



COST

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

COST Action TD1105

WGs and MC Meeting at Cambridge, 18-20 December 2013

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

Year 2: 1 July 2013 - 30 June 2014 (*Ongoing Action*)



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Participant WG2 & SIG3

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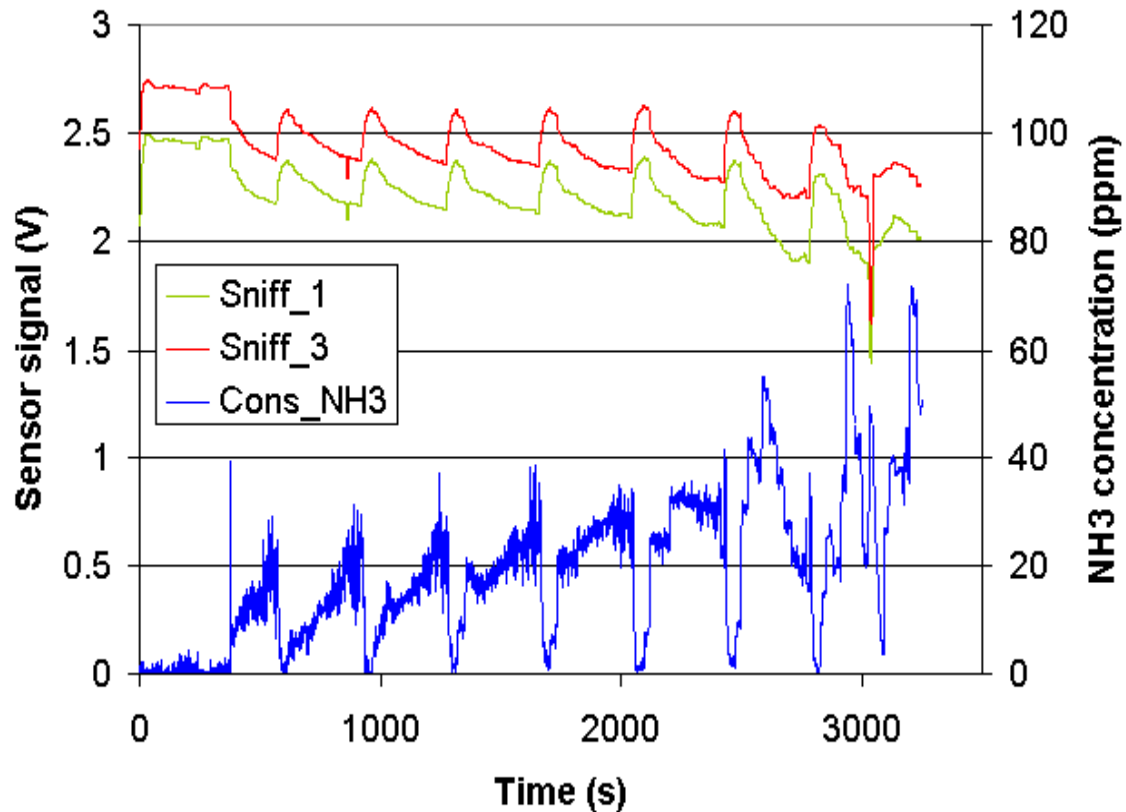
 **cost**
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



SiC-FET BASED SO₂ SENSORS FOR POWER PLANT APPLICATIONS

- SO₂ is a poisonous gas produced in power plants especially when burning low quality fuel. A cheap sensor system is required for control.
- SO₂ gives low response in SiC-FET sensors. Instead of hunting for new sensing layers, new sensor operation modes, like temperature cycling, may be used.
- The SiC-FET transducer platform is possible to mass produce with high performance and low price
- The project is related to **WG2** and **SIG3**

