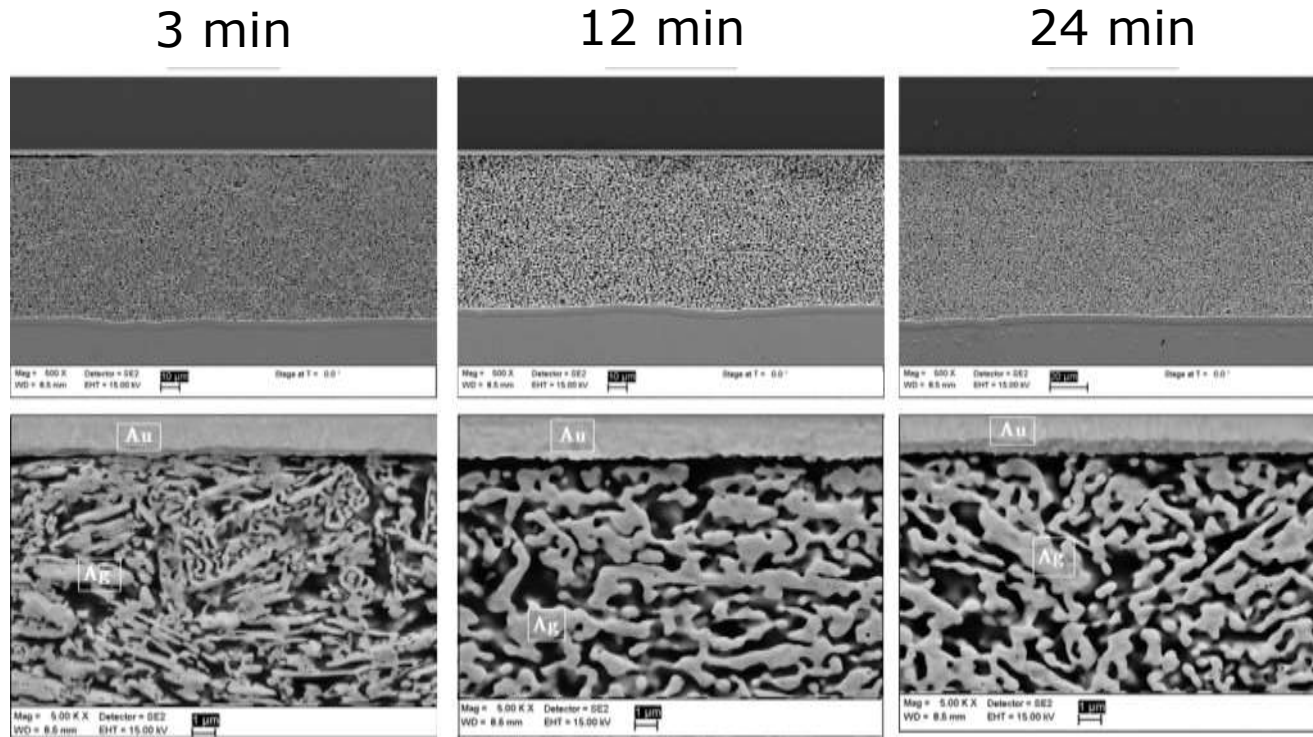


Ag sinter paste

- 3 types of pastes tested:
for pressures > 10 MPa, 5 – 10 MPa, and for pressureless sintering
- pressureless paste showed highest sintering degree at 0.45 MPa

Process evaluation – Ag sintering

- Low pressure silver sintering



- bonding duration for pressureless paste lowered significantly
- porosity is similar to conventional pressureless process

Future work

- chip to wafer packaging
- fully automatic handling
- integration with die placer
- upscaling
- Cu sintering

Acknowledgments



- my colleagues at ATV Technologie



- our academic partners from Fraunhofer Institute and TU Berlin



- The Federal Ministry for Economic Affairs and Energy for funding
grant no.: KF3242702ZG4

Gefördert durch:



Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages

