

# Fluidic Devices in PCB Technology

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Traditio et Innovatio

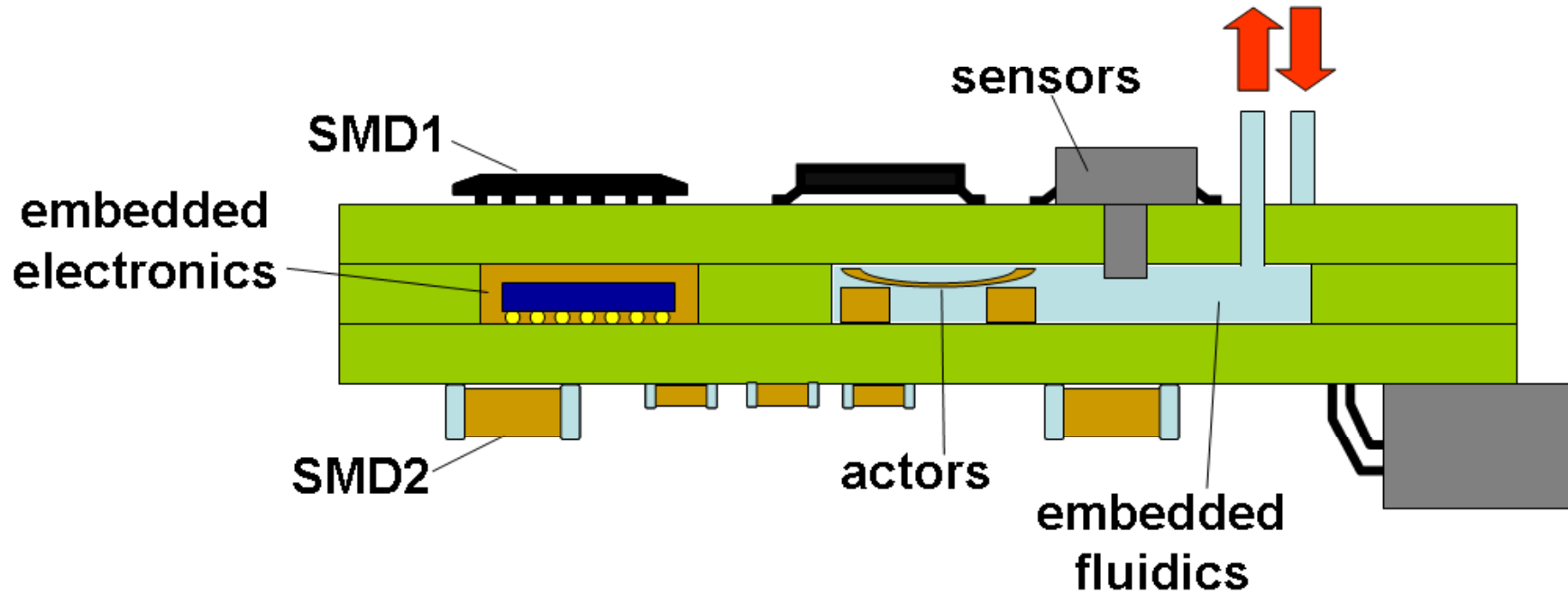
# FLUIDIC DEVICES IN PCB TECHNOLOGY

## OUTLINE

- Microsystems in Board
- Micro Fluidic Applications
- High Flow / Pressure Applications
- Quality & Reliability
- Special Coating and Joining Technologies
- Outlook

# FLUIDIC DEVICES IN PCB TECHNOLOGY

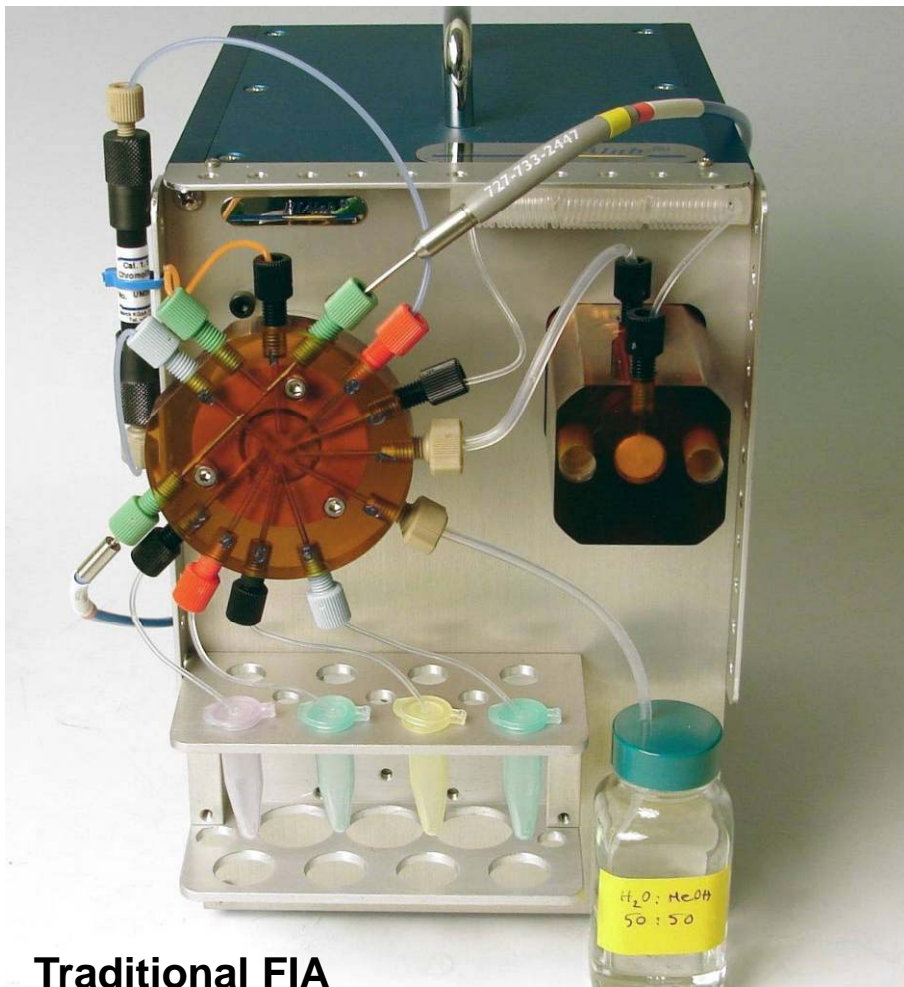
## Microsystems in Board



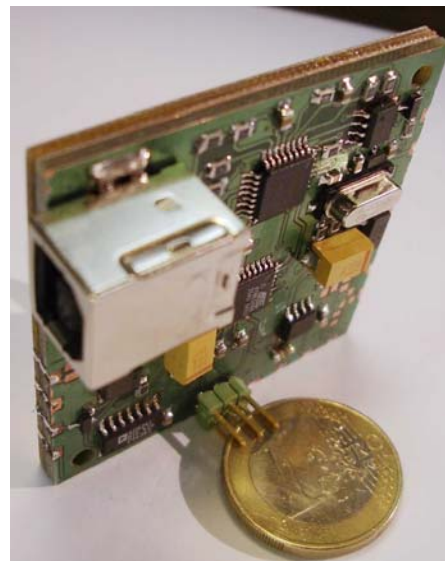
Principle and structure of combined fluidic-electronic systems in board