The SiC-FET ammonia sensor

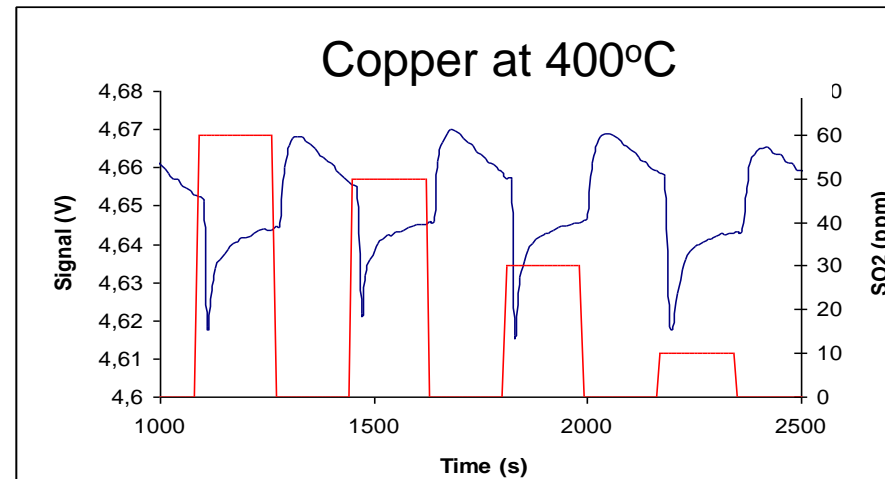
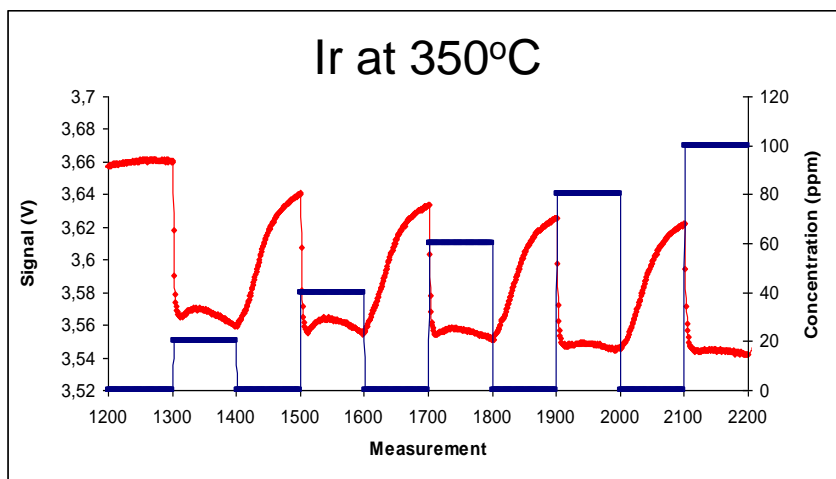
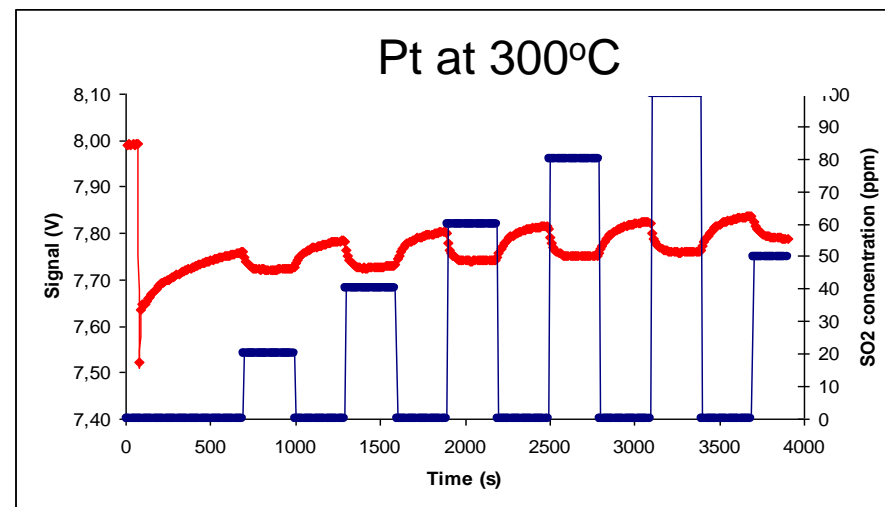
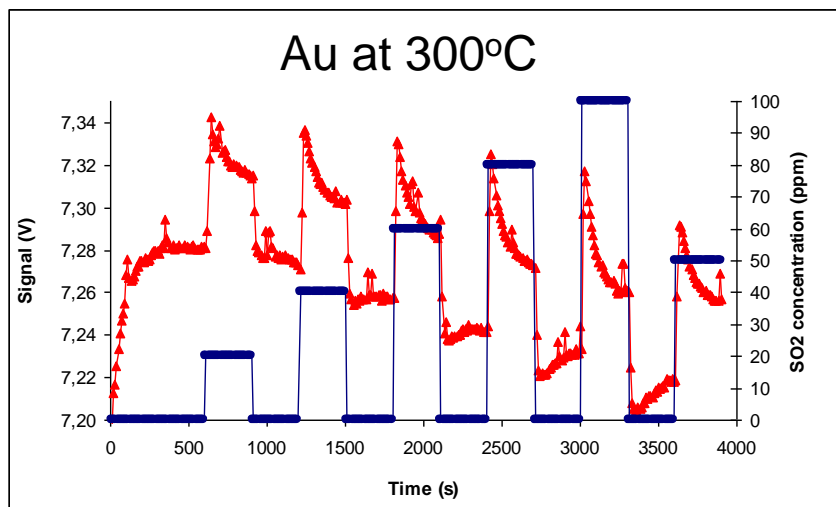


