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

COST Action TD1105

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Year 3: 1 July 2014 - 30 June 2015 (*Ongoing Action*)

New Methods for Control of Nanoparticles in Indoor (or outdoor) Environment

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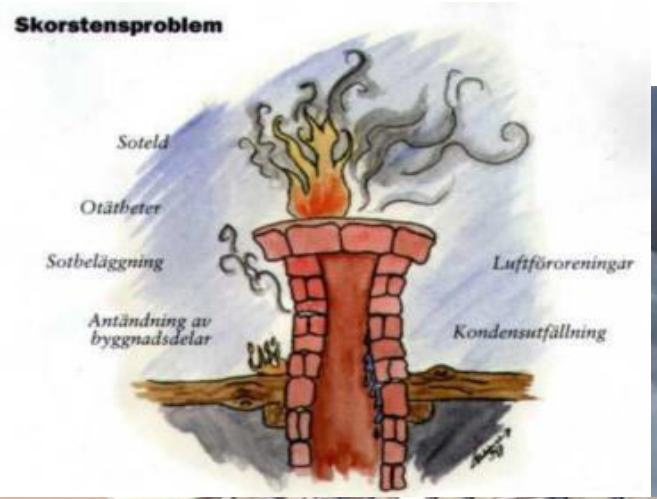
Allowed levels of emissons of toxic gas molecules and particles are today very low

Sensors systems for control are needed



Toxic substances include: NO_x, SO_2, CO, O_3, PAH/VOC, PM_{10}, $PM_{2.5}$, PM_1

Outline

Development of a particle detector:

- LTCC technology based particle detector
- Integration of funtionality in LTCC packaging
- Heating and detection of emissions

LTCC Technology for particle sensing

- H. Jantunen, R. Rautioaho, A. Uusimäki, S. Leppävuori, Preparing low-loss low-temperature cofired ceramic material without glass addition, J of the American Ceramic Society, 83,11 (2000),2855-2857.

- M. T. Sebastian and H. Jantunen, Low loss dielectric materials for LTCC, applications: a review, International Materials Reviews 53, 2 (2008) 57-90.

- Maciej Sobocinski, Mikko Leinonen, Jari Juuti, Noora Mantyniemi, Heli Jantunen, A co-fired LTCC–PZT monomorph bridge type acceleration sensor, Sensors and Actuators A, 216 (2014) 270-275.