# FLUIDIC DEVICES IN PCB TECHNOLOGY

## Micro Fluidic Application



**Traditional FIA**



### **FIA in PCB:**

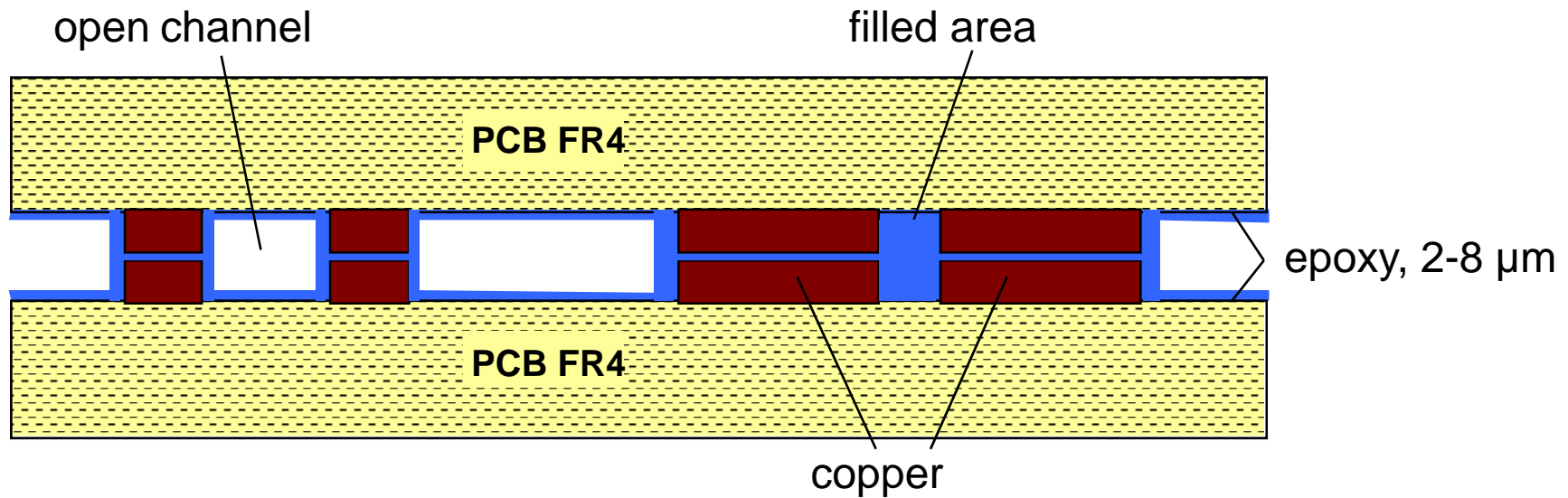
- 2 micro pumps
- 1 mixer
- 1 optical sensor
- $\mu$ C
- power driver
- USB connection



Example of a micro fluidic Flow Injection Analysis (FIA)

# FLUIDIC DEVICES IN PCB TECHNOLOGY

## Micro Fluidic Application



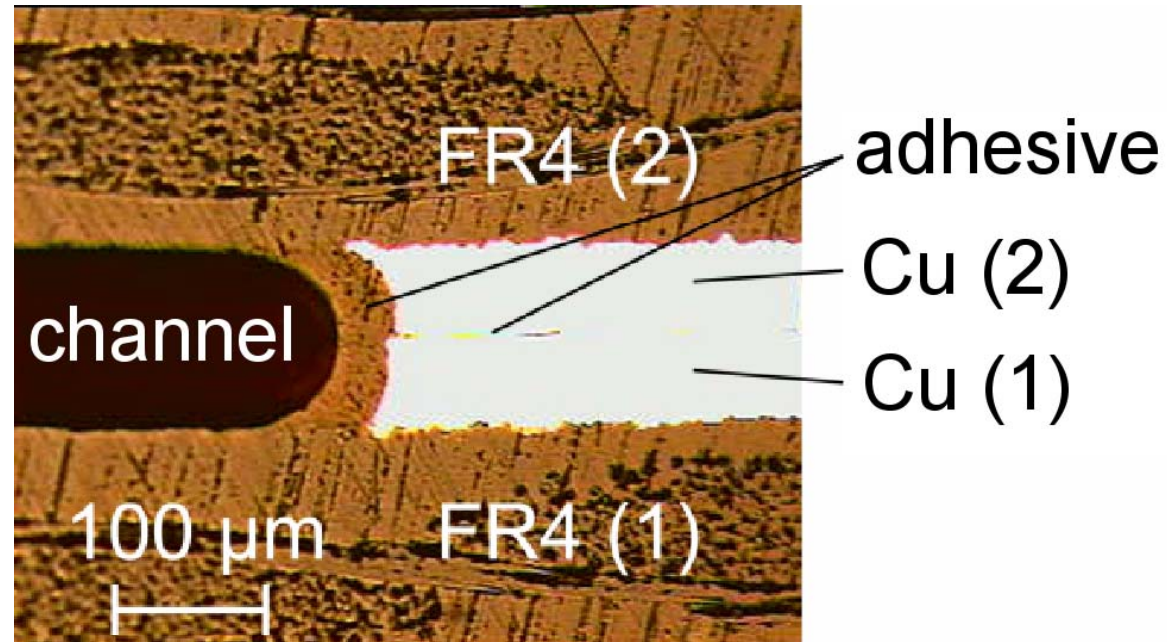
### Technology and design of open and closed channels

# FLUIDIC DEVICES IN PCB TECHNOLOGY

## Micro Fluidic Application

### Channels:

height 50...100  $\mu\text{m}$   
 width < 1 mm  
 flow rate 0.5 ml/min



Channel structure of a micro fluidic PCB

# FLUIDIC DEVICES IN PCB TECHNOLOGY

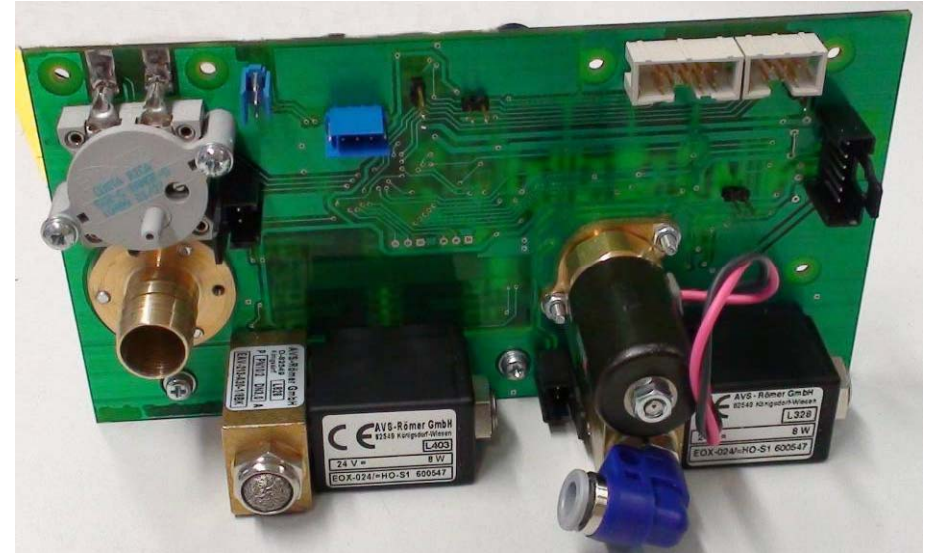
## High Pressure / High Flow Application