- Diesel engine measurement
- SCR system
- Two MISiCFET sensors and optical reference instrument

- 40ppm NH3 gives about 500 mV response.

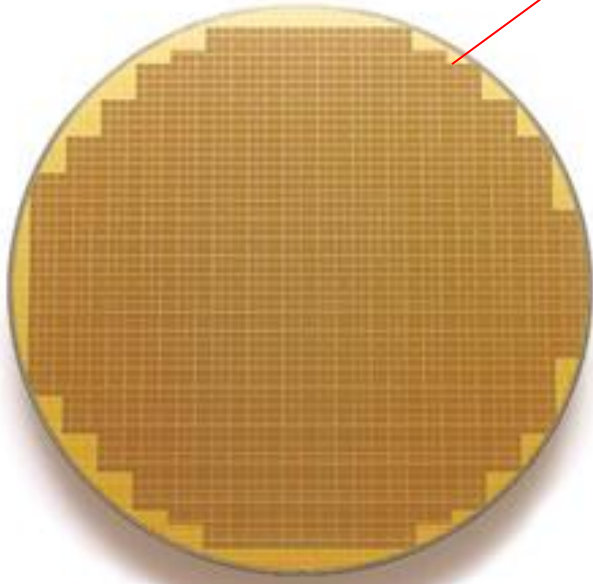
H. Svenningstorp, H. Wingbrant

Sensor Characterization – Static Operation

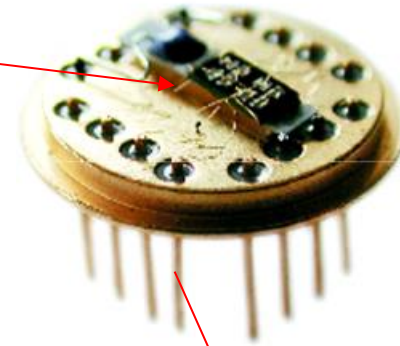
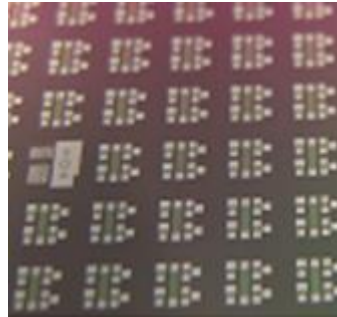


Sensor responds to 40 ppm SO₂: Au, Ir, Cu < 10 mV, Pt < 50 mV

SiC-FET sensor platform processing, mounting and electronics



4" SiC wafer, ~2000 chip



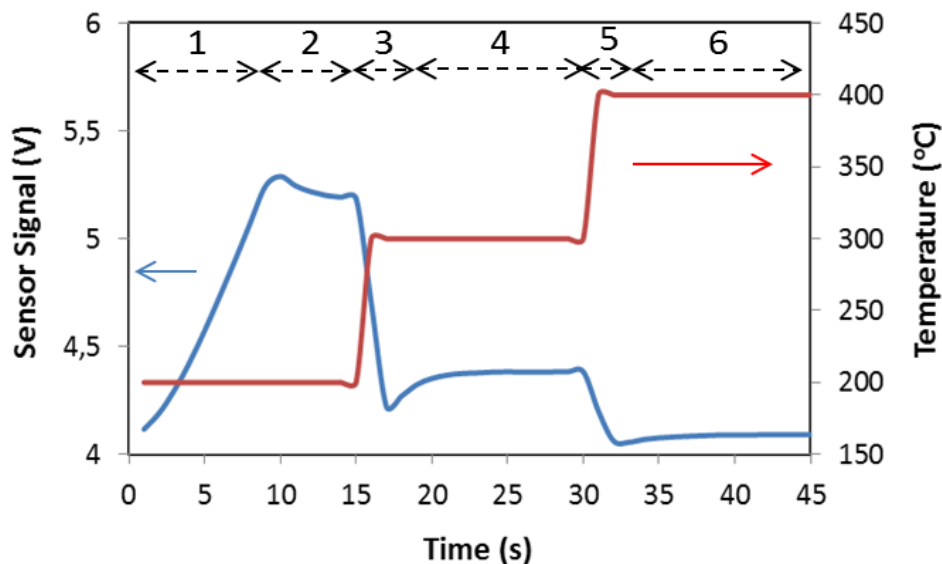
SiC-FET
sensor system



Processing on 4" SiC wafers using standard methods – low cost high quality transducer

