European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

EUROSENSORS in Freiburg, 7 - 9 September 2015

Action Start date: 01/07/2012 - Action End date: 30/06/2016

Year 4: 1 July 2015 - 30 June 2016 (*Ongoing Action*)

LTCC, New Packaging Approach for Toxic Gas and Particle detection

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Toxic substances needed to be measured: NO_x, NH_3, SO_2, CO, O_3, PAH/VOC, PM_{10}, $PM_{2.5}$, PM_1

Two areas need more development and research within the sensor community:
Packaging and Portable particle detectors

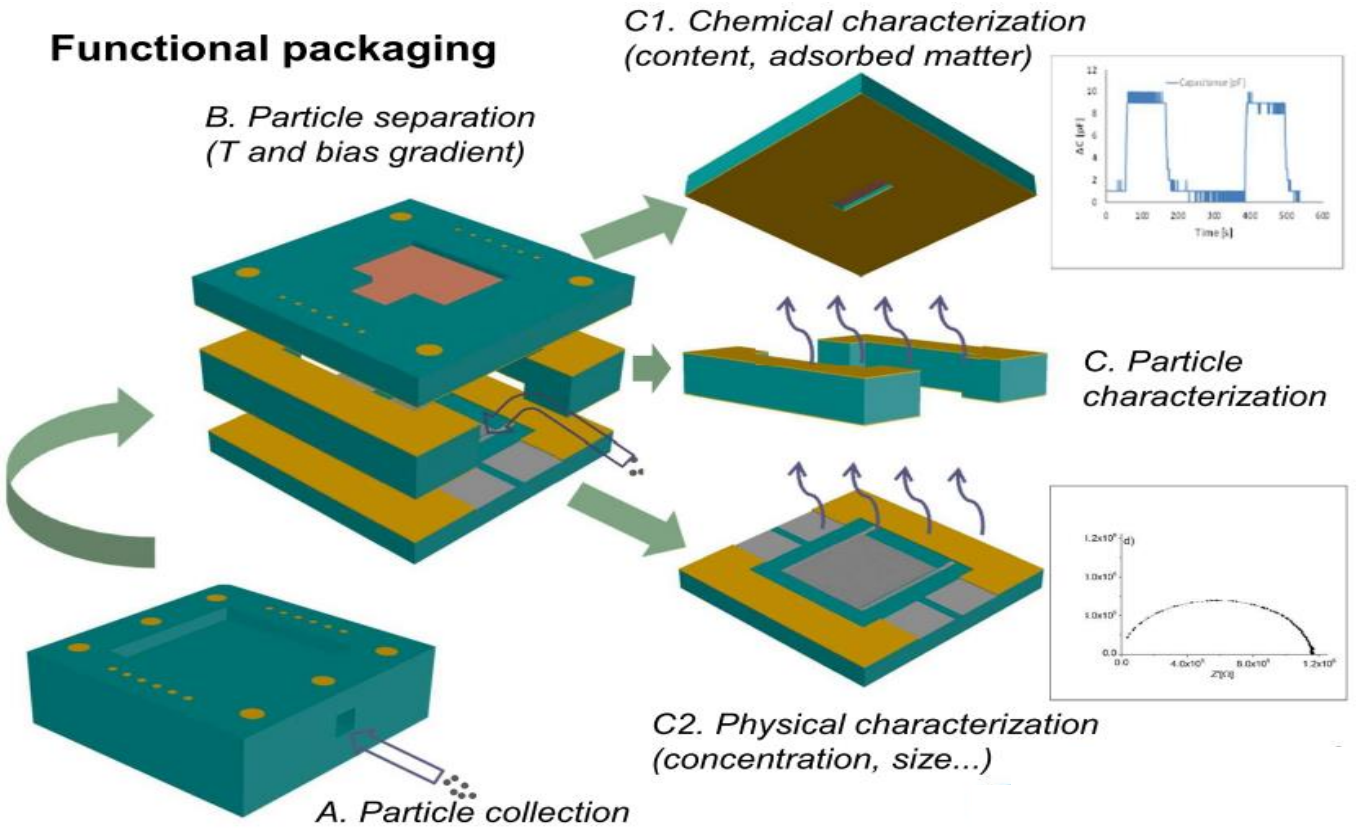
Outline

- LTCC technology:
  - Smart packaging of
    - chemical gas sensors
    - Portable particle detectors
    - The Cell clinic

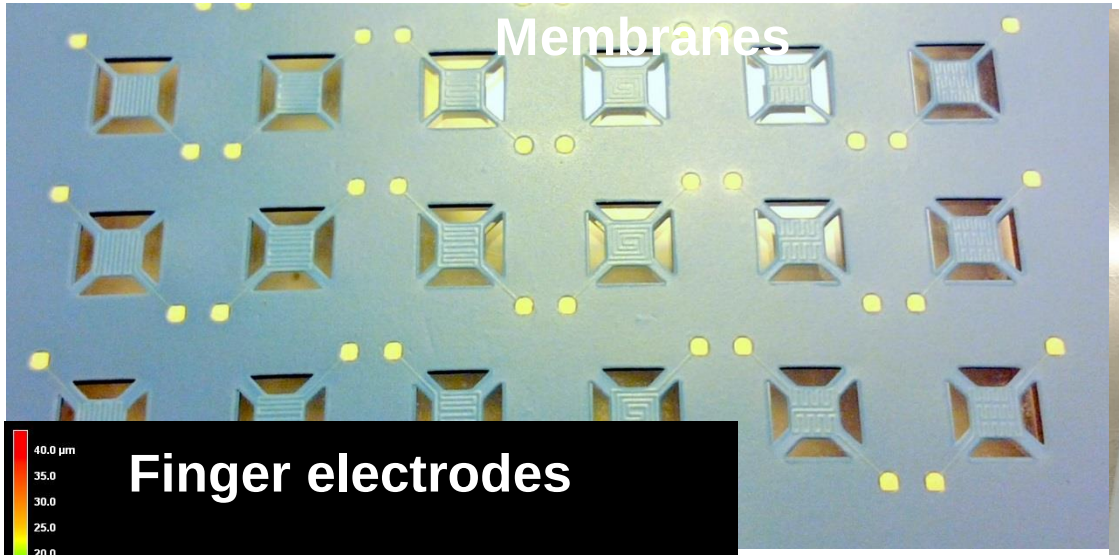
LTCC platform for sensor devices

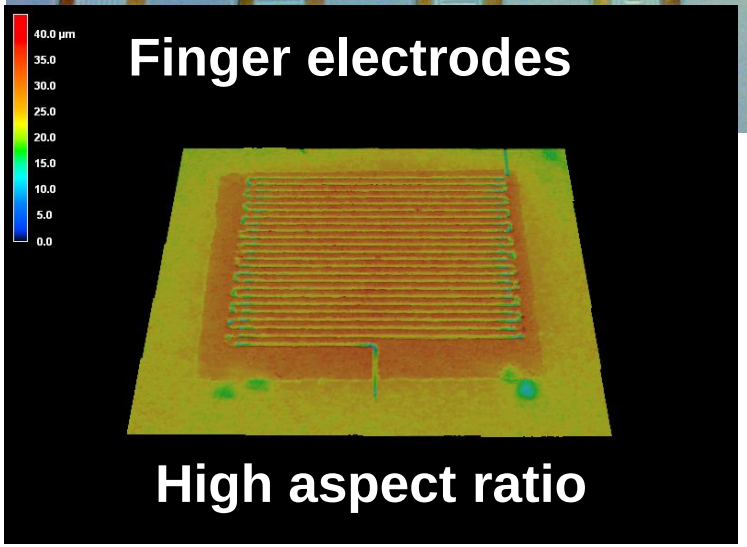
Benefits of LTCC (Low Temperature Co-fired Ceramics)

