AGENDA

Wednesday, 10 September 2014

Engineering Campus, University of Brescia, Italy

09:30 - 12:30	***Open Session COST: New Sensing Technologies for Air-Quality Monitoring*** *Chairperson: Michele Penza*, ENEA, Brindisi, Italy
09:30 - 10:00	**COST Action TD1105: European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability. Overview of Sensor-Systems for Air Quality Monitoring** *Michele Penza*, Action Chair, ENEA, Brindisi, Italy
10:00 - 10:30	**Performance Analysis of Low-Cost Gas Sensors for Air Quality Control** *Michel Gerboles and Laurent Spinelle*, JRC, EC DG ENV, Institute for Environment and Sustainability, Ispra, Italy
10:30 - 11:00	**Break**
11:00 - 11:20	**Gas and Particle Sensors for Air Quality Monitoring** *Anita Lloyd Spetz,* Action Vice-Chair, Linkoping University, Linkoping, Sweden
11:20 - 11:40	**Nanostructured Metal Oxides Low-Cost Gas Sensors: Trends and Challenges** *Juan Ramon Morante*, Action WG1 Leader, IREC, Barcelona, Spain
11:40 - 12:00	**Highly Sensitive and Selective VOC Detection for Indoor Air Quality Applications** *Andreas Schuetze*, Action WG2 Leader, Saarland University, Saarbrucken, Germany
12:00 - 12:20	**Smart Sensors in Mobile Phones for Environmental Monitoring Applications** *Julian W. Gardner*, Action MC Substitute, University of Warwick, Coventry, UK

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

COST Action TD1105

OPEN SESSION COST *EuNetAir* on

New Sensing Technologies for Air Quality Monitoring

CORE-GROUP MEETING at EUROSENSORS-2014 Conference

University of Brescia, Engineering Campus, Brescia, Italy, 10 September 2014

COST Action TD1105: OVERVIEW OF SENSOR-SYSTEMS FOR AIR-QUALITY MONITORING

Michele Penza

Chair of COST Action TD1105

ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development / Brindisi, ITALY

COST is supported by the EU Framework Programme

ESF provides the COST Office through a European Commission contract

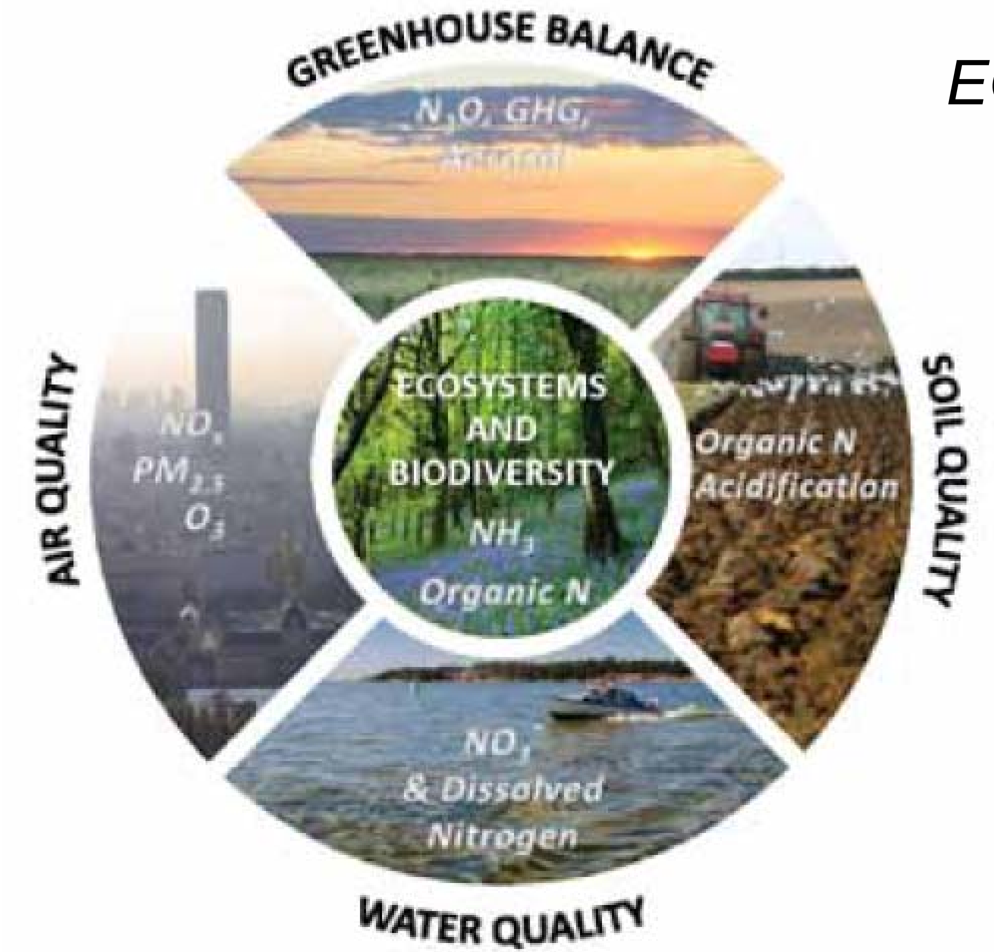
OUTLINE

- **PROBLEM STATEMENT**: *Air Pollution*
- **S&T CONTEXT**:
  - ✓ **Sensor Materials**
  - ✓ **Sensor Technologies**: *Proofs-of-concept and devices*
  - ✓ **Applications**: *Indoor and Outdoor*
- **COST Action TD1105 EuNetAir**:
  - ✓ **Results versus Objectives:** *Significant Highlights*
  - ✓ **Future Plans and Challenges:** *Expected Impact*
- **CONCLUSIONS**

Scientific context: Environmental Sustainability (1/3)

Nitrogen Pollution and the European Environment
Implications for Air Quality Policy

EC In-Depth Report, September 2013



Source: Sutton and Billen, 2010

Excess reactive nitrogen represents a major environmental threat that is only now beginning to be fully appreciated. At a global level, humans have more than doubled the production and cycling of reactive nitrogen, leading to a plethora of impacts that interact across all global spheres: atmosphere, biosphere, hydrosphere and geosphere.

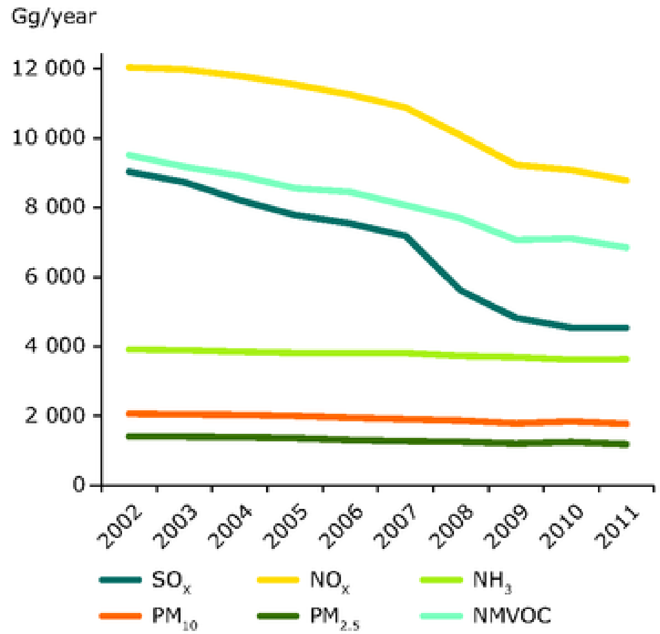
Sutton et al., 2009

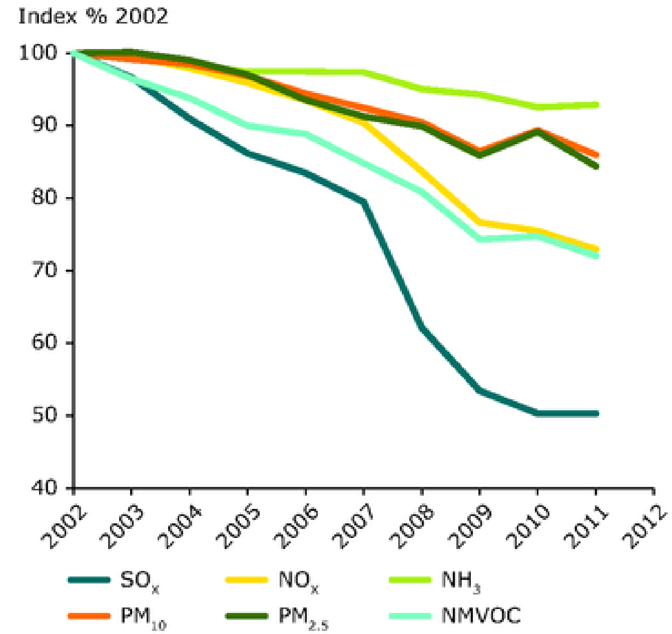
Nitrogen Pollution:

NO_x, N_2O, NH_3, NH_4, NO_2^-, NO_3^-, etc.