SiC-FETs for detection of SO₂ using temperature cycling

Temperature cycle operation and multivariate data analysis,
LDA and PLS (in collaboration with Saarland University)



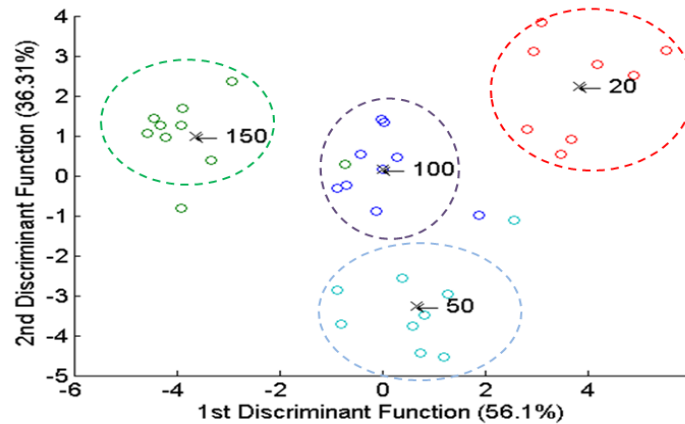
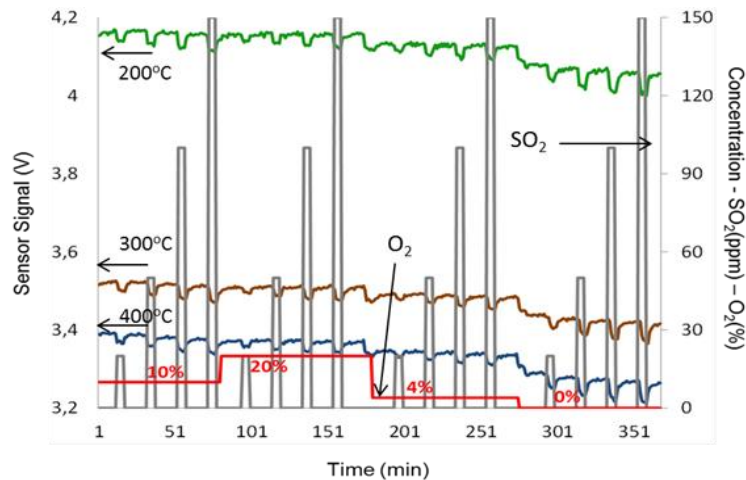
Dynamic operation at 3 different temperatures:

- 200°C, 300°C, and 400°C.

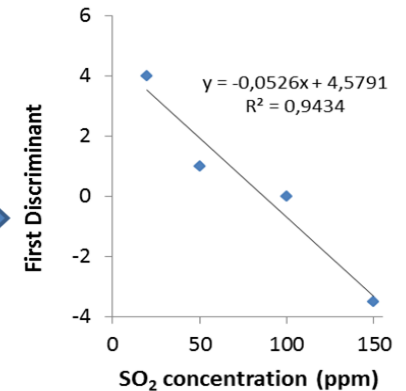
Response during the cycle divided into 6 intervals:

- Steady state intervals:
2 (200°C), 4 (300°C), 6 (400°C)
- Transient intervals between operating temperatures (1, 3, 5)