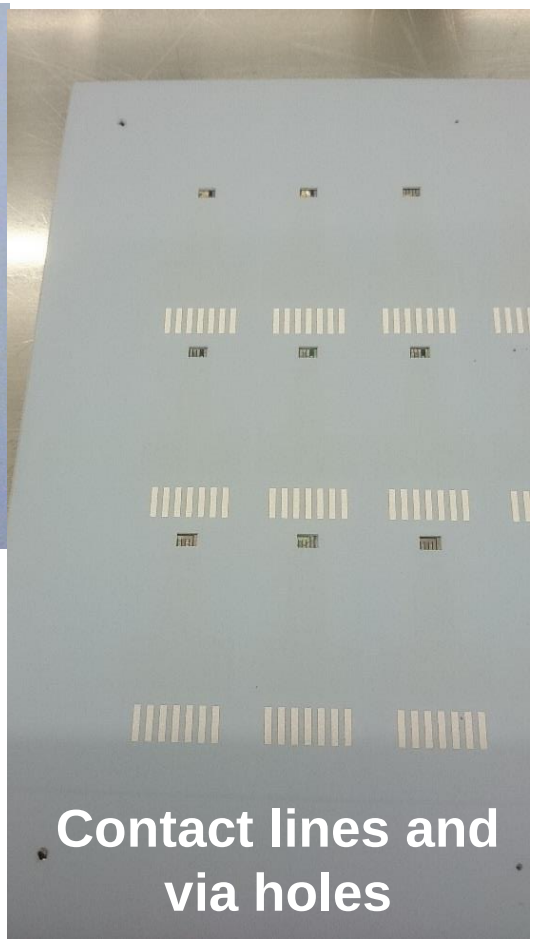
- ✓ **Fast processing**
- ✓ **Durable, hermetic, resistant**
- ✓ **Relatively cheap**