Scientific context: Air Quality Control (2/3)

European Environment Agency, EEA Report 9/2013



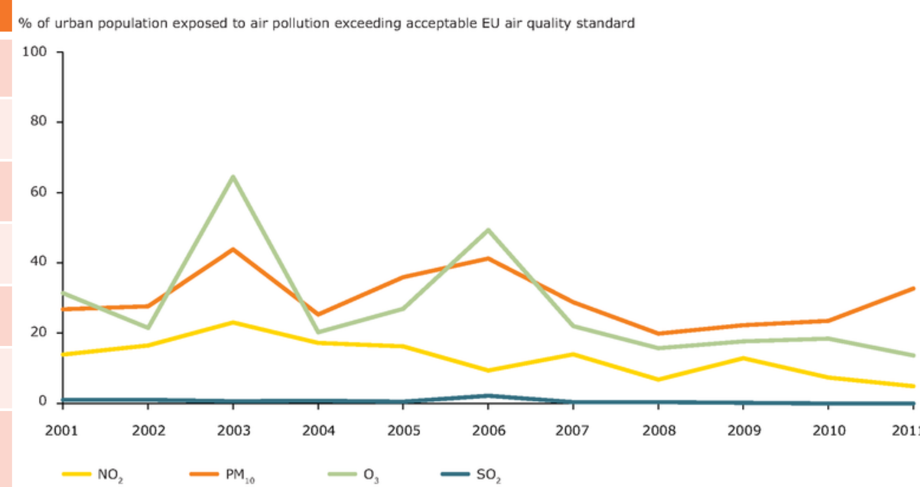


Some Environmental Emergencies:

- 1930 - Meuse Valley (Belgium)
- 1952 - Great London Smog (UK)
- 1954 - Los Angeles (USA)
- 1984 - Bhopal (India)
- 2005 - Teheran (Iran)
- 2006 - Hong Kong (China)
- 2008 - Shanghai, Peking (China)
- 2012 - Taranto (Italy)
- ....

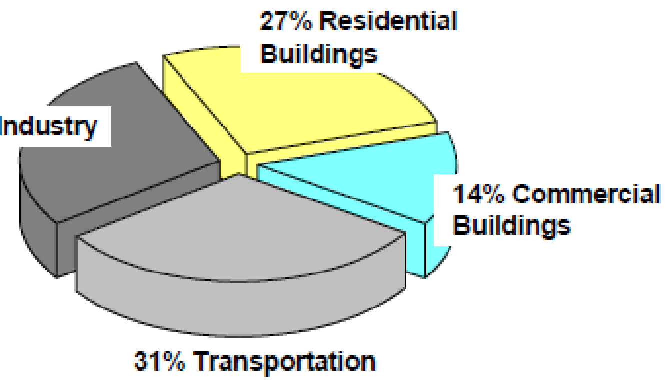
AMBIENT AIR QUALITY EU DIRECTIVE 2008/50/EC and Daughters

Pollutant	Limit Level
NO_x	100, 200 ppb
CO	8 ppm
SO_2	130, 190 ppb
O_3	120 μg/m³
PM_{10}	50 μg/m³
BTEX	6 μg/m³
PAH (BaP)	1 ng/m³
$PM_{2.5}$	25 μg/m³



cost EUROPEAN COOPERATION I

Scientific context: Indoor/Outdoor Energy Efficiency (3/3)



Primary energy consumption in the EU[1]

[1] O. Seppanen,

11th Conference on Indoor Air Quality

2008, Copenaghen, Denmark

41% Primary Energy consumed in Buildings:

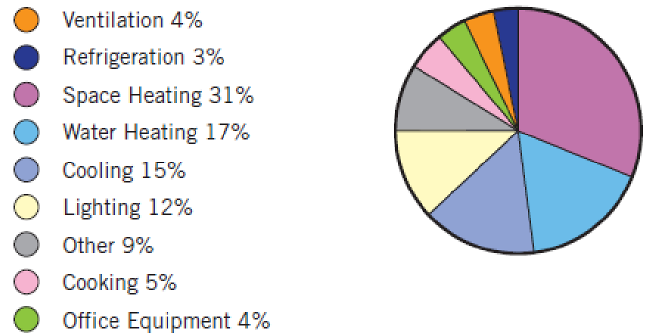
- **2/3 in Residential Buildings**
- **1/3 in Commercial Buildings**

Energy Performance of Buildings EU Directive

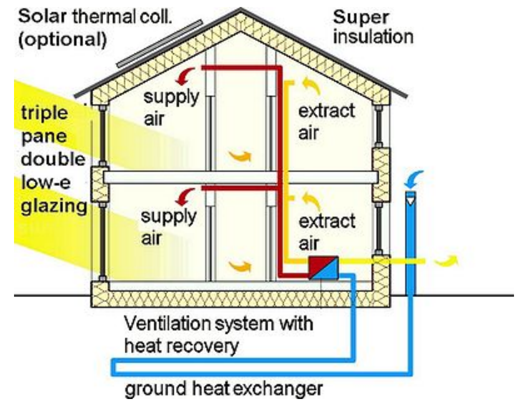
EPBD 2010/31/EC

Figure 2 – Total Energy Consumption by End Use

Adapted from E Source, 2006



Source: Environmental Protection Agency's National Action Plan for Energy Efficiency Sector Collaborative on Energy Efficiency Hotel Energy Use Profile