Insufflator for keyhole surgery

# FLUIDIC DEVICES IN PCB TECHNOLOGY

## High Pressure / High Flow Application



### Traditional version:

Realization of flow with tubes and hoses.  
Fluidics and electronics separated

### New PCB version:

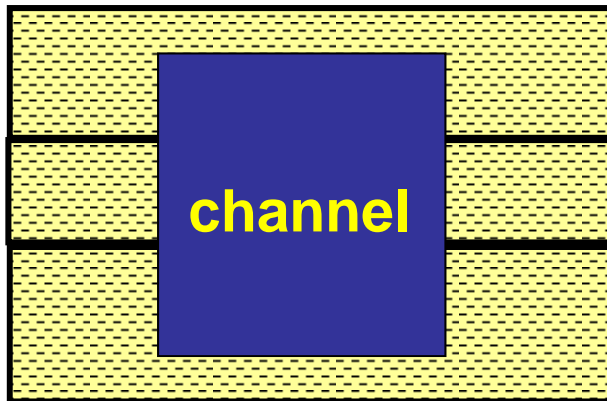
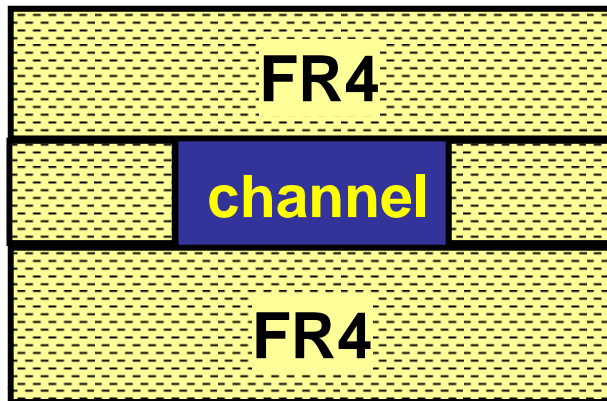
Realization of flow with channels in PCB  
Integration of fluidics and electronics

Example of an electronic-pneumatic system in PCB (insufflator)



# FLUIDIC DEVICES IN PCB TECHNOLOGY

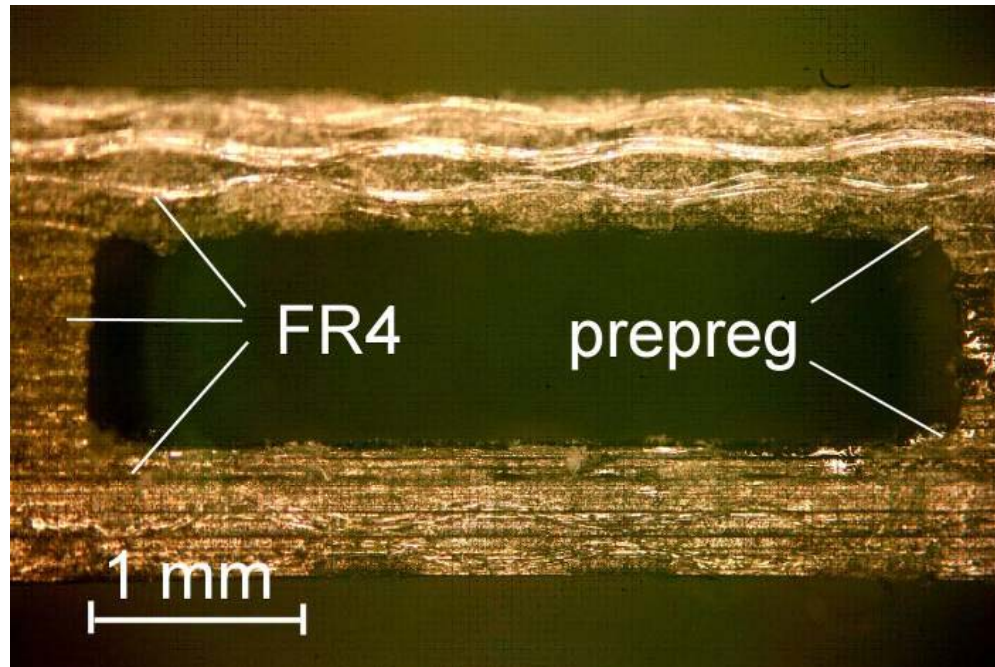
## High Pressure / High Flow Application



Schematically cross section of channels produced by milling

## FLUIDIC DEVICES IN PCB TECHNOLOGY

### High Pressure / High Flow Application

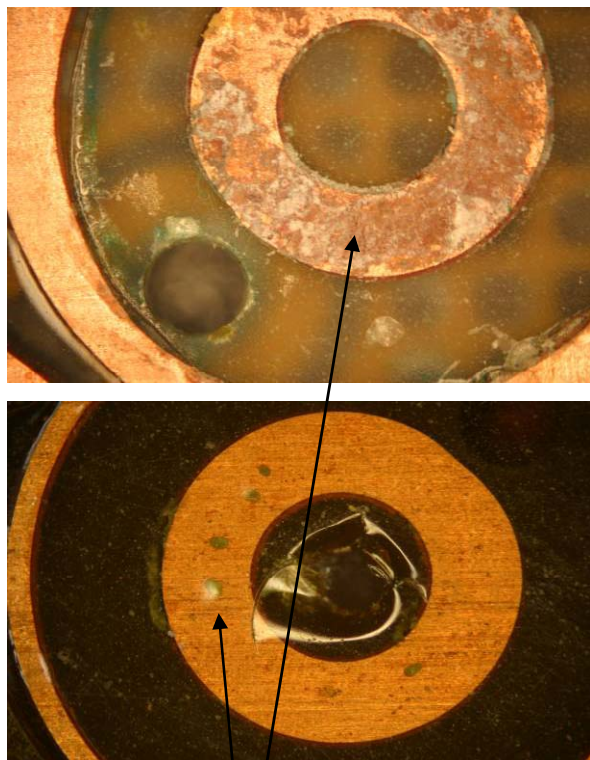


**PCB-Channels:**  
flow rate < 50 l/min  
pressure < 8 bars  
height 1 mm  
width 6 mm

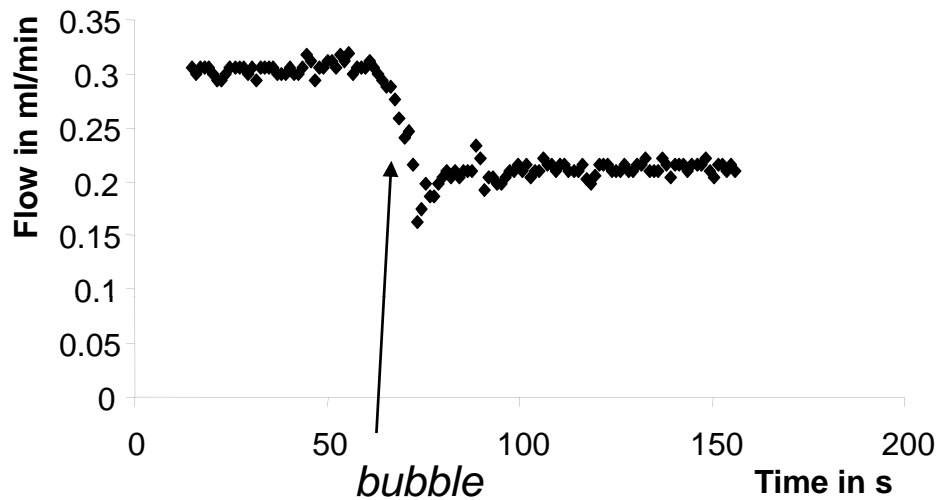
Channel structure of an electronic-pneumatic PCB