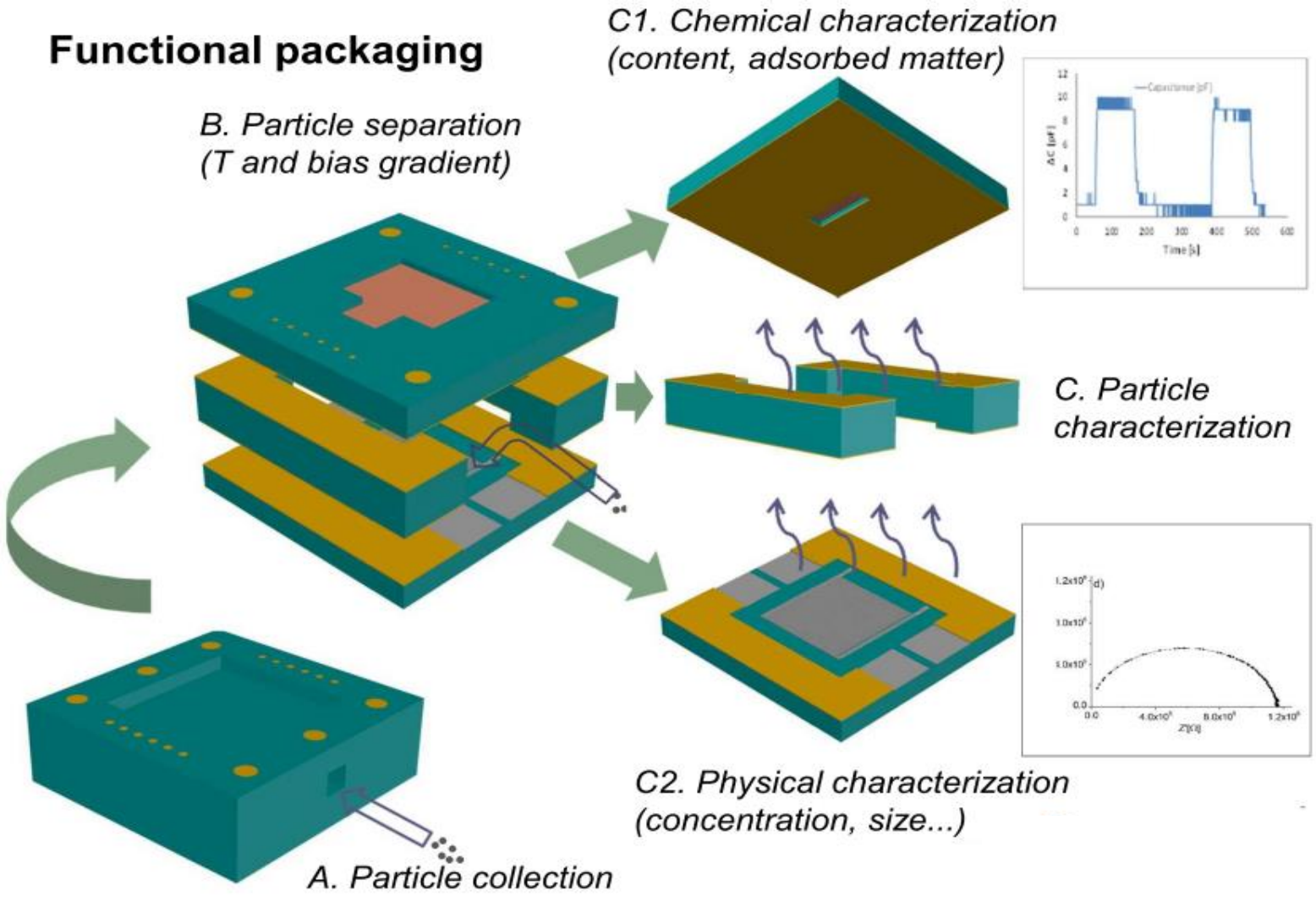
Vision

Miniaturized device for the on-line monitoring of particles for

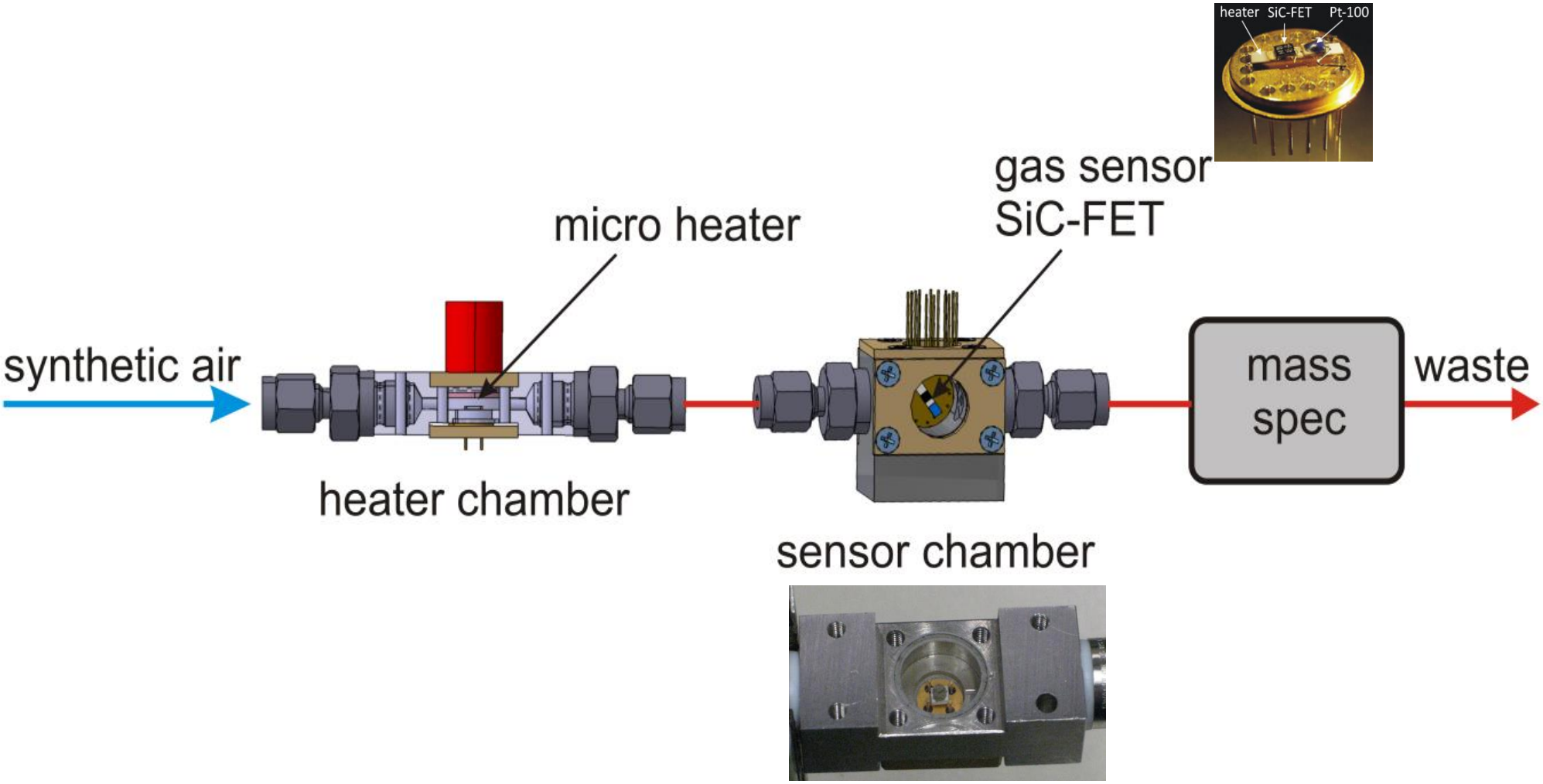
- Work places (specific)
- Public use (general)

Giving information about particle number (concentration), size, “shape”, and content since these parameters influence the adverse health effect of particles