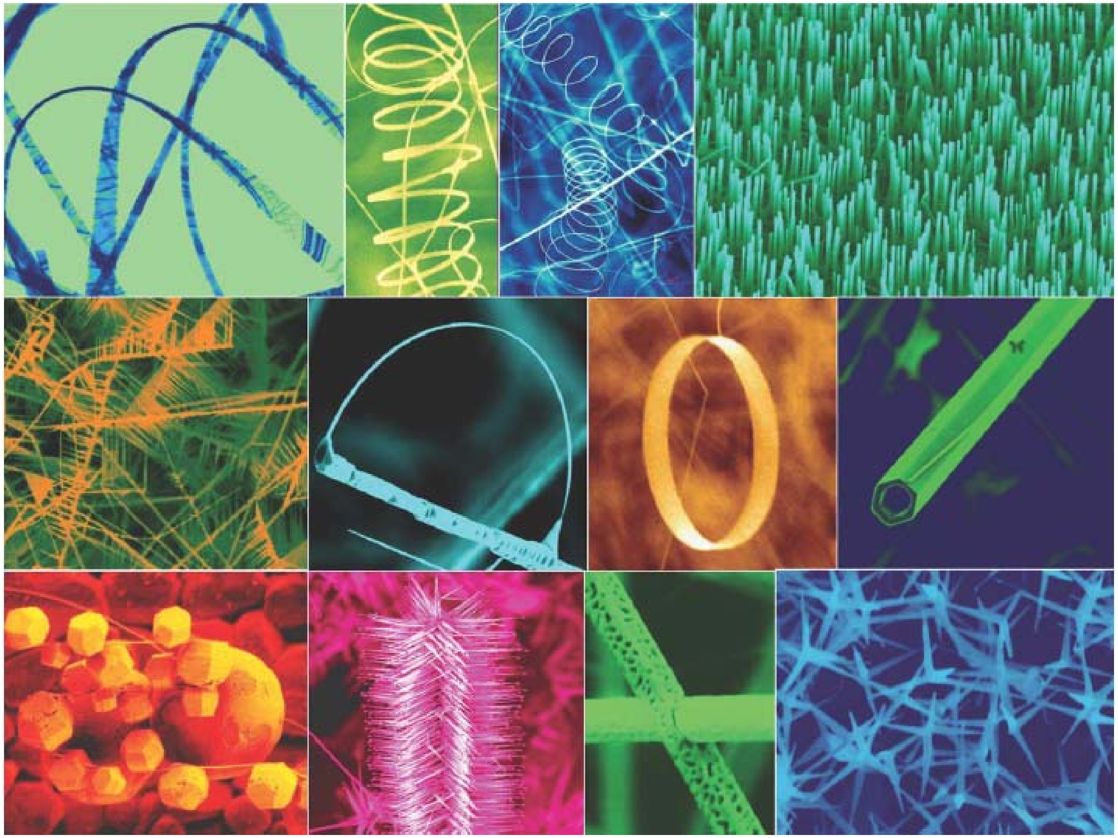
IAQ by WORLD HEALTH ORGANIZATION

Indoor Air		Typical Substances		Cure
Contamination Source	Emission Source	VOCs	Others	
• Human Being	• Breath	Acetone, Ethanol, Isoprene		demand controlled ventilation
		CO_2		
		Humidity		
	• Skin Respiration & Transpiration	Nonanal, Decanal, α-Pinene		
		Humidity		
	• Flatus	Methane, Hydrogen		
	• Cosmetics	Limonene, Eucalyptol		
	• Household Supplies	Alcohols, Esters, Limonene		
	• Combustion (Engines, Appliances, Tobacco Smoke)	Unburnt Hydrocarbons		
		CO		
		CO_2		
		Humidity		
• Building Material • Furniture • Office Equipment • Consumer Products	• Paints, Adhesives, Solvents, Carpets	Formaldehyde, Alkanes, Alcohols, Aldehydes, Ketones, Siloxanes		permanent 5-10% ventilation
	• PVC	Toluene, Xylene, Decane		
	• Printers, Copiers, Computers	Benzene, Styrene, Phenole		

Table 1 – Typical Indoor Air Contaminants (VOCs and others)

SENSOR MATERIALS

FOR AIR QUALITY CONTROL



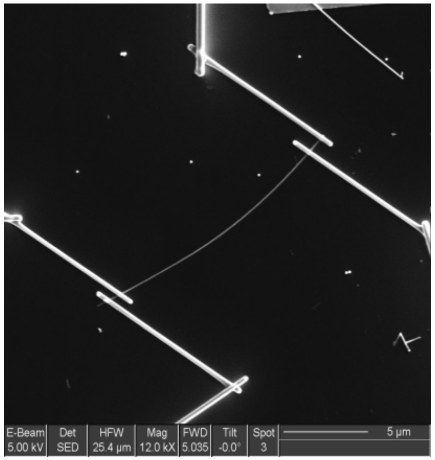
Nanostructures by Z. L. Wang, Materials Today 144 (2004) 26-33

SENSOR MATERIALS FOR AIR QUALITY CONTROL

Sensor Technology	Sensitivity	Selectivity	Stability	Fabrication	Sensing Mechanisms
Metal Oxides Thin Films	*Good*	*Poor*	*Moderate*	*Good*	Chemisorption Physisorption Charge Transfer Catalytic, Spillover
Metal Oxides Nanostructures	*Excellent*	*Poor*	*Good*	*Good*	Chemisorption Physisorption Catalytic, Spillover
Carbon Nanotubes	*Excellent*	*Poor*	*Good*	*Good*	Intertube Modul. Intratube Modul. Catalytic, Spillover
Graphene	*Good*	*Poor*	*Moderate*	*Good*	Chemisorption Physisorption Charge Transfer Catalytic, Spillover
Conducting Polymers	*Good*	*Poor*	*Moderate*	*Good*	Chemical doping Chemical gating Deprotonation
Nanocomposites	*Good*	*Poor*	*Moderate*	*Good*	Chemical gating Deprotonation Catalytic

SENSOR MATERIALS FOR AIR QUALITY CONTROL:

FUNCTIONAL NANOMATERIALS (1/9)

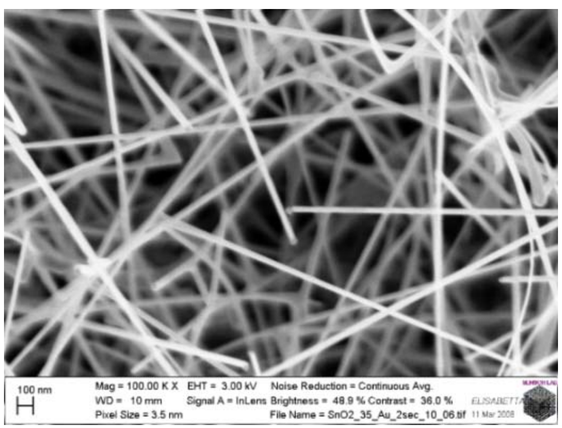


Self-heating SnO_2 Nanowire

by University of Barcelona and IREC

NO_2 (0.5 - 10 ppm) and CO (10 - 100 ppm) detection

J.D. Prades et al., Sensors and Actuators B 144 (2010) 1-5



Metal Oxide (SnO_2) Nanowire Nets

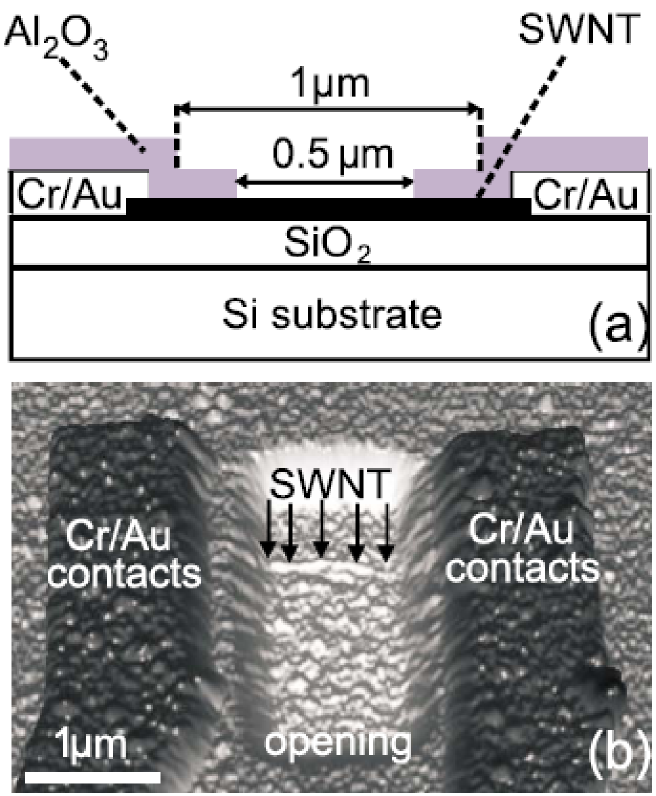
by University of Brescia

NO_2 (0.1 - 10 ppm) and CO (10 - 100 ppm) detection

E. Comini and G. Sberveglieri, Materials Today, 13 (2010) 36-44

SENSOR MATERIALS FOR AIR QUALITY CONTROL:

FUNCTIONAL NANOMATERIALS (2/9)



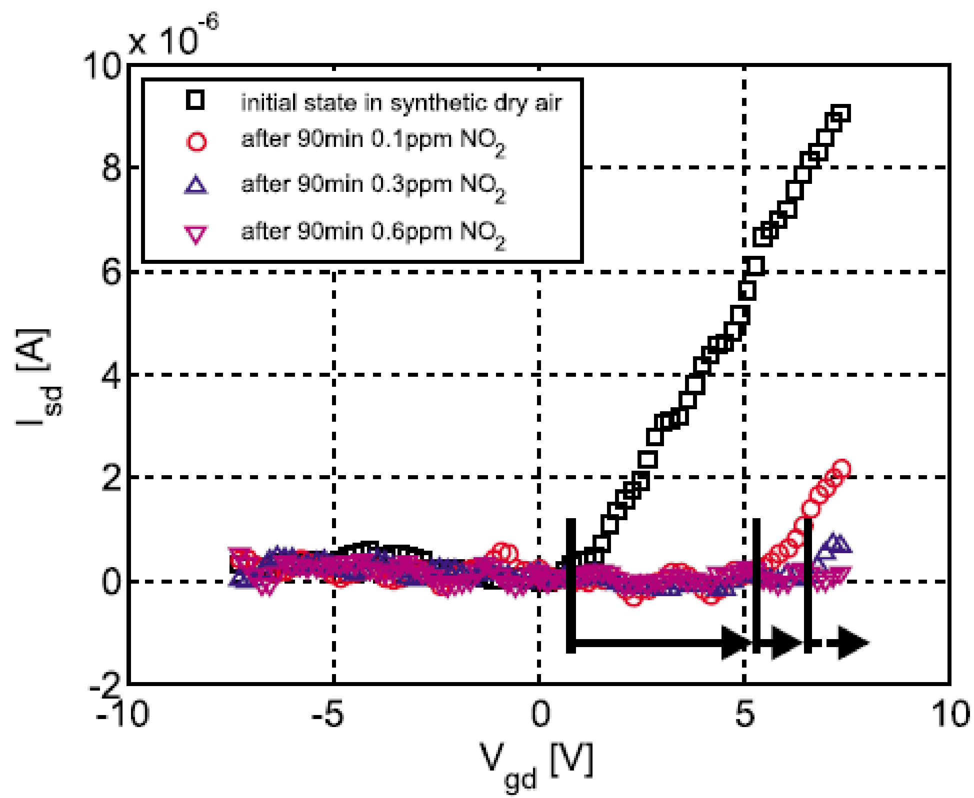
Individual pristine SWCNT integrated in FET