LTCC processing of dedicated structures

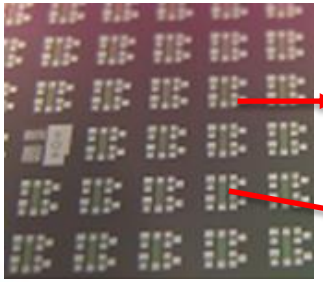


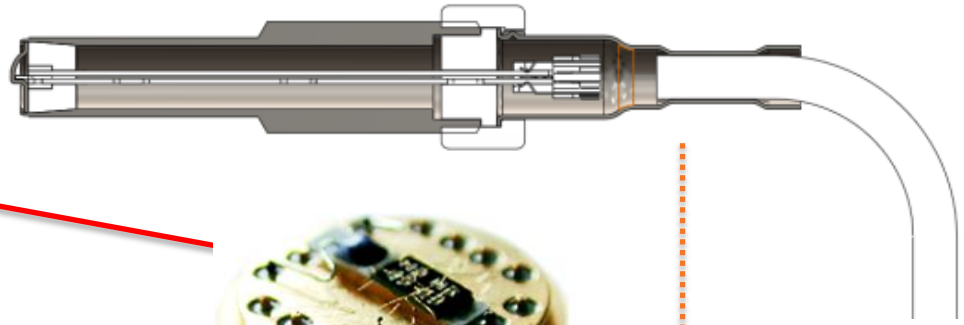


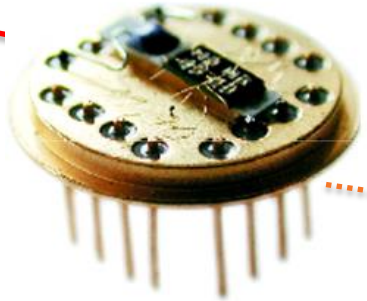


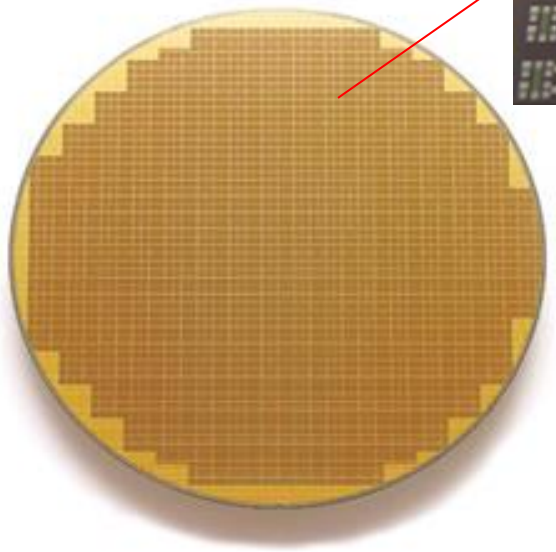
Processing in one (fast) step possible

SiC-FET sensors wafer and mounting





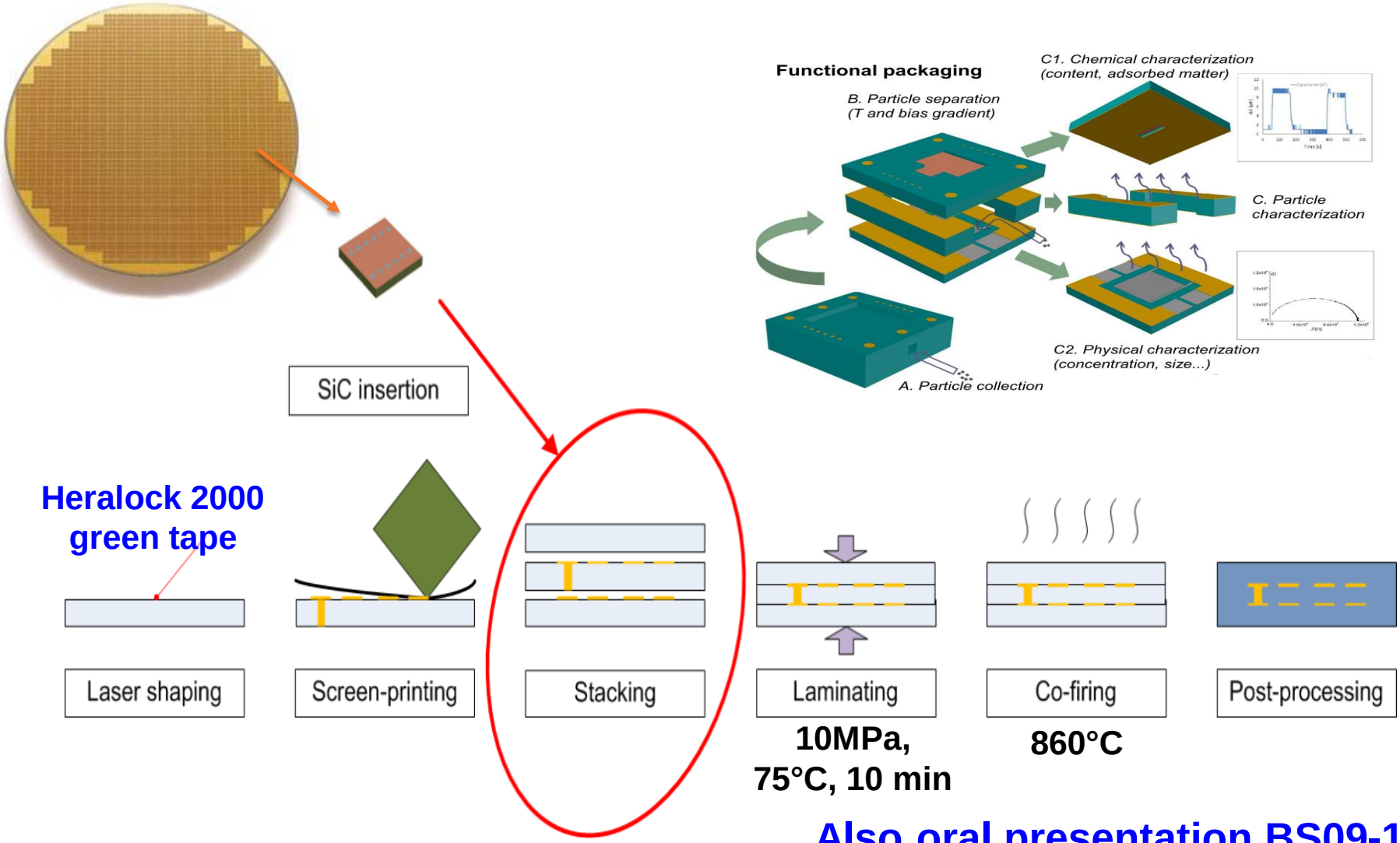




4” SiC wafer up to 2000 chips
Design and processing,
SenSiC AB/ (Ascatron AB)

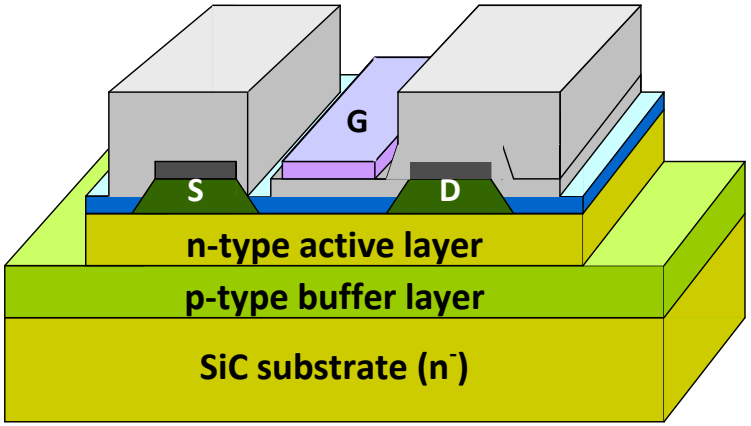
SiC-FET
sensor system
Traditional mounting