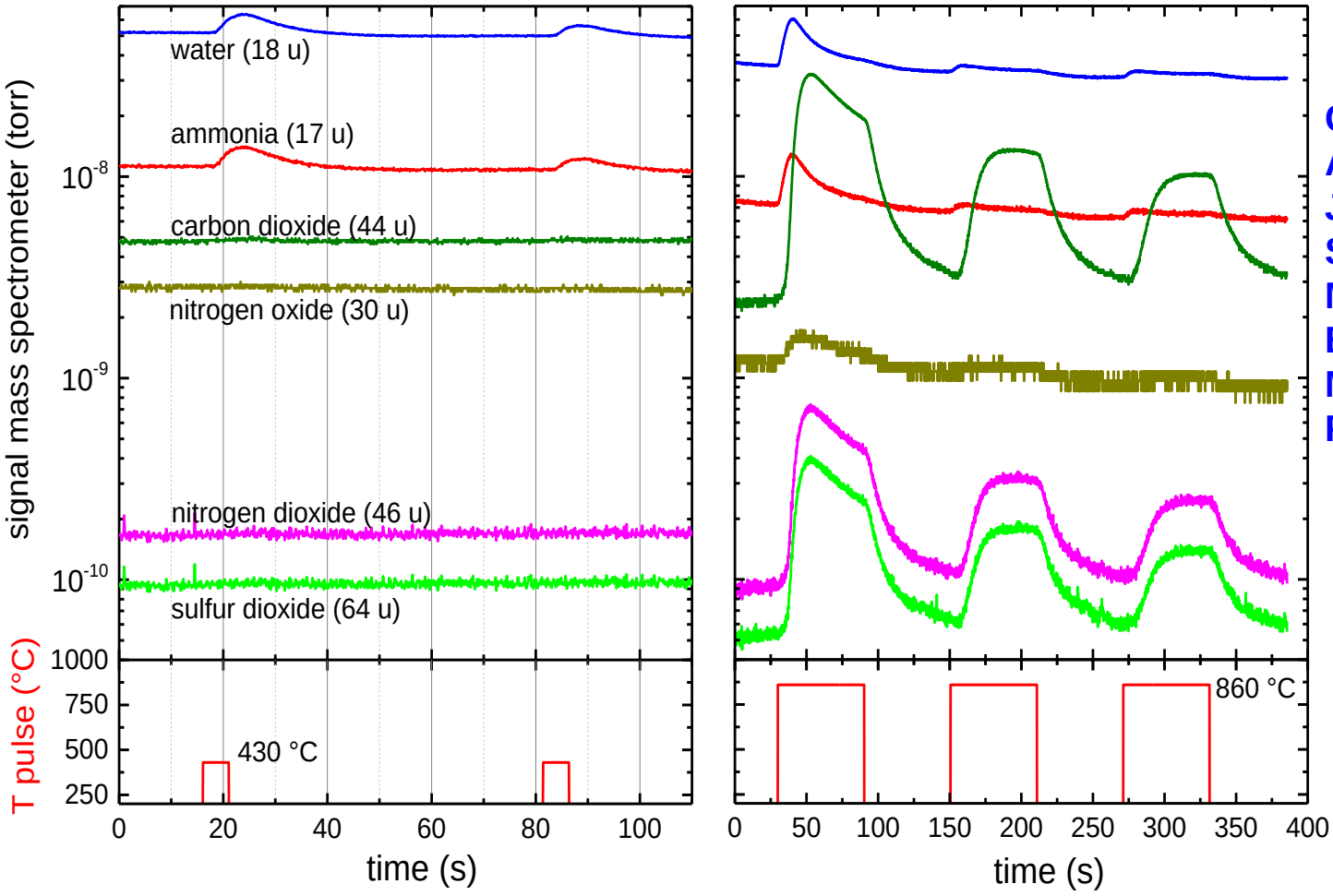
Nanoparticle detector LTCC platform - overview



Particle content meausurment set up



Detection of particle content

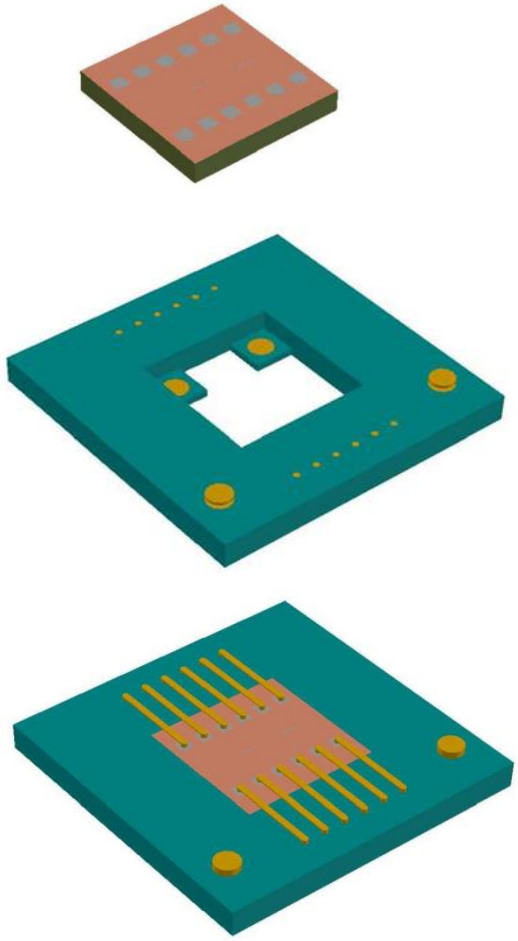


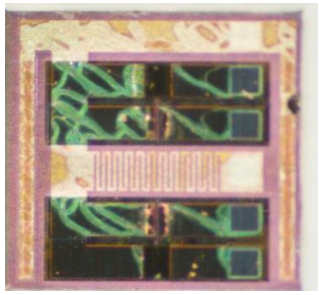
C. Bur, M. Bastuck, A. Schütze, J. Juuti, A. Lloyd Spetz, M. Andersson, E-MRS 2014, May 26-30, Lille, France, poster.