SiC-FETs for detection of SO₂ using temperature cycling



LDA

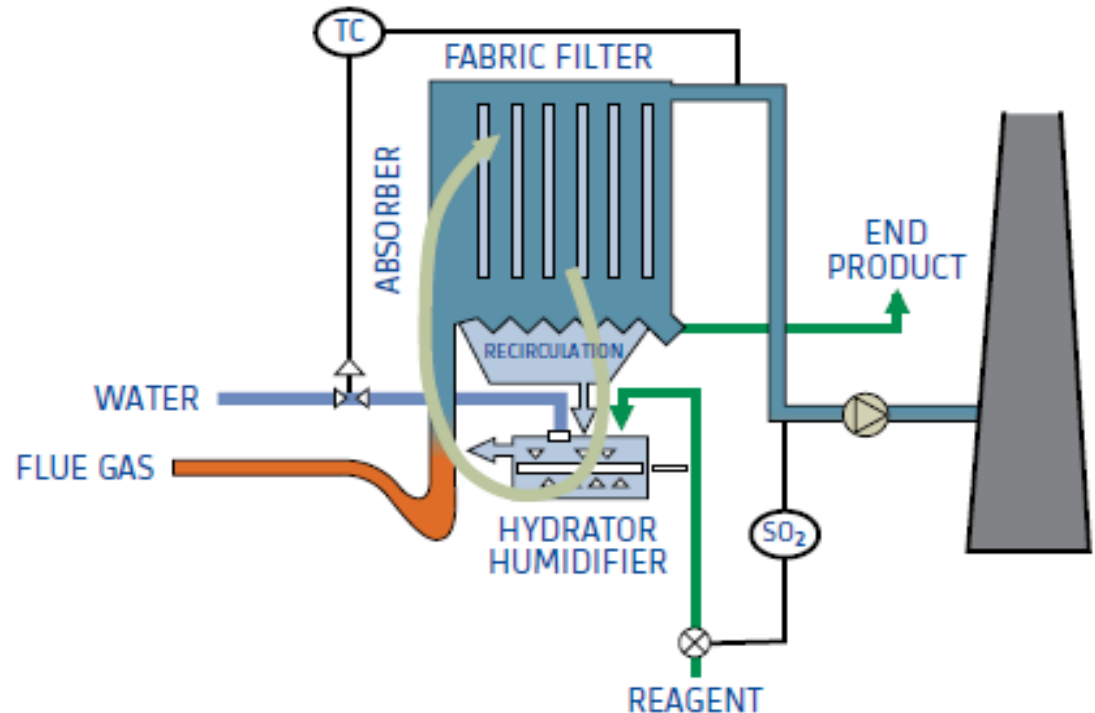


PLS

**Influence of oxygen concentration (4 or 10%)
Power plant application**

Pilot plant testing at Alstom

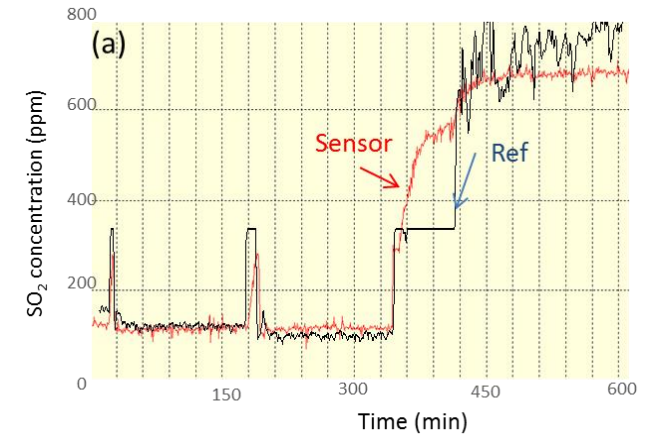
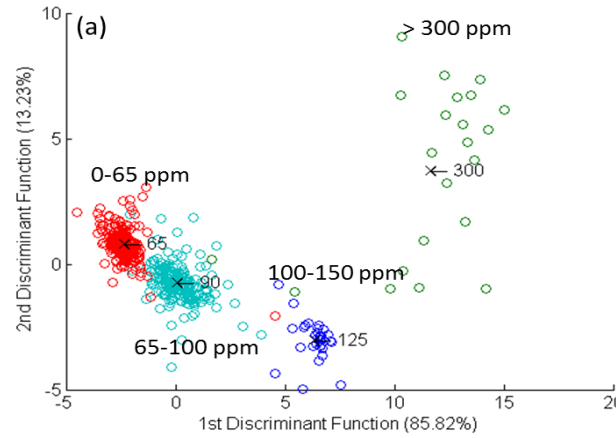
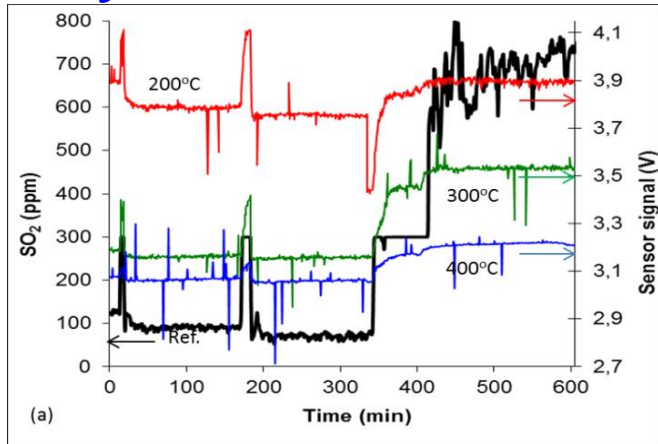
- Sensor installed at the outlet of the desulphurization pilot unit
- Other gases: N₂, O₂ (0-22%),
CO₂ (0-7%), H₂O (0-10%),
HCl (0-300 mg/Nm³ dg)
- Gas temperature: 60-170°C
- T cycling mode of operation:
200-400°C