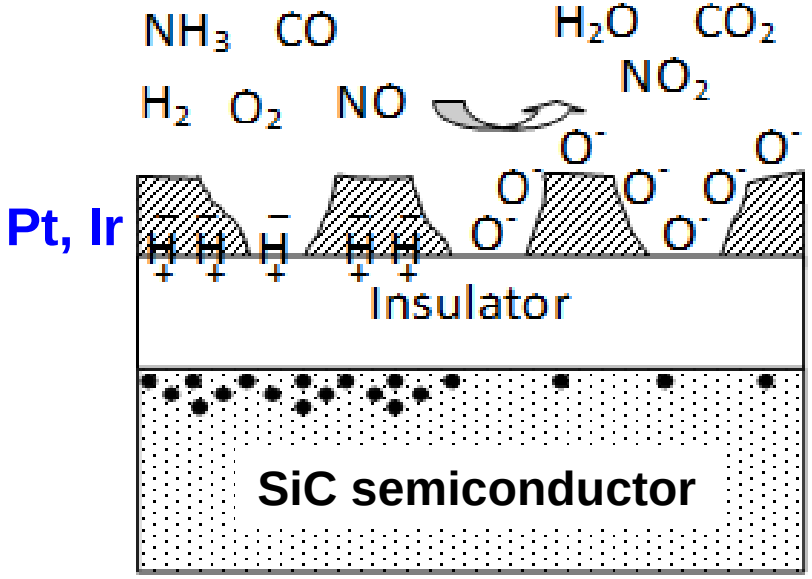
LTCC platform for SiC–FET sensors



Also oral presentation BS09-1 by Maciej Sobocinski on Tuesday

SiC-FET gas sensors



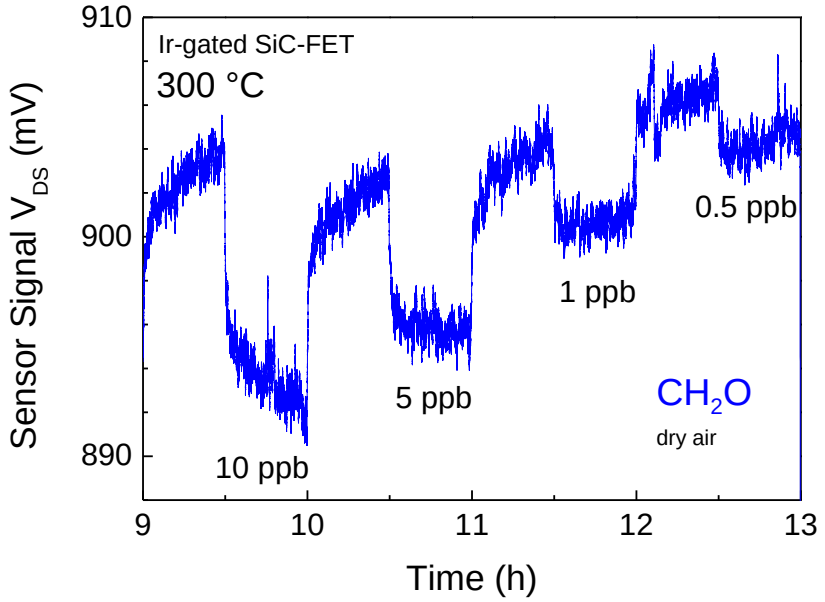


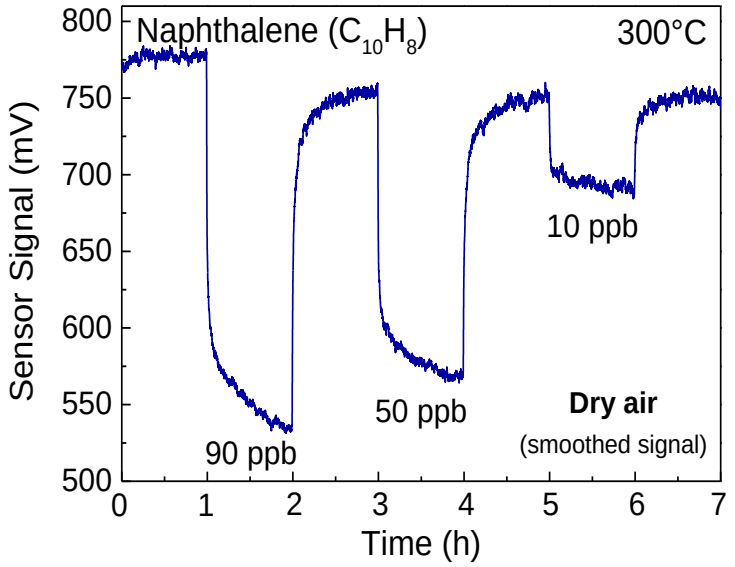
Cross section of depletion SiC-FET
Gate sensing layer:
porous catalytic metal, Pt, Ir

Molecule decomposition and reactions on the catatlytic metal – charging of the gate area - a change in the current through the transistor

Temperature and sensing layer modulation enhances selectivity and sensitivity: H_2, CO, NH_3, SO_2, VOC

VOC detection by SiC-FET sensors



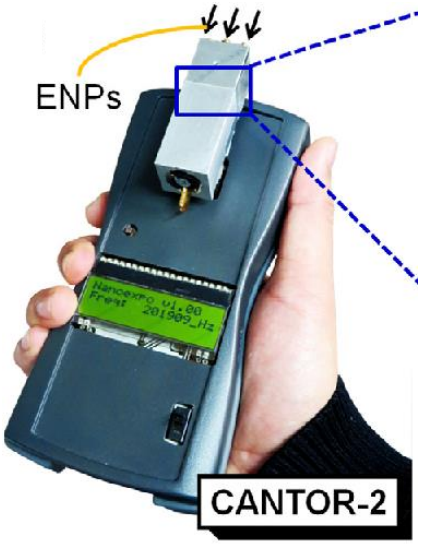


Measurements performed by Donatella Puglisi, Linköping University at Saarland University in an STSM activity within the EuNetAir

Portable particle detectors

Miniaturized devices for the on-line monitoring of particles for

- Work places
- Public use



Giving information about particle

- number (concentration)
- Size
- Shape (needle like, asbestos like (branched needles)
- Content (CNTs containing Ni, Fe, Co has shown adverse effect in animal studies)

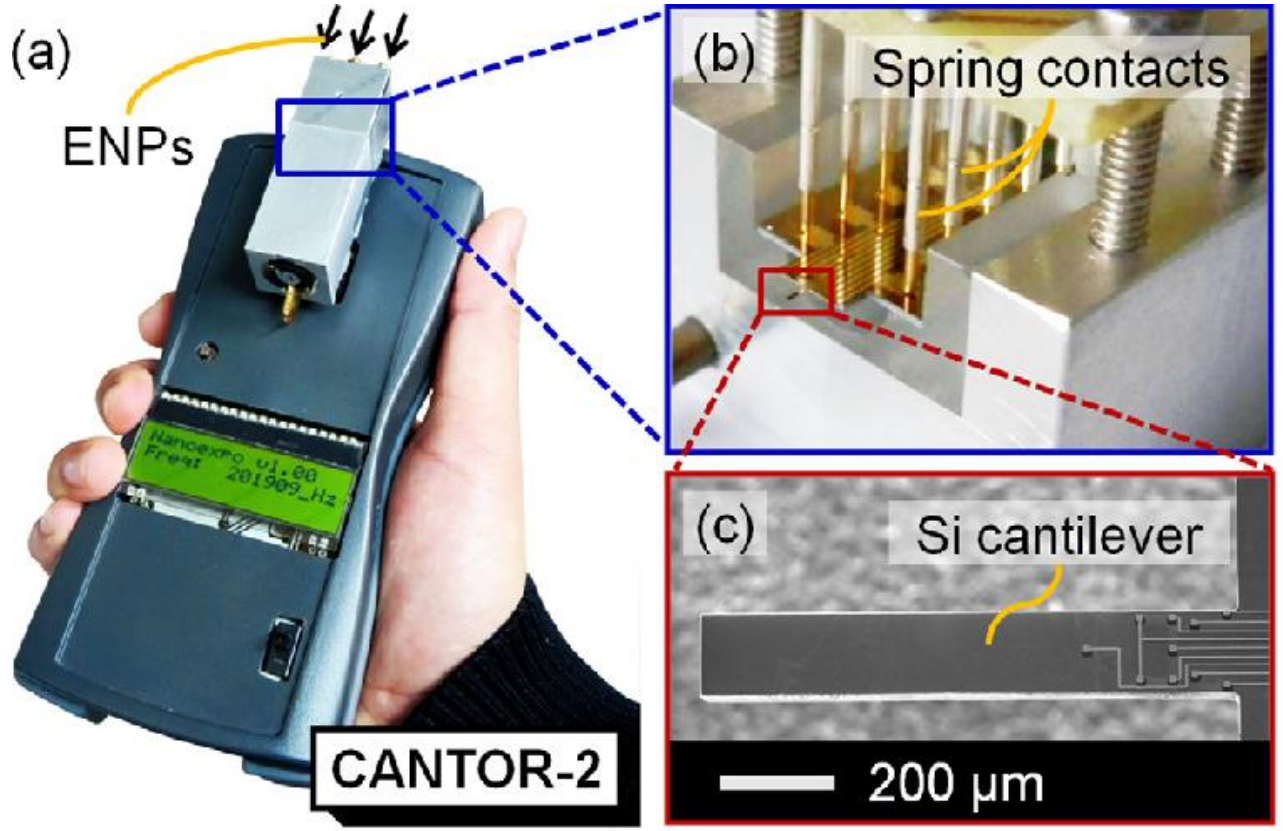
Since these parameters influence the adverse health effect of particles