Single-Walled Carbon Nanotube FET

by ETH Zurich and Siemens AG Munich

NO_2 (0.1, 0.3, 0.6 ppm) detection

M. Mattmann et al., APL 94 (2009) 183502



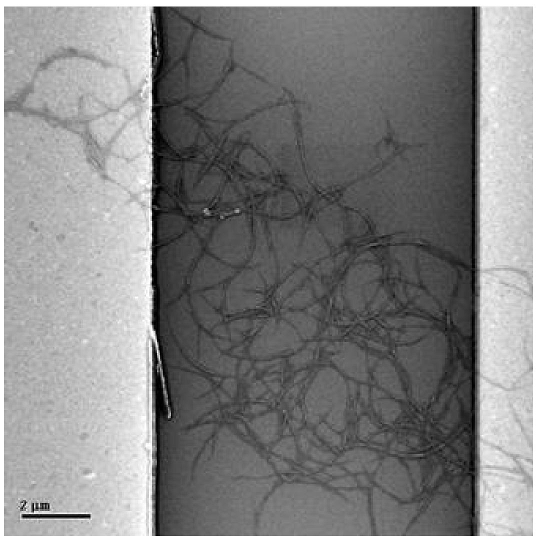
SENSOR MATERIALS FOR AIR QUALITY CONTROL

Single-Walled Carbon Nanotube Nets

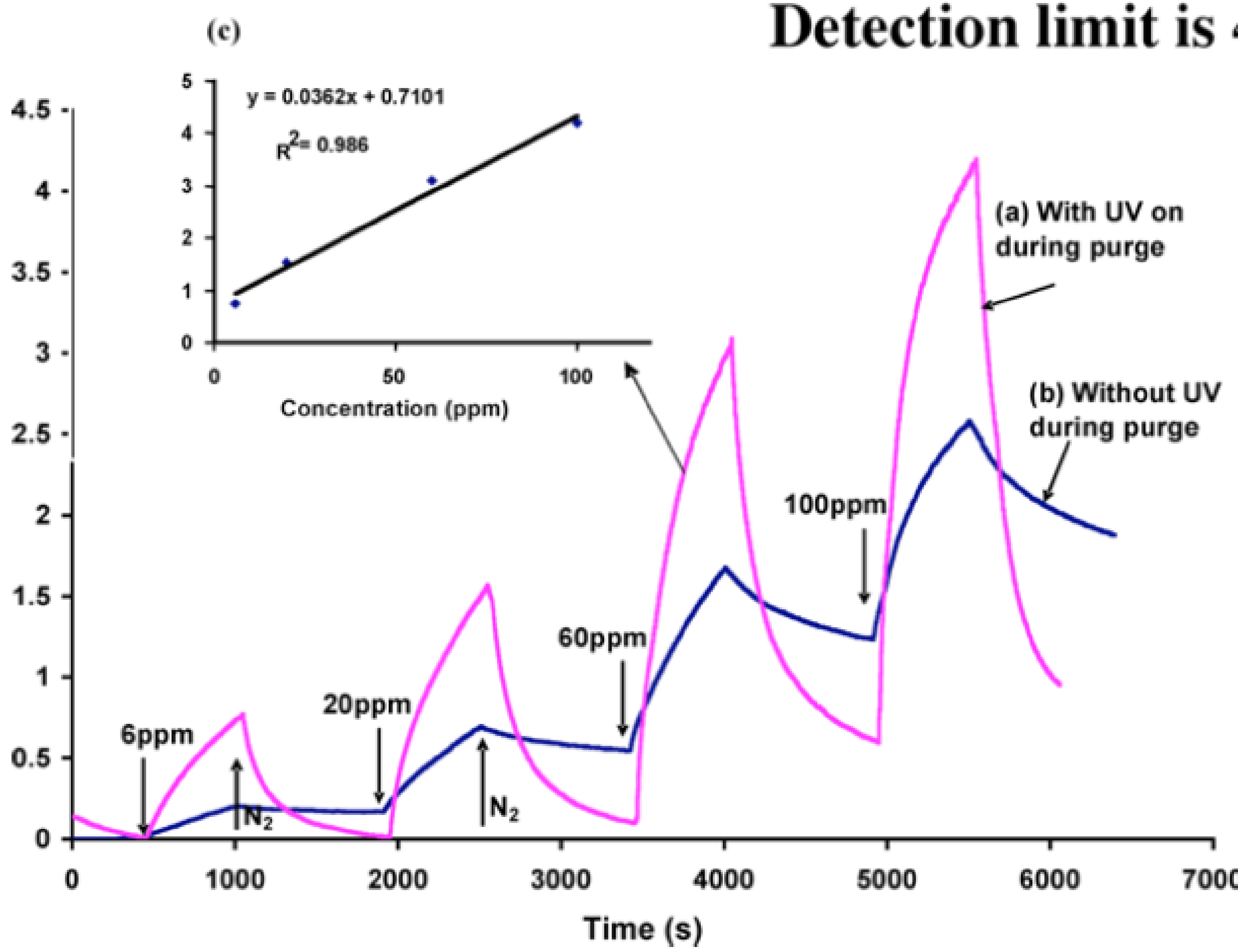
by NASA Ames Research Center, Moffett Field, USA

Detection Limit: 44 ppb NO_2; 262 ppb Nitrotoluene. UV light purge

J. Li et al., Nanoletters 3(7) (2003) 929-933



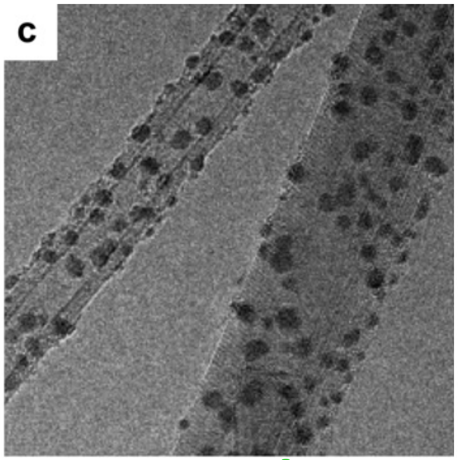
Detection limit is 44ppb.



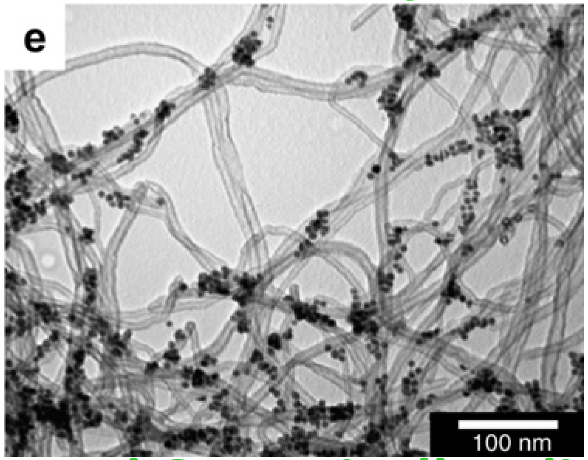
SENSOR MATERIALS FOR AIR QUALITY CONTROL

Metal-Decorated Multi-Walled Carbon Nanotube Nets

Pd-MWCNTs



Rh-MWCNTs by Universitat Rivira I Virgili, Tarragona, Spain



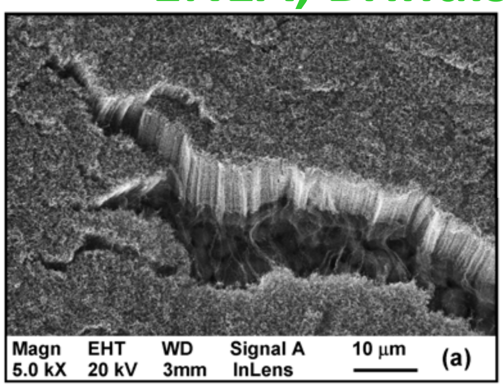
Detection Limit: 50 ppb Benzene (C_6H_6)