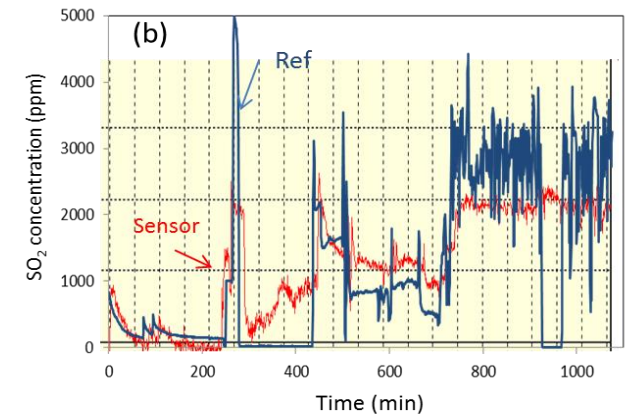
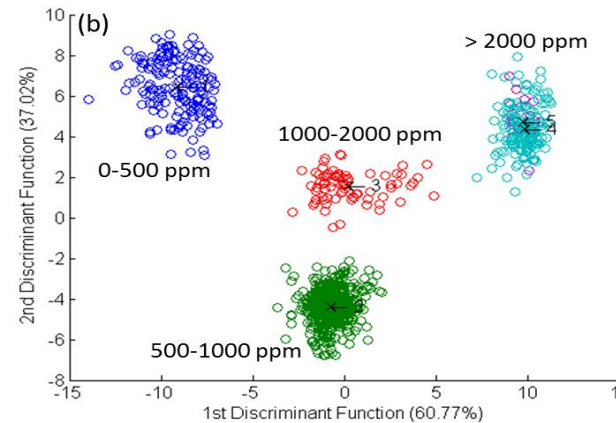
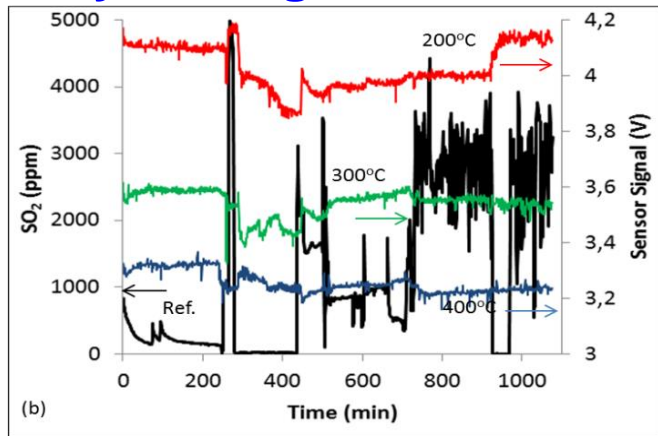
Z. Darmastuti, C. Bur, P. Möller, R. Rahlin, N. Lindqvist, M. Andersson, A. Schütze, and A. Lloyd Spetz, SiC-FET based SO₂ sensor for power plant emission applications, Sensors and Actuators B, in press.

Pilot plant testing at Alstom

Day 1 – Low concentration



Day 2 – High concentration



LDA

PLS





Current research activities

- SiC-FET gas sensors for harsh environment
 - Device layout
 - Sensing layers
 - Ohmic contacts
 - Applications together with industry (FunMat)
- Graphene based gas sensors for ultra low detection
- At University of Oulu in collaboration with Linköping University
 - Particle detector for personal use
 - CMOS based cell clinic for detection of toxic effect of particles



Research Facilities

- **Research Facilities:**
- Deposition systems for sensing layers, sputtering systems (multiple targets), thermal evaporation
- Sensor mounting facilities, e.g. bonding machine
- Gas mixing systems
- Analysis instruments: Environmental Mass spectrometer, Kelvin probe, (Environmental) AFM, SEM, TEM
- University of Oulu:
 - Particle generator