Particle detector, commercial device

Particle Sense P600

Measures PM1, PM2.5 and PM10

Portable black carbon detector for work places

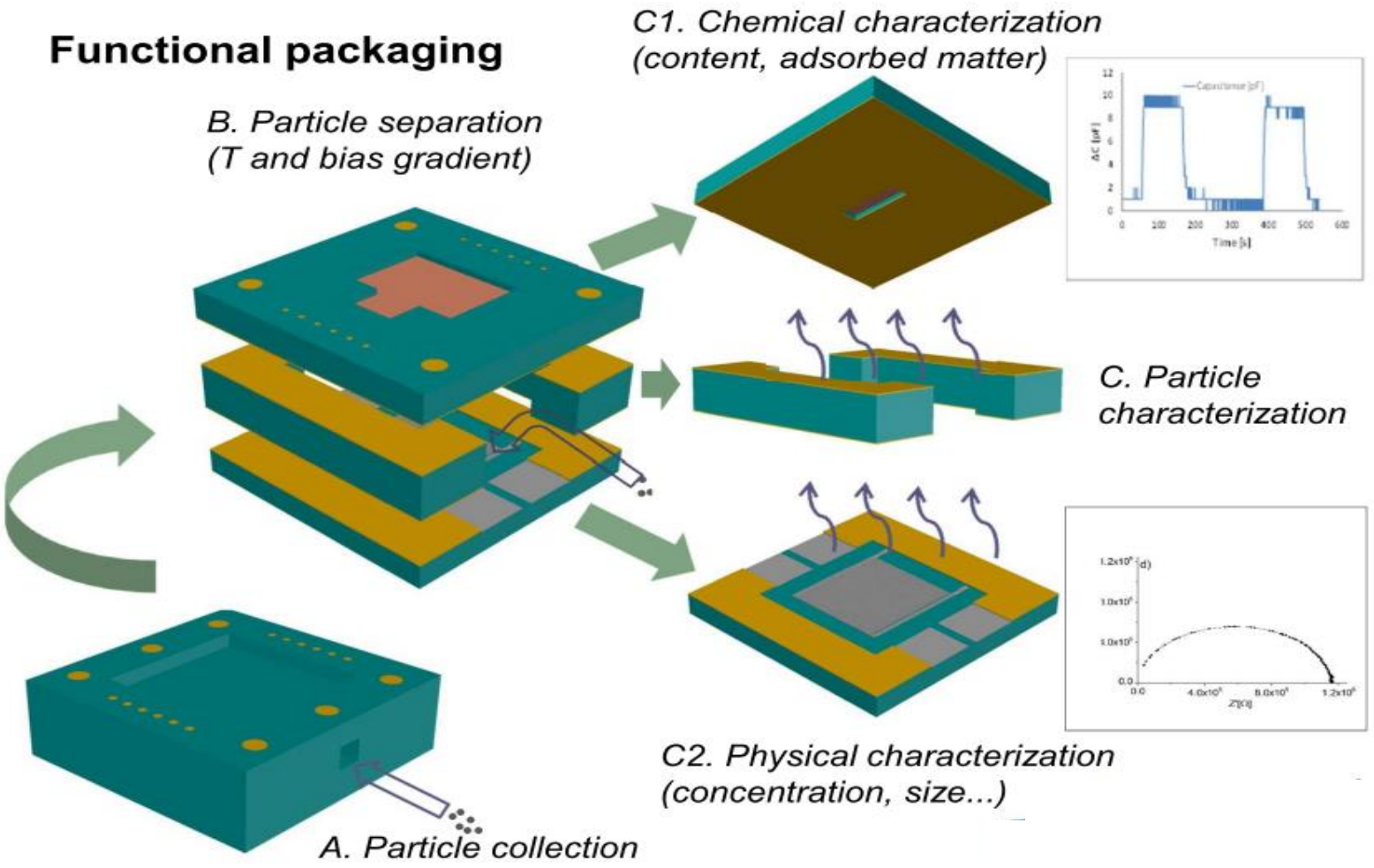


H.S. Wasisto et al, Handheld personal airborne nanoparticle detector based on microelectromechanical silicon resonant cantilever, Microelectronic Engineering, 145 (2015) 96-103. (Braunschweig Germany)

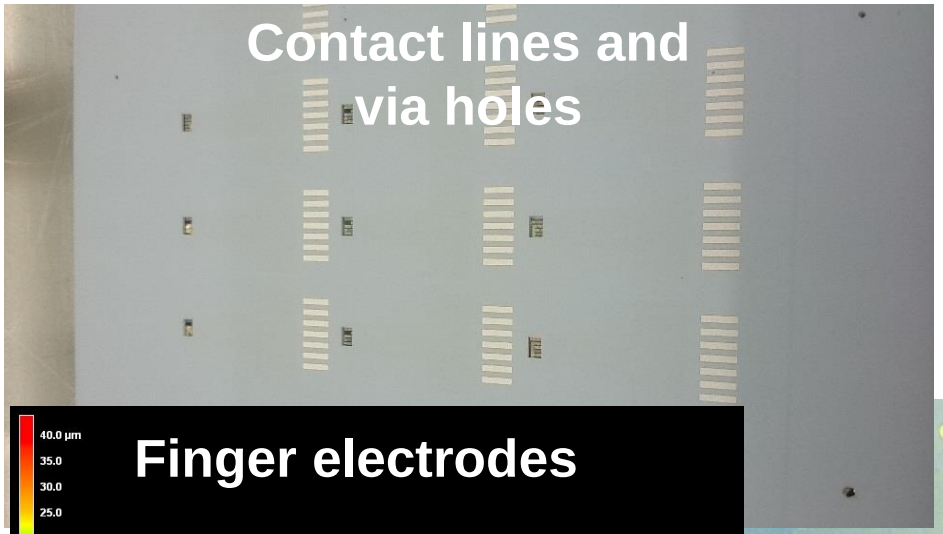
cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Gunter Hagen et al. Capacitive soot sensor, Bayreuth, Oral presentation Tuesday BS08-3

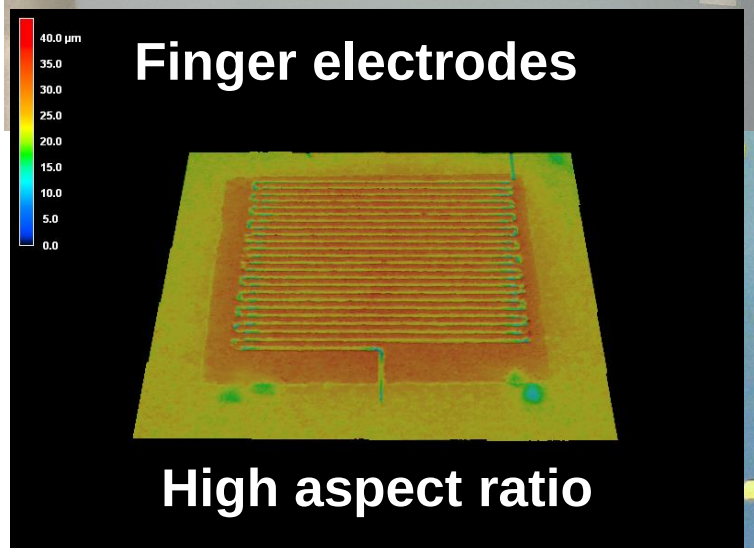
LTCC platform for Portable particle detectors