# FLUIDIC DEVICES IN PCB TECHNOLOGY

## Quality & Reliability



particles and bubbles on valve seat



pump behavior with bubble

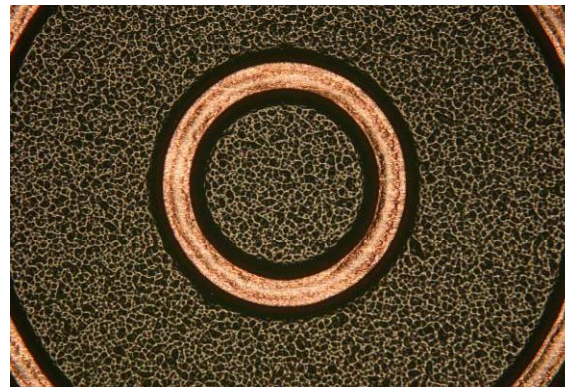
### Investigation of robustness of micro pumps

# FLUIDIC DEVICES IN PCB TECHNOLOGY

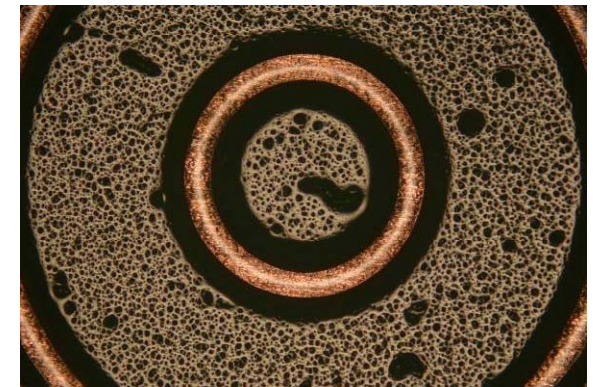
## Quality & Reliability



10 cm/min  
no complete layer



20 cm/min  
ring on valve seat



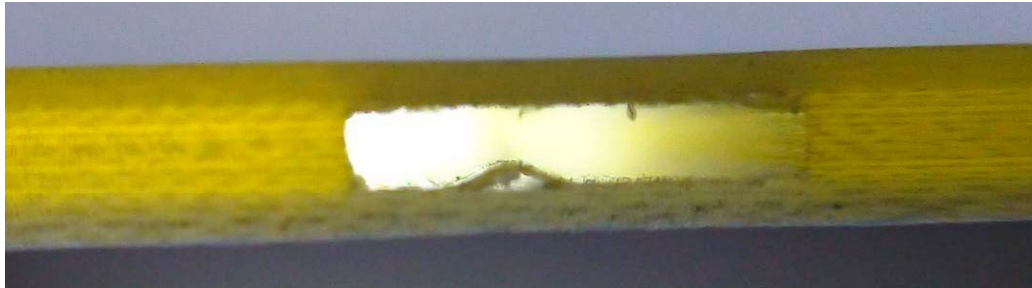
30 cm/min  
complete layer

coating with epoxy glue with optimized viscosity

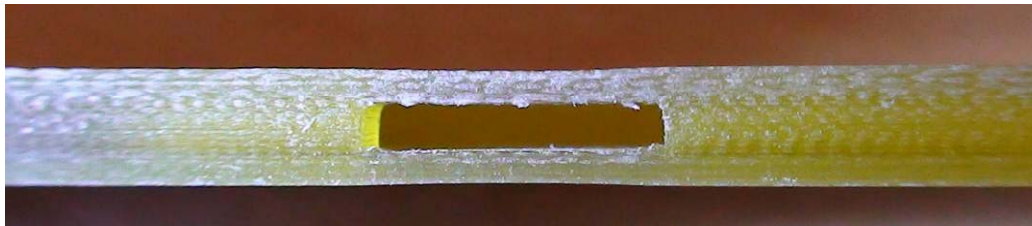
Increasing reliability by covering of the valve seat