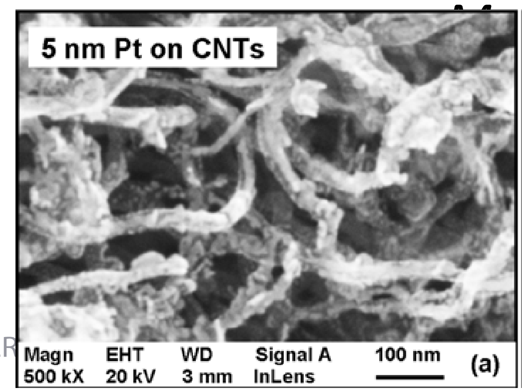
R. Leighrib, Carbon 48 (2010) 3477-3484

Metal-Decorated & Vertically-Aligned Multi-Walled Carbon Nanotube Nets

ENEA, Brindisi, Italy. Detection: 0.33-3.3 ppm NO_2 in LFG (CO_2, CH_4, NH_3, H_2)

M. Penza et al., Nanotechnology 21 (2010) 105501





Pt-MWCNTs

SENSOR MATERIALS FOR AIR QUALITY CONTROL

Graphene

University of Manchester, UK. Molecular Detection: ppb NO_2 by 2-pole device

F. Schedin et al., Nature Materials 6 (2007) 652-655

Detection of individual gas molecules adsorbed on graphene

Nobel Prize in Physics 2010

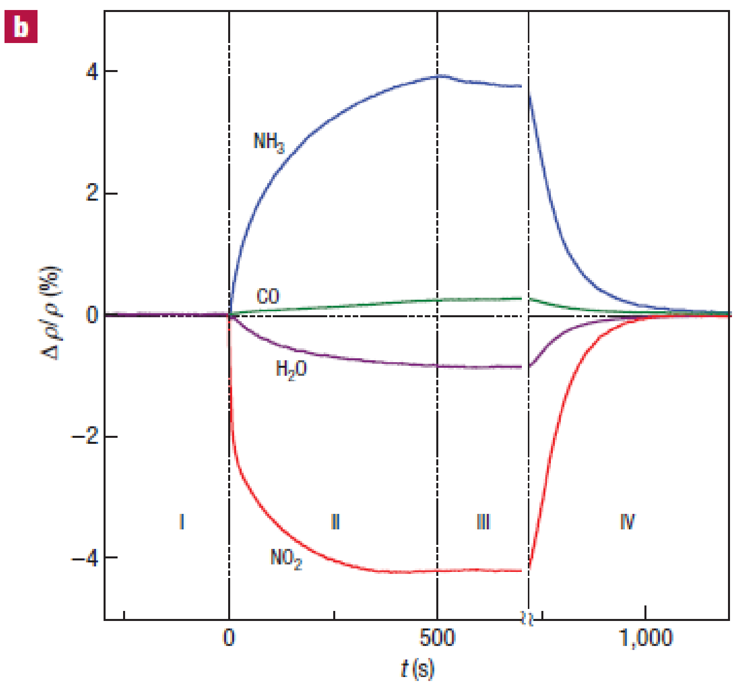
F. SCHEDIN[1], A. K. GEIM[1], S. V. MOROZOV[2], E. W. HILL[1], P. BLAKE[1], M. I. KATSNELSON[3] AND K. S. NOVOSELOV[1]*

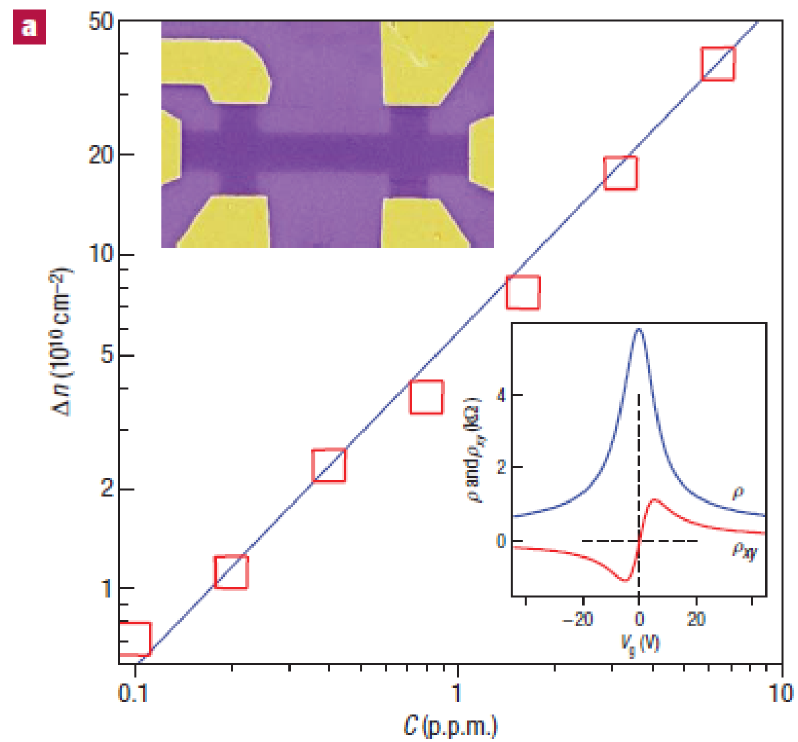
[1]Manchester Centre for Mesoscience and N

[2]Institute for Microelectronics Technology,

[3]Institute for Molecules and Materials, Univ

*e-mail: Konstantin.Novoselov@mancheste





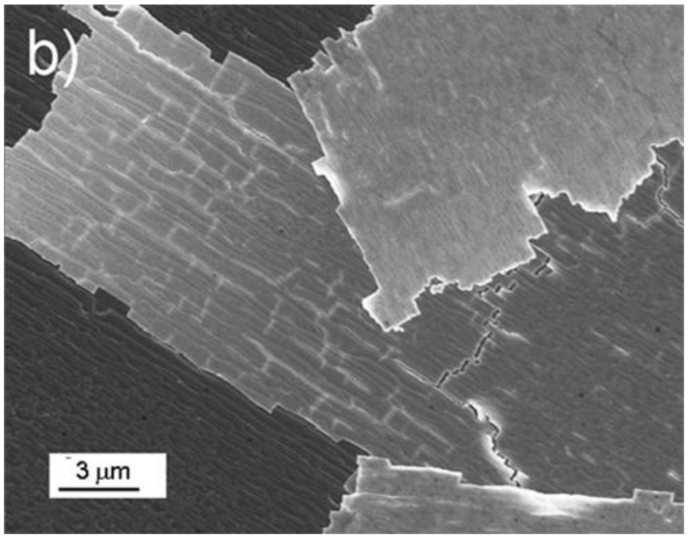
SENSOR MATERIALS FOR AIR QUALITY CONTROL