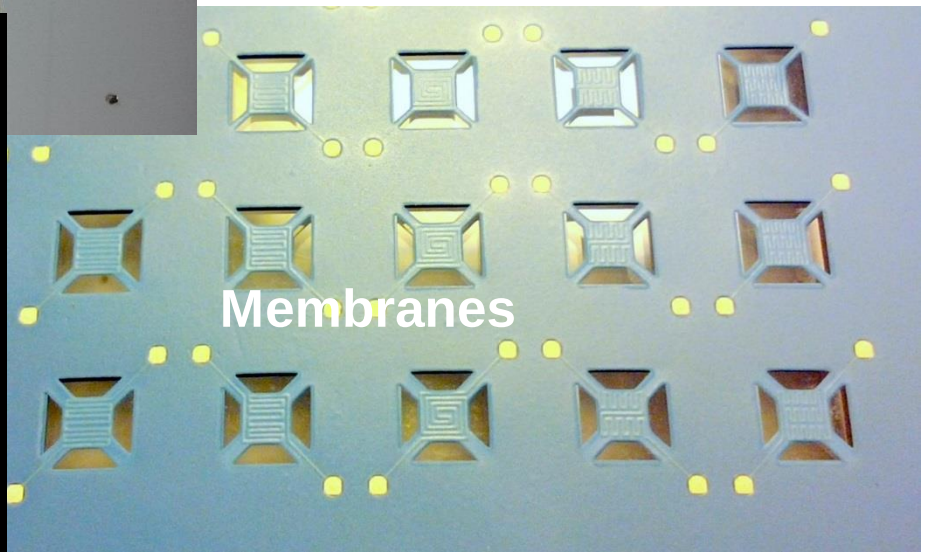


LTCC processing of dedicated structures for particle detectors



Membranes: heating collected particles, detecting emitted gases for content /adsorbent analysis

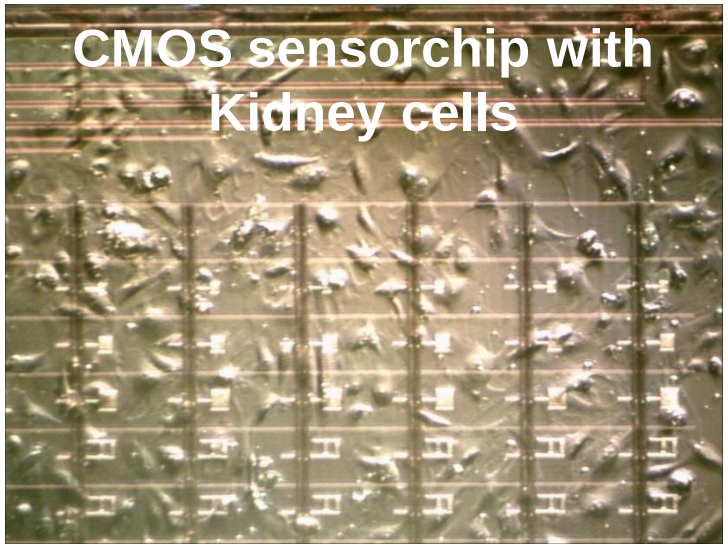


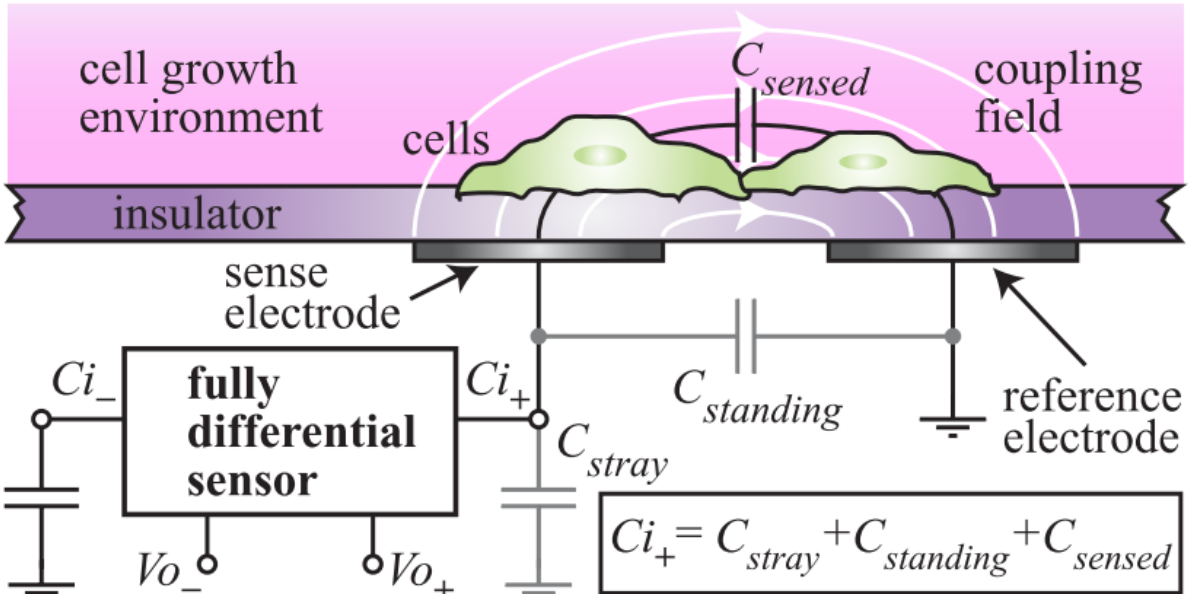


Finger electrodes, high aspect ratio: concentration size, content

Nicole Neubauer et al, Functionality based detection of airborne engineered nanoparticles in quasi real time: A new type of detector and a new metric, Ann. Occup. Hyg. 57 (2013) 842-852 (Karlsruhe)

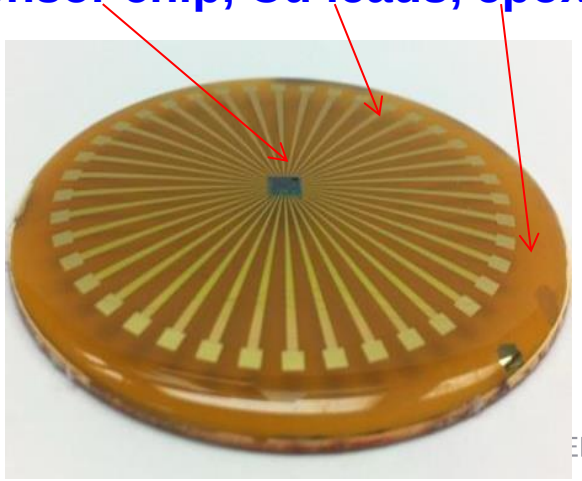
Cell Clinic: Measurement of Toxic effect of particles on cells