# FLUIDIC DEVICES IN PCB TECHNOLOGY

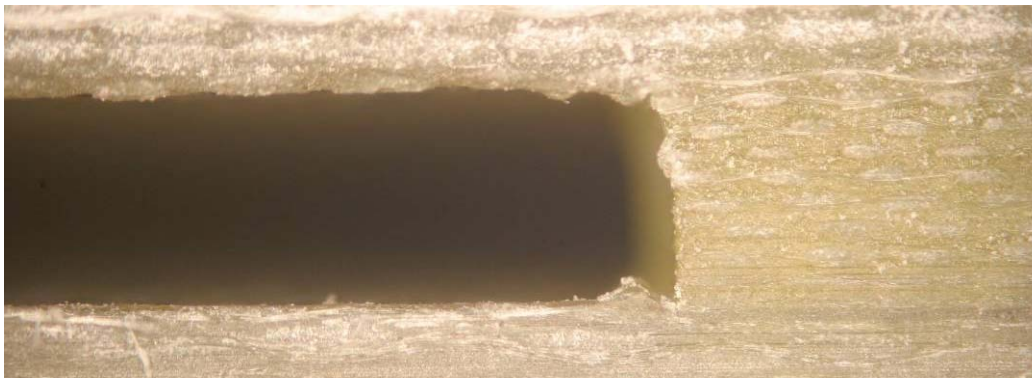
## Quality & Reliability



warping of prepreg layers



deformation of channel covers

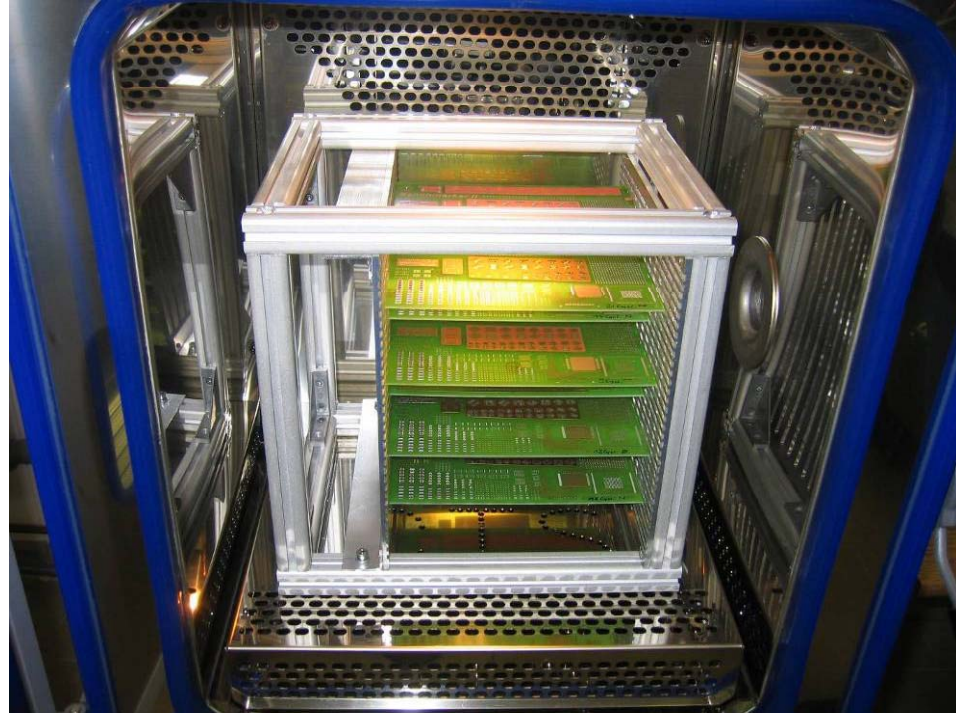


squeezing of material excess

Typical problems in manufacturing of high-flow channels

# FLUIDIC DEVICES IN PCB TECHNOLOGY

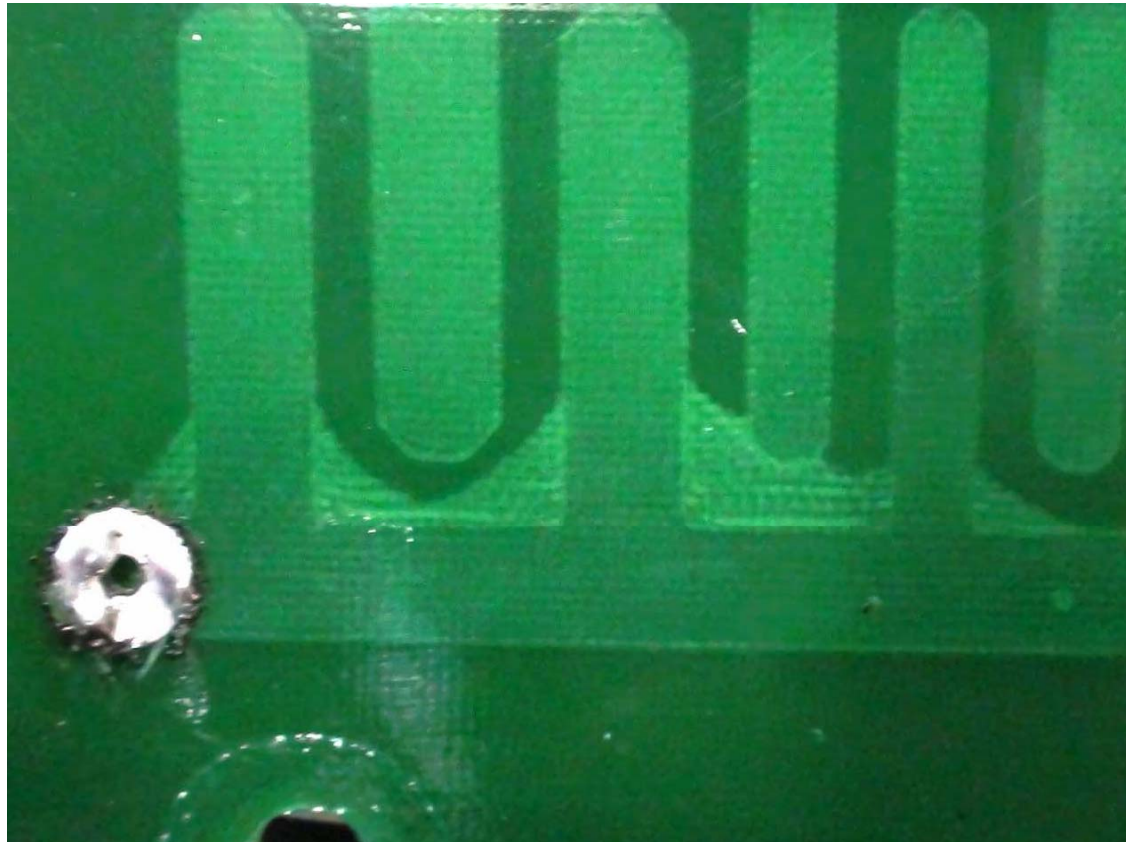
## Quality & Reliability



Reliability testing at elevated temperature (and humidity)