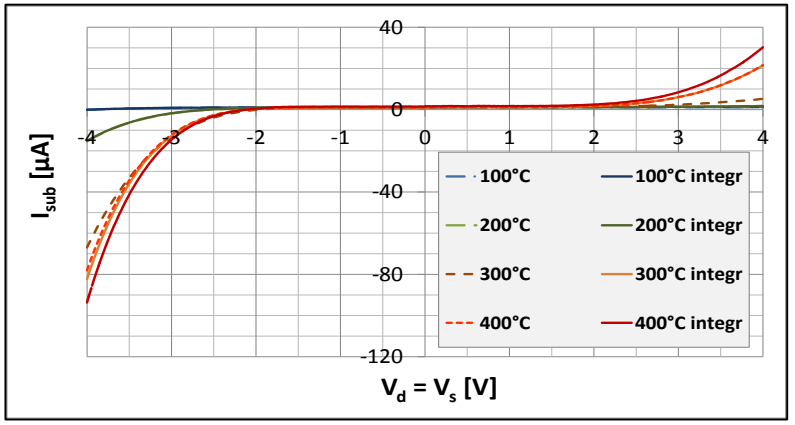
Mass spectra of fly ash with 84 mg/kg ammonia when heated to 430 °C (left) and 860 °C (right).

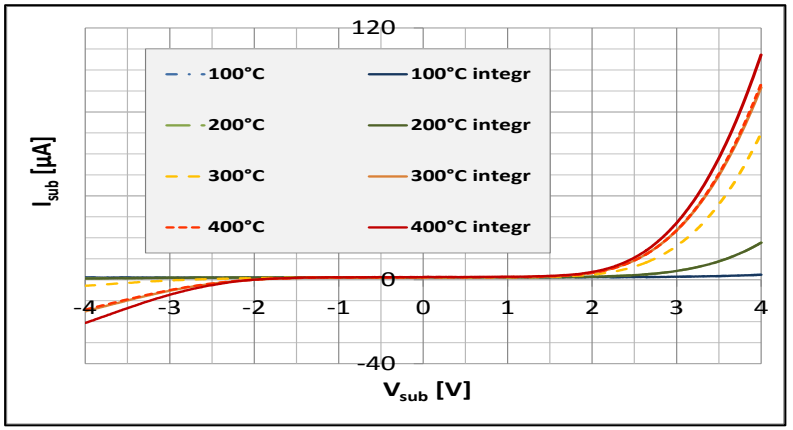
(C. Bur et al, poster session)