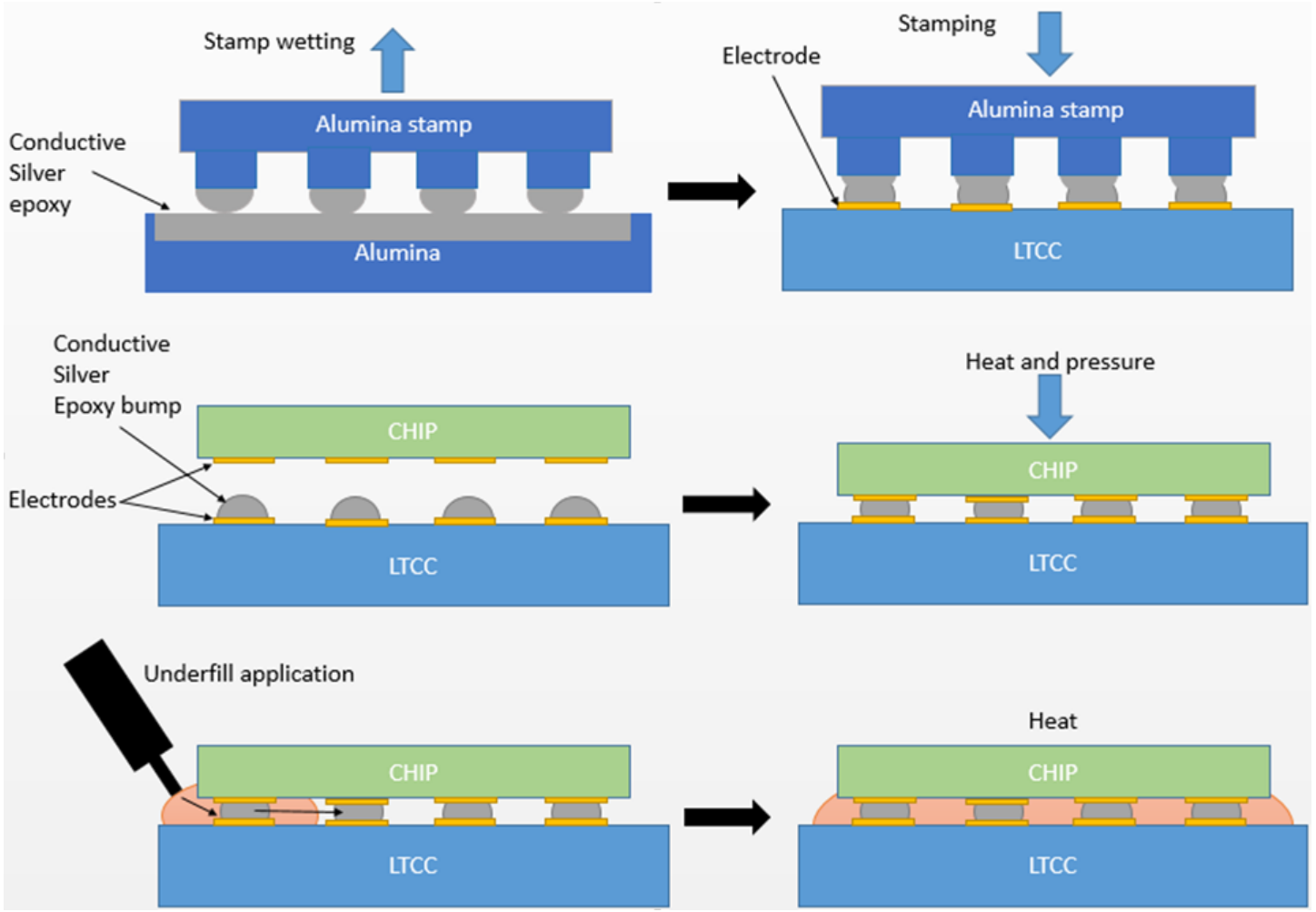
Capacitive measurement principle

Sensor chip, Cu leads, epoxy



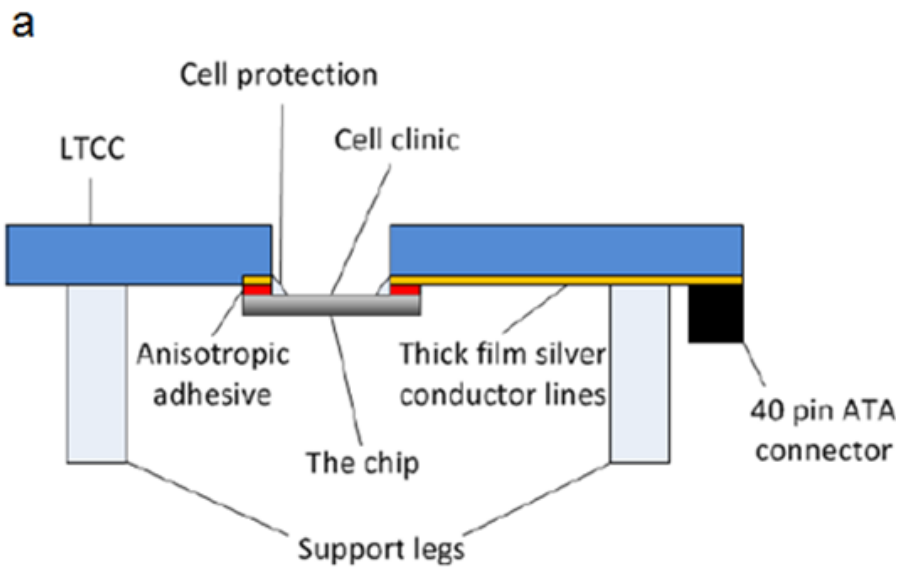
Packaged chip by epoxy molding

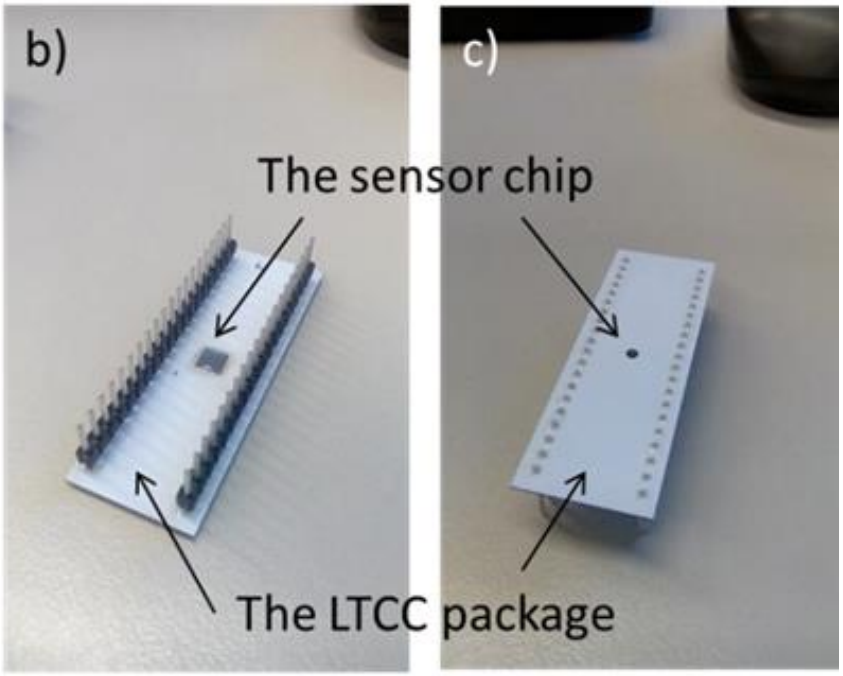
LTCC packaging for the cell clinic

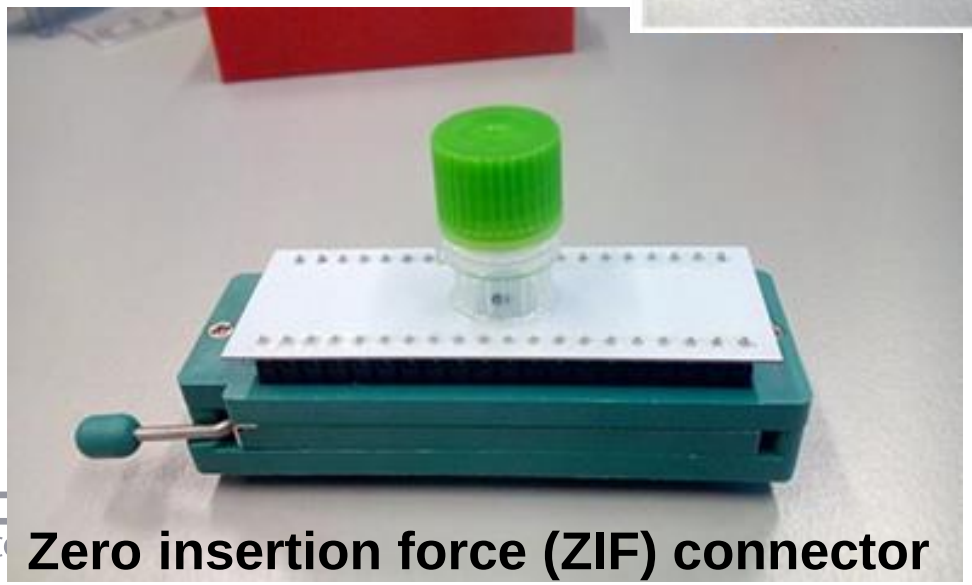


Also poster presentation TP-F05 by Niina Halonen on Tuesday

LTCC packaging for the cell clinic

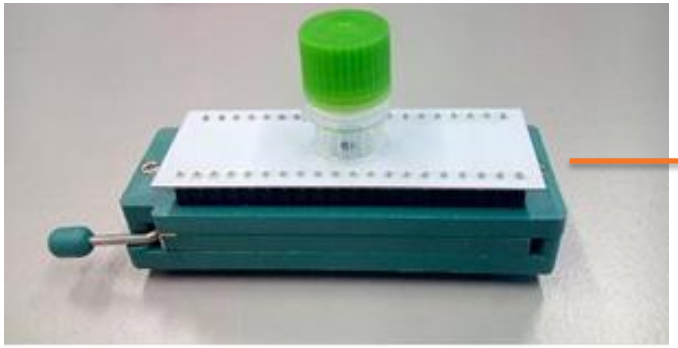






Zero insertion force (ZIF) connector

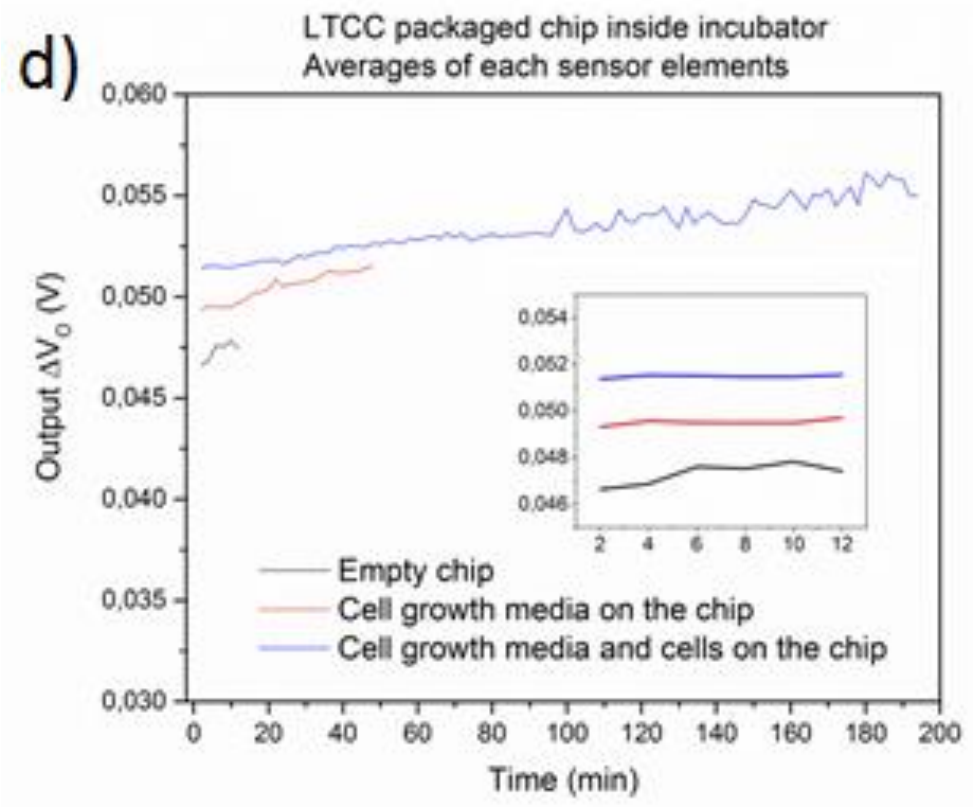
Development of microincubator



LTCC packaging of the chip potential as microincubator

LTCC packaged chip with electronics in the incubator

Development of microincubator



First electrical measurements with LTCC mounted sensorchip

Conclusions

- The LTCC (Low Temperature Co-fired Ceramic) facilitates as sensor platform for
  - SiC-FET Gas sensors
  - Portable nanoparticle detector
  - A microincubator

Applied Sensor Science at Linköping University

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Assistant Prof. Donatella Puglisi
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Hossein Fashandi, PhD student
Lida Khavalezadeh, PhD student
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Manuel Bastuck, PhD student

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Prof. Krisztian Kordas
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