# FLUIDIC DEVICES IN PCB TECHNOLOGY

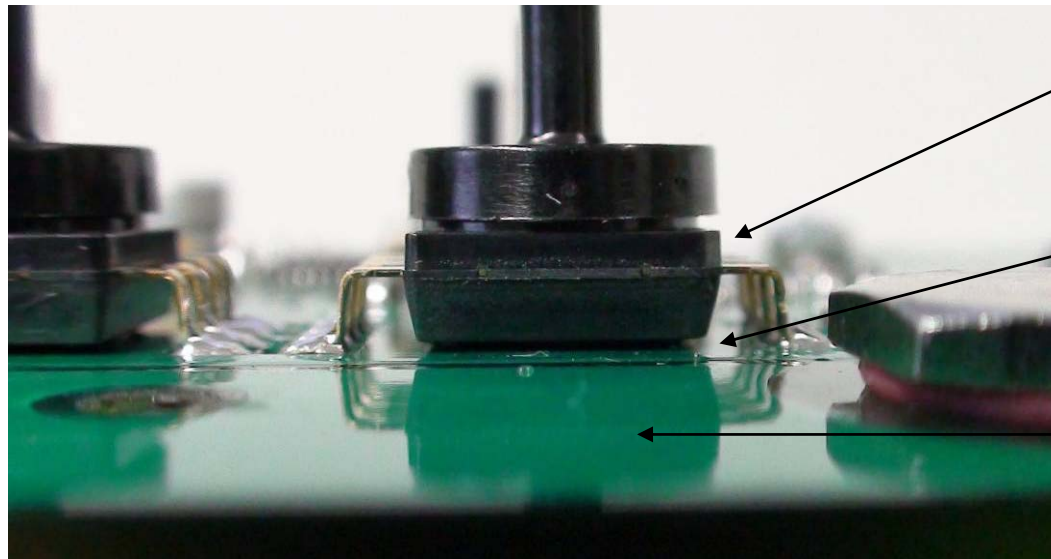
## Quality & Reliability



Delamination after a high-temperature/high pressure test at 135 °C / 10 bar

# FLUIDIC DEVICES IN PCB TECHNOLOGY

## Quality & Reliability



Pressure sensor

Sealing by glue deposition  
by dispensation

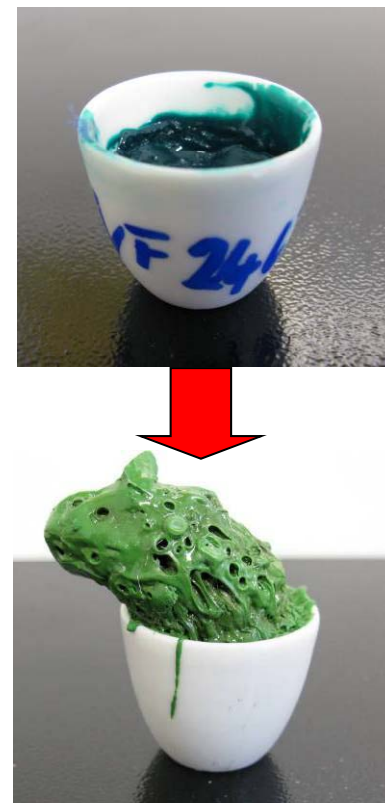
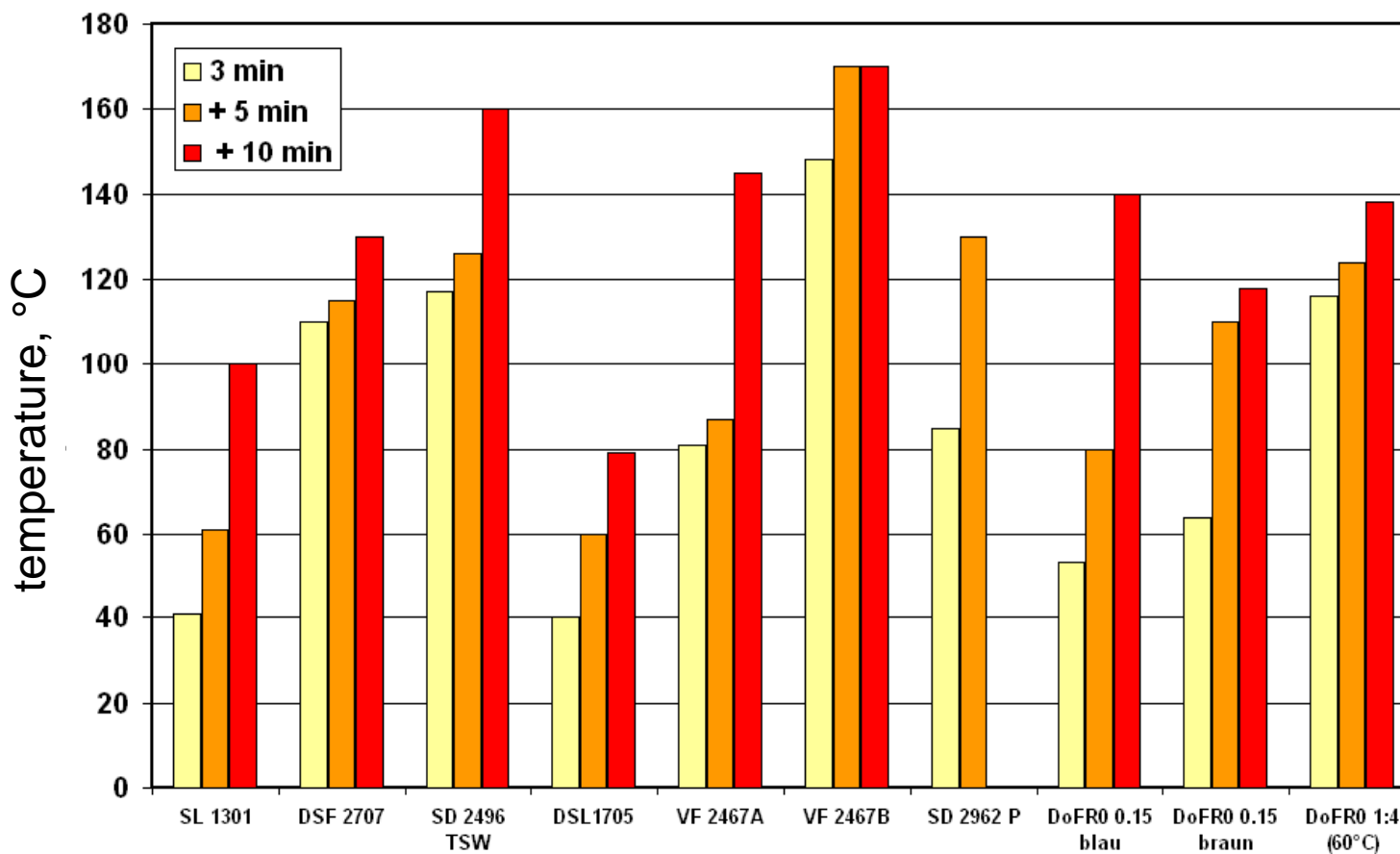
Channel inside board (not  
visible)

### Joining and sealing of pressure sensors



# FLUIDIC DEVICES IN PCB TECHNOLOGY

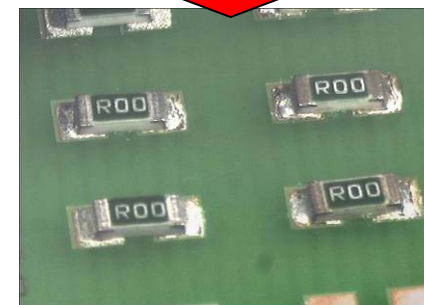
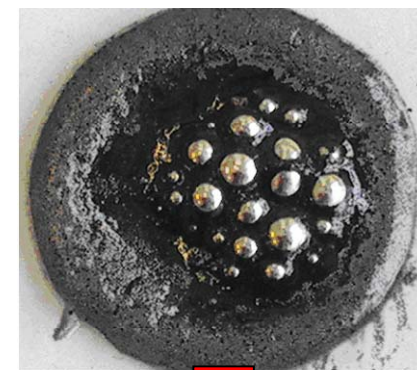
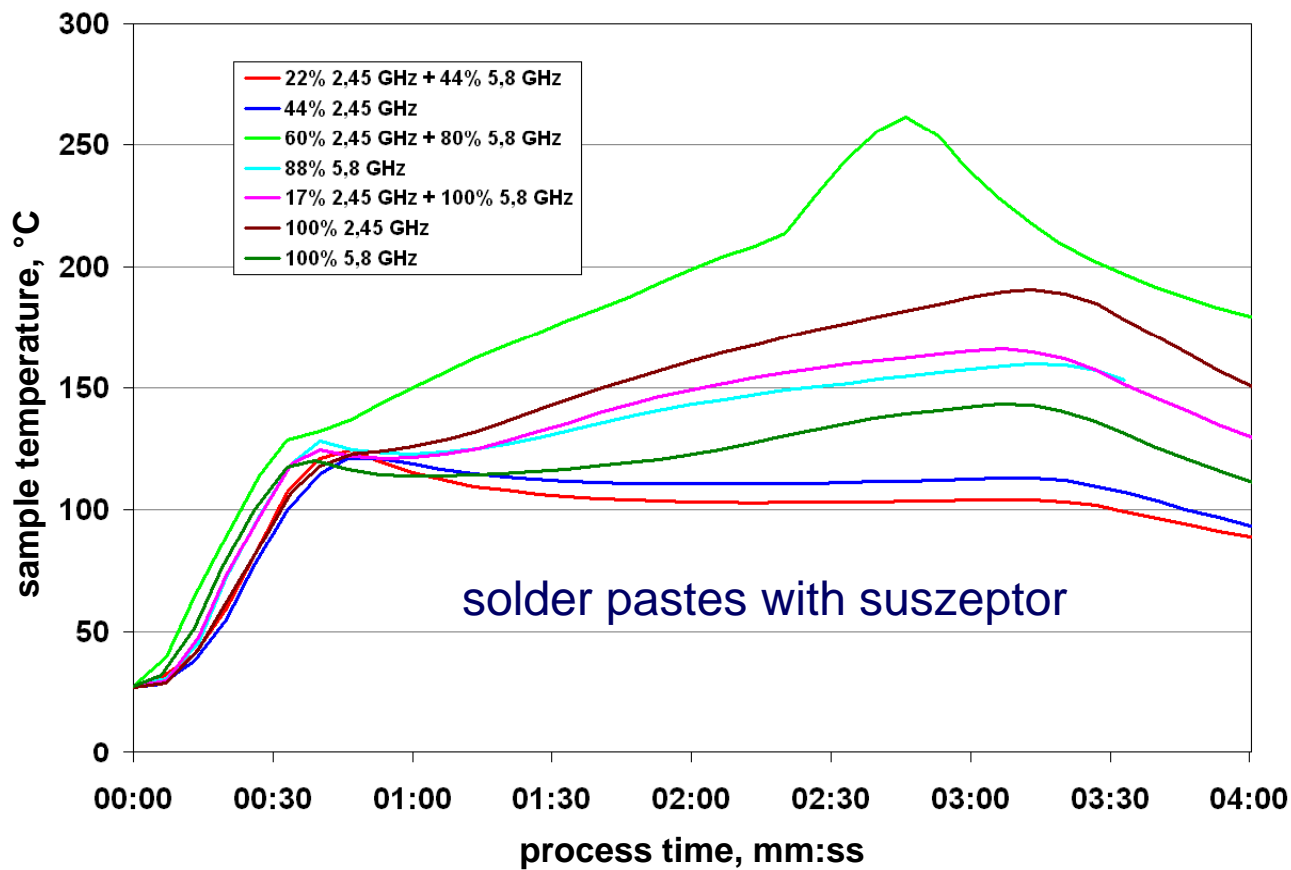
## Special Coating and Joining Technologies