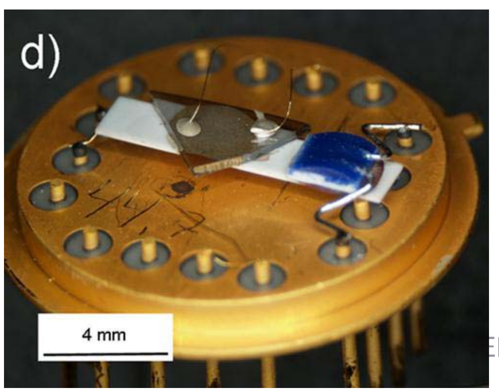
Graphene

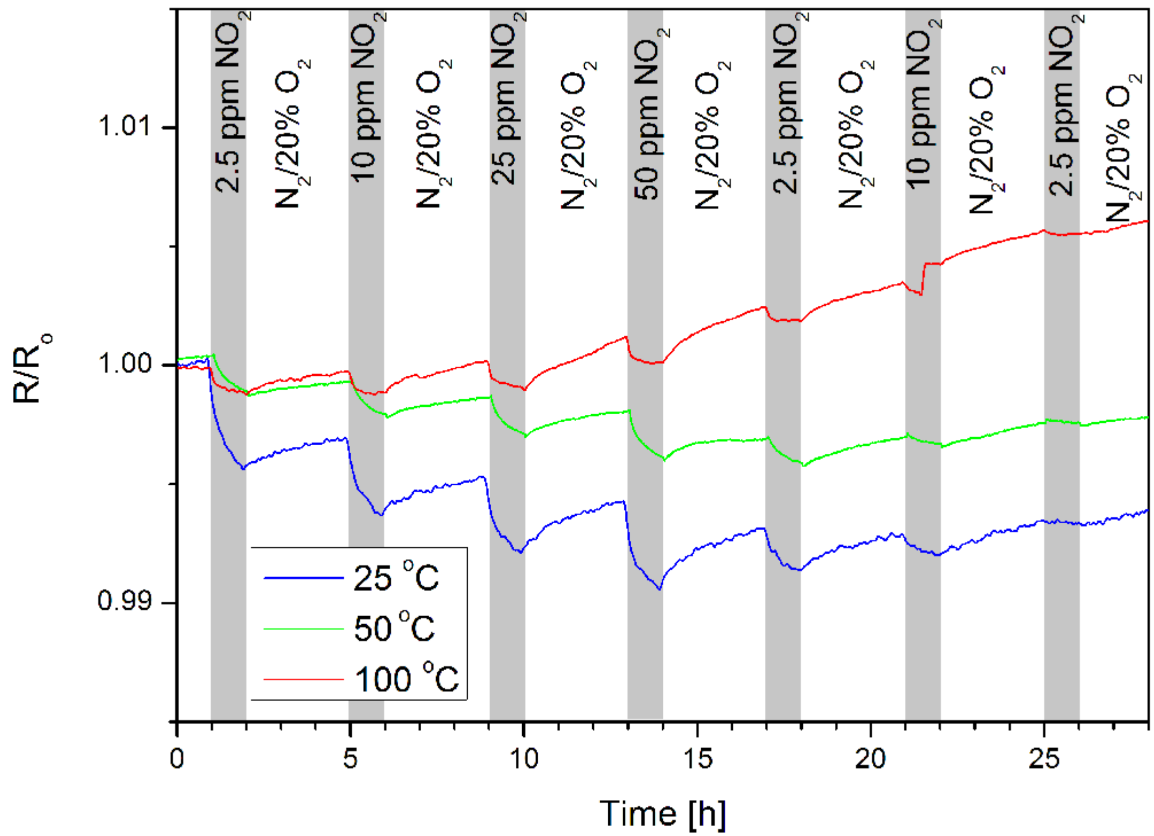
by Linkoping University, Sweden. Detection: sub-ppm NO_2 by SiC-device

R. Pearce et al., Sensors and Actuators B 155(2) (2011) 451-455

Flakes of multi-layer Graphene







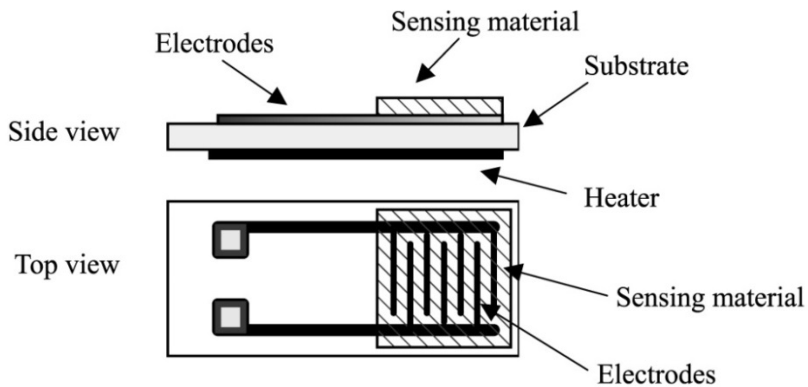
Epitaxial Graphene grown on SiC substrate for NO_2 gas sensor

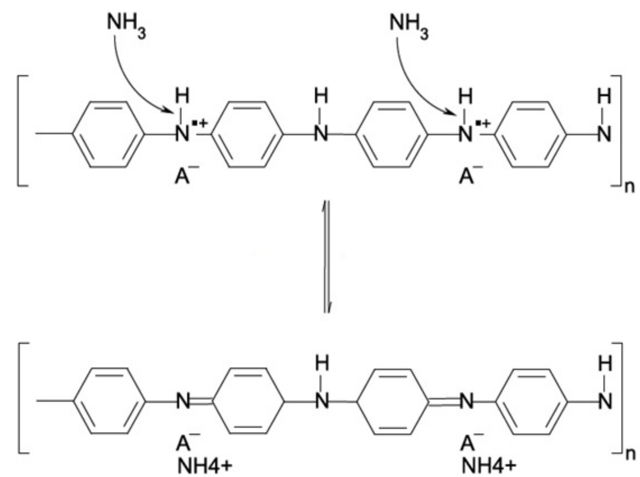
SENSOR MATERIALS FOR AIR QUALITY CONTROL

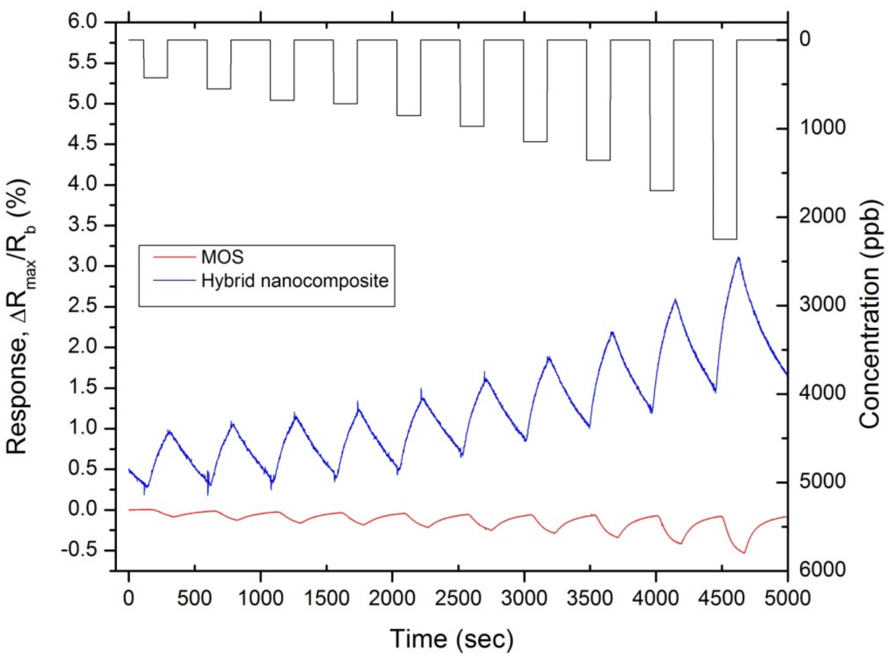
Conducting Polymers

University of Machester, UK. Detection: ppb NH_3 by Polyaniline device

K. C. Persaud et al., Chemical Senses 21 (1996) 495-505







NH_3 range: 100 - 3000 ppb

Real-time NH_3 test in field successful for measuring trace levels

Commercial ammonia MOS sensor: from Synkera Technologies, Inc.

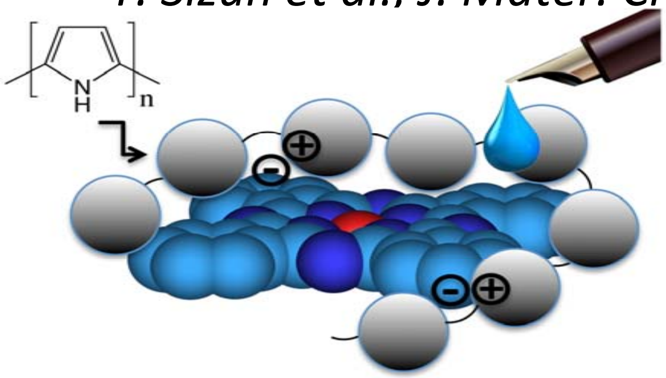
Hybrid nanocomposite, dip-coated on Kapton® @ 80 °C

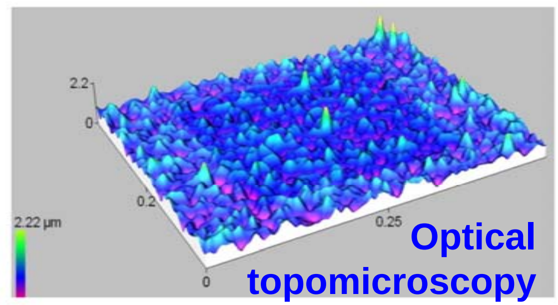
SENSOR MATERIALS FOR AIR QUALITY CONTROL