Integration of SiC-FET during LTCC processing





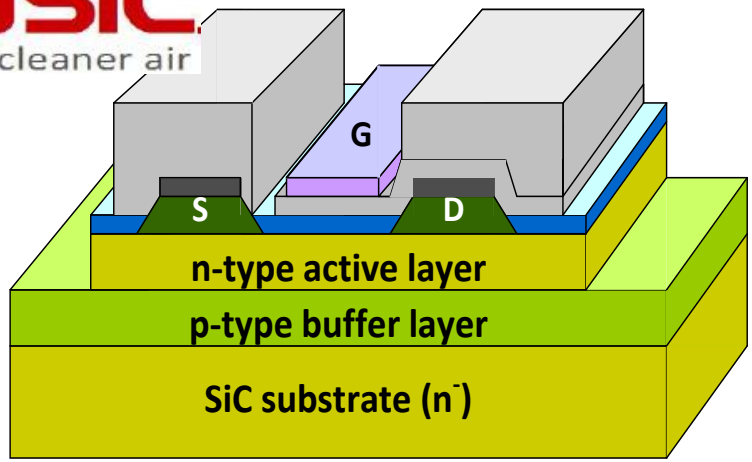


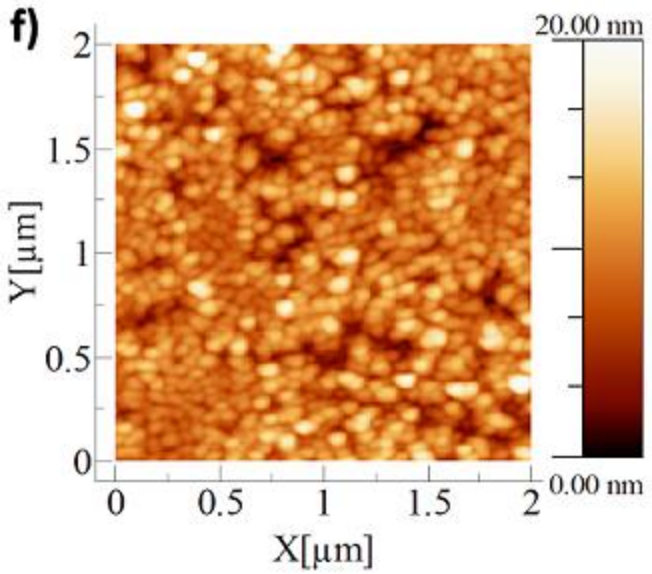


Direct, hermetic sensor integration

SiC-FETs and MOS gas sensors

SENSIC
Sensors for cleaner air





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

AFM micrograph of V_2O_5 + V_7O_{17} mixed phase material for MOS gas sensor for NH_3 sensing

Humidity content of nanparticle detector
Differential calorimeters

M. Tuhkala, J. Juuti, and H. Jantunen, Use of an open-ended coaxial cavity method to characterize powdery substances exposed to humidity, Applied Physics Letters 103 (2013) 142907

J. Kita, W. Missal, E. Wappler, F. Bechtold, R. Moos, Development of a miniaturized Ceramic Differential Calorimeter device in LTCC Technology, J. Ceramic Science and Technology, 04, 03 (2013)137-145
(Device based on 2 cavities, one is reference, the other is used to heat powder. The dynamic heat flux is measured)

Conclusions

- (Toxic gases and) airborne nanoparticles need to be monitored for environmental control
- LTCC technology is a powerful method for a cost efficient particle detecor
- The content of nanoparticles is important to measure. Our present approach is based on LTCC technology with integrated gas sensors and finger electrodes and measurement capability like impedance spectroscopy or heating particles and subsequent detection of the emissions

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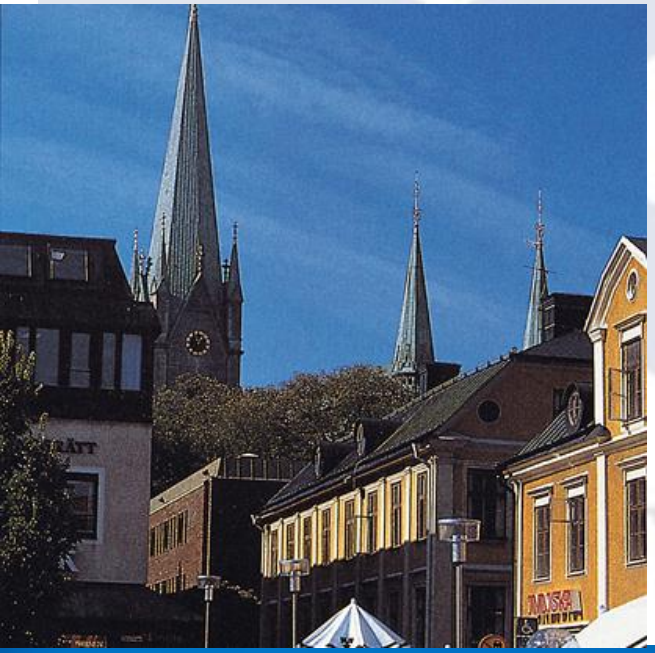

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