Microwave-curing of polymer coatings (epoxy, silicon, polyurethane) [Project MicroFlam]

# FLUIDIC DEVICES IN PCB TECHNOLOGY

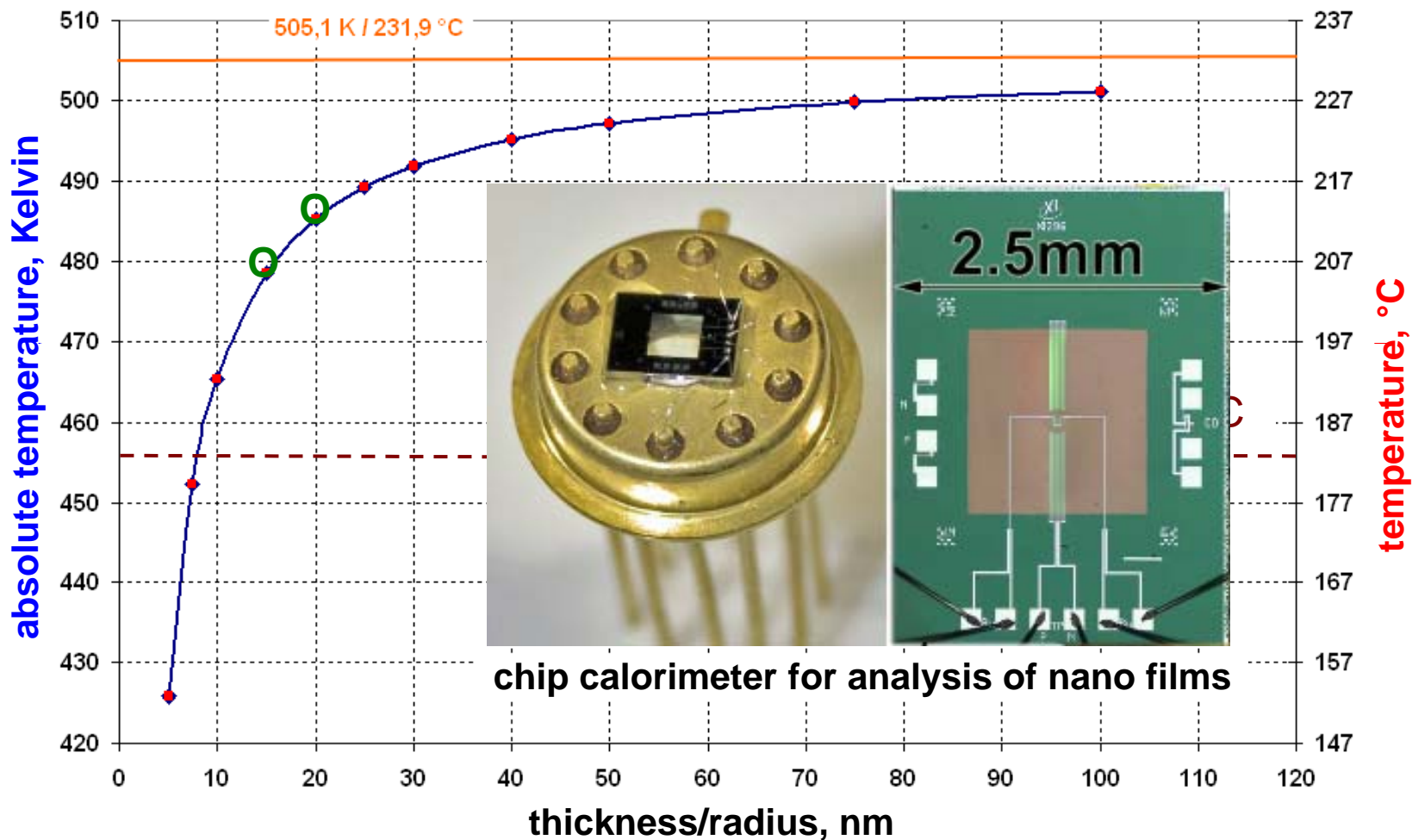
## Special Coating and Joining Technologies



Melting behaviors of solder pastes in a combined microwave oven [Project Microflow]

# FLUIDIC DEVICES IN PCB TECHNOLOGY

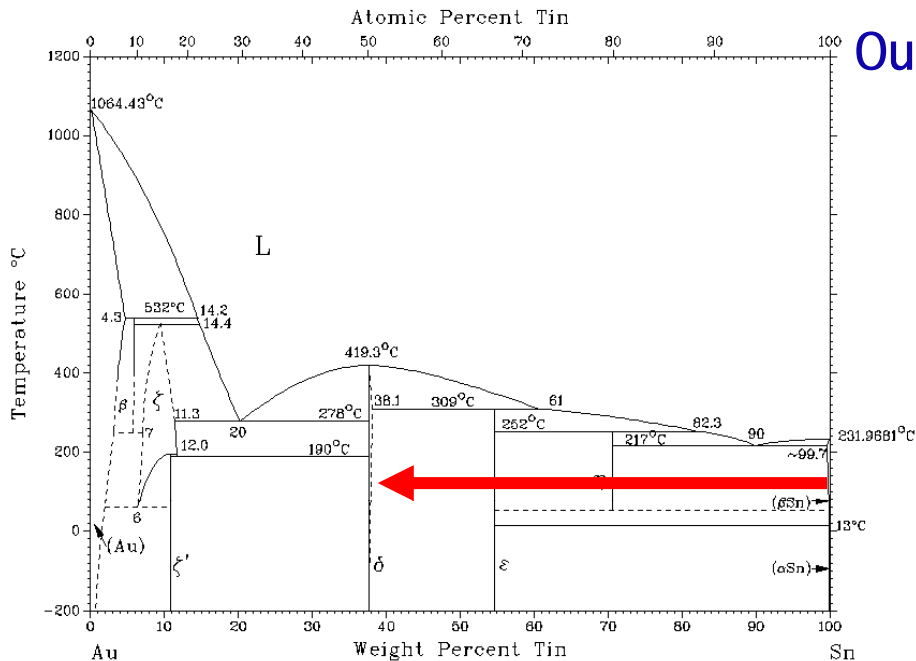
## Special Coating and Joining Technologies - Outlook