PolyPyrrole-sCo-Phthalocyanine Hybrid Material

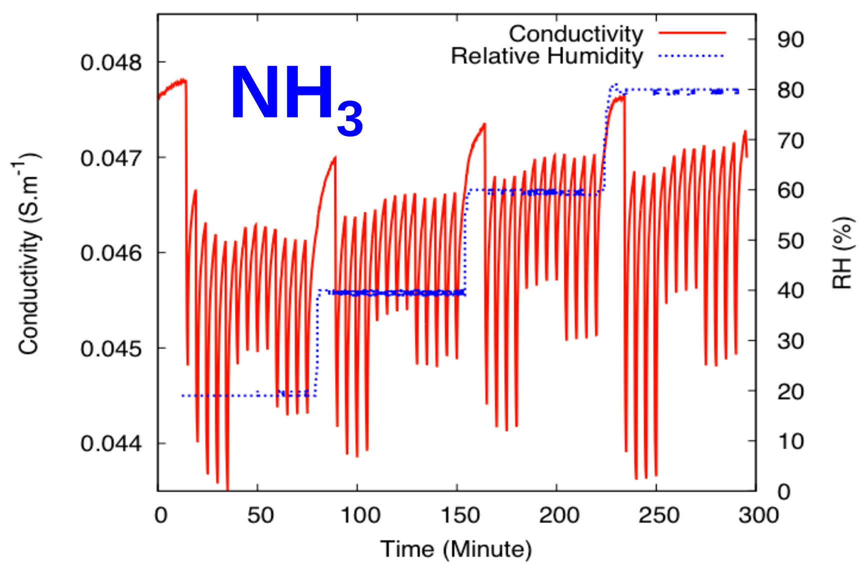
University of Burgundy, France. Detection: ppm NH_3 at low RH cross-sensitive

T. Sizun et al., J. Mater. Chem. 22 (2012) 254246-25253





High stability of the response to NH_3 in a broad range of RH



NH_3 detection range: 10 - 100 ppm

WG1 PRIORITIES: Sensor Materials and Nanotechnology

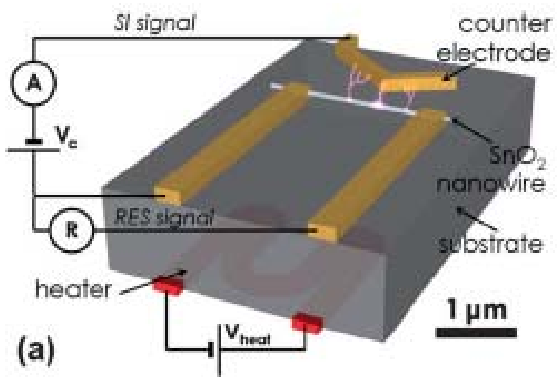
WG1-Leader:	• **Prof. Juan Ramon Morante, IREC, Barcelona, Spain** • **Prof. Jyrki Lappalainen, Oulu University, Finland** **(*Rome and Cambridge Meeting WG1 Chair*)**
WG1 Composition:	**3 Sub-WG Leaders and 30 Members**

PRIORITY #1:	**Metal Oxides (MOX)**: Thin Films, Nanoparticles, Nanowires, Nanotubes, Nanoneedles, Nanoporous Forms of Materials (ZnO, SnO_2, WO_3, TiO_2, InO_x, NiO, and magnetic materials Fe_3O_4, doped dielectrics $BaSrTiO_3$, etc.)
PRIORITY #2:	**Carbon Nano MATerials (CNMAT):** Nanotubes, Nanoparticles, Graphene, 1D and 2D-nanostructures and their functionalization and doping
PRIORITY #3:	**Molecular, Organic/Inorganic Materials**: Heterostructures (semiconductors, polymers) and Schottky junctions
PRIORITY #4:	**Processing of low-cost sensors on flexible substrates**: •Printing techniques, inkjet printing, spin coating, droplet casting, etc. •Template assisted growth of nanostructures
PRIORITY #5:	**Other sensitive materials**: biomaterials, enzymes, antibodies, etc.
PRIORITY #6:	**Chemical modifications** of the sensor materials with tuned properties to address selectivity and specific applications
PRIORITY #7:	**Combination of different approaches** and defining the state-of-art of the best available technologies, for example, to realize smart sensor structures

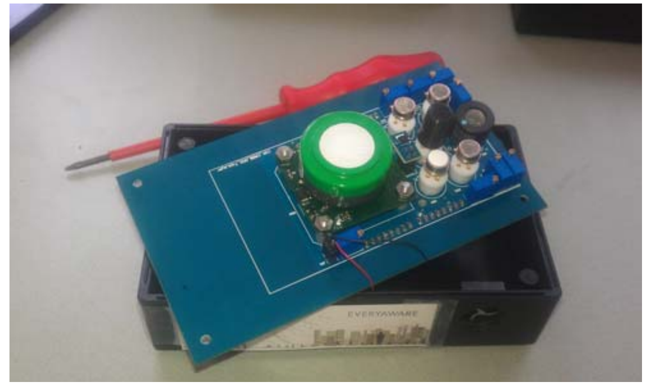
SENSOR TECHNOLOGIES

PROOFS-OF-CONCEPT

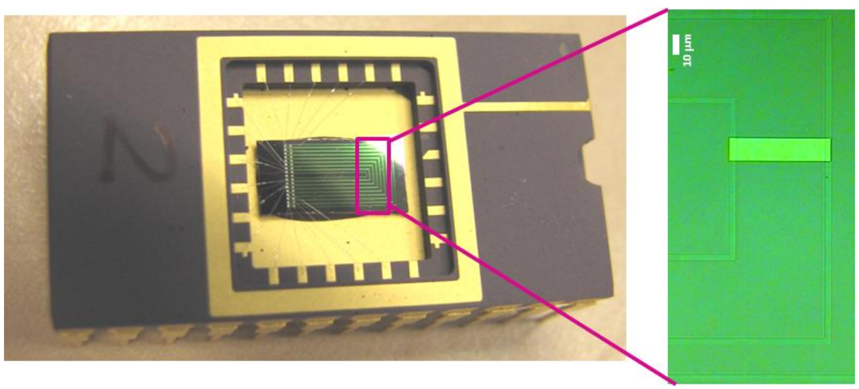
by IREC



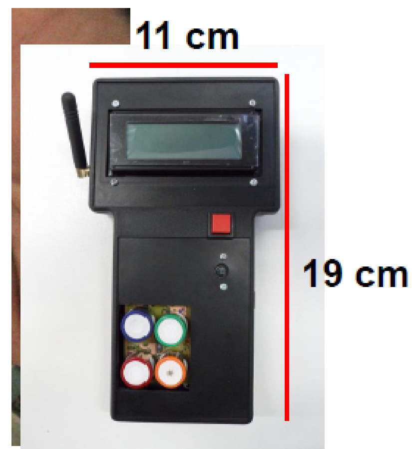
by VITO



by IMEC



by ENEA

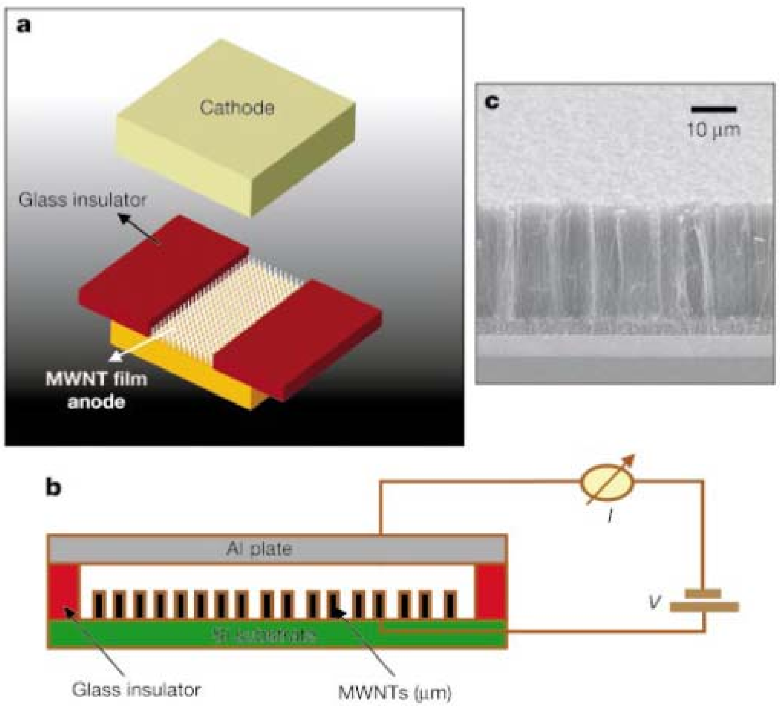


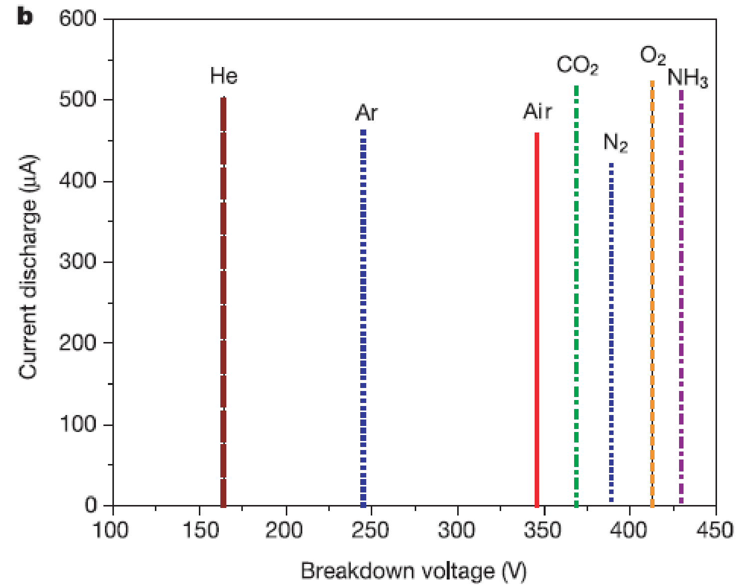
SENSOR TECHNOLOGIES: *Proofs-of-Concept*

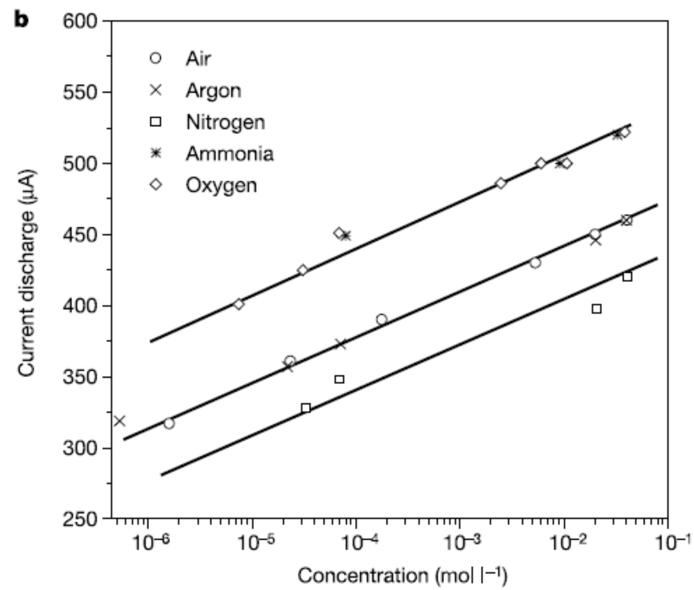
SURFACE IONIZATION GAS SENSOR (SIGS) (1/3)

A. Modi et al., Nature 424 (July 2003) 171-174

MWCNT SIGS







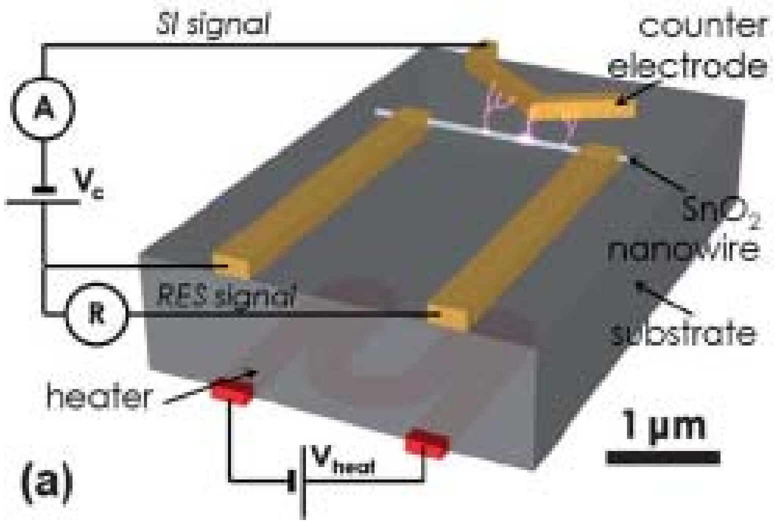
Electrode separation: 20 - 130 μm
Breakdown Voltage: 350 - 1050 V
High Voltage Operation !
High Sensitivity and Selectivity !

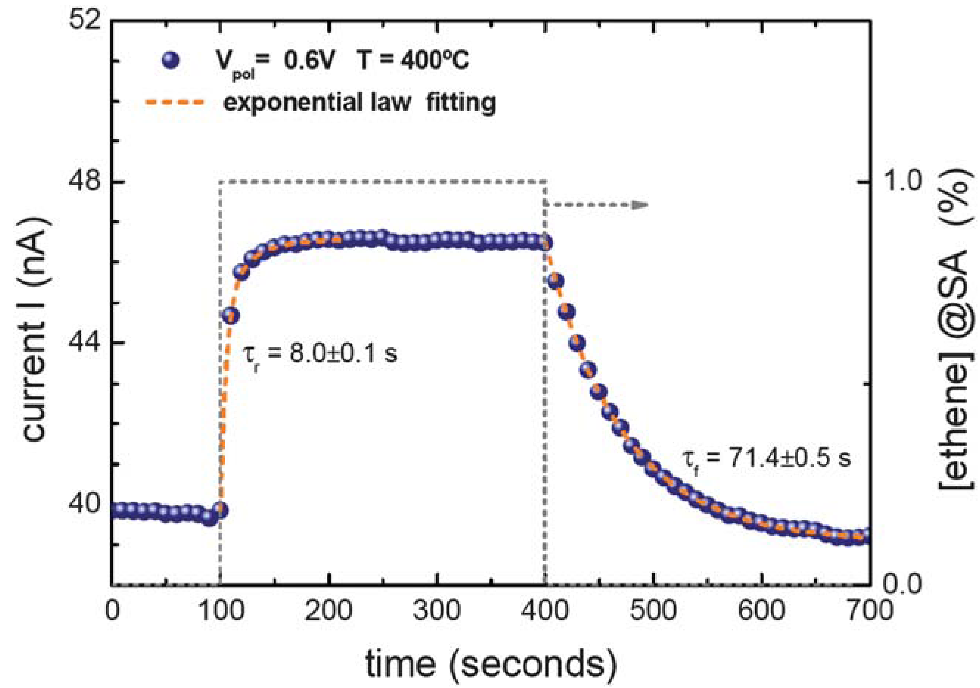
SENSOR TECHNOLOGIES: *Proofs-of-Concept*

SURFACE IONIZATION GAS SENSOR (SIGS) (2/3)

F. Hernandez et al., Nanoscale 3 (2011) 630-634

Individual SnO_2 Nanowire SIGS with a Vertical Counter Electrode





Courtesy from IREC

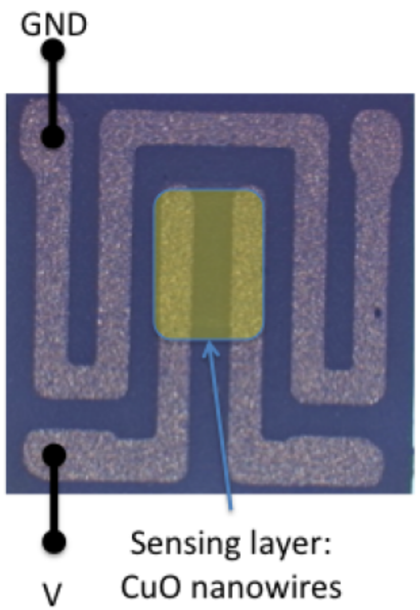
Tested Gases: 1% Ethene; 100 ppm NO_2, 1000 ppm CO
Electrode separation: ~ 1 µm
Breakdown Voltage: 0.5 - 5 V
Sensor Operating Temperature: 200 - 400°C
Low Voltage Operation !
High Sensitivity and Enhanced Selectivity

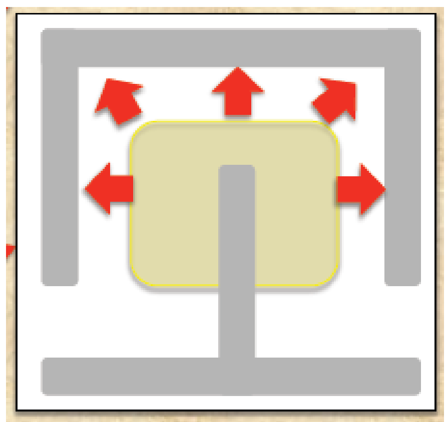
SENSOR TECHNOLOGIES: *Proofs-of-Concept*