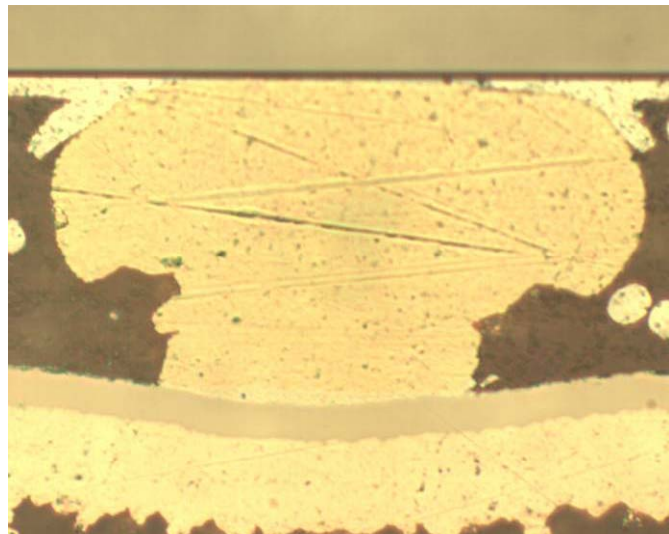
chip calorimeter for analysis of nano films

Field of research: Low temperature soldering with nano-solder-films [A. Novikov]

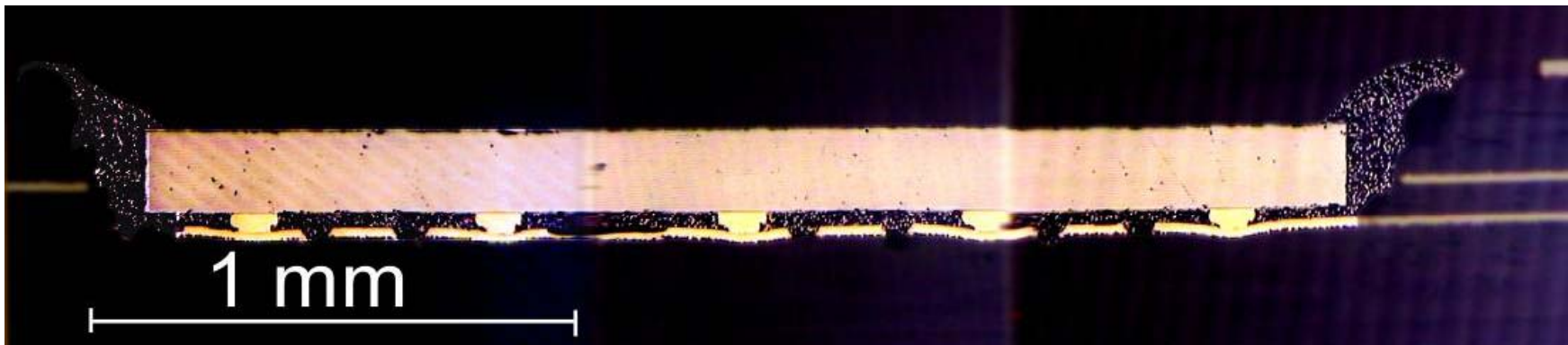
# FLUIDIC DEVICES IN PCB TECHNOLOGY



Outlook



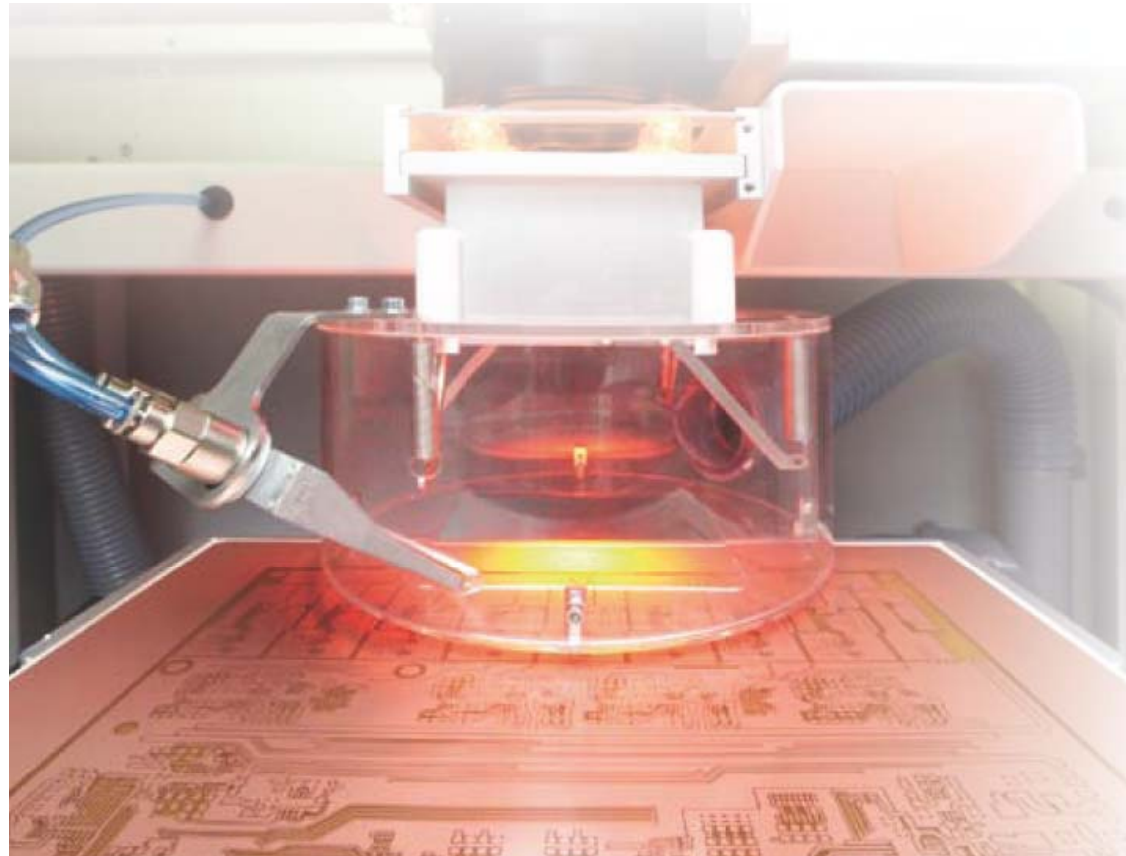
diffusion soldered gold stud bump



Example of an embedded chip in PCB with "Laser Cavity" (Wuerth)

# FLUIDIC DEVICES IN PCB TECHNOLOGY

## Outlook



Finer structures ( $>25 \mu\text{m}$ ) by laser treatment of PCB (LPKF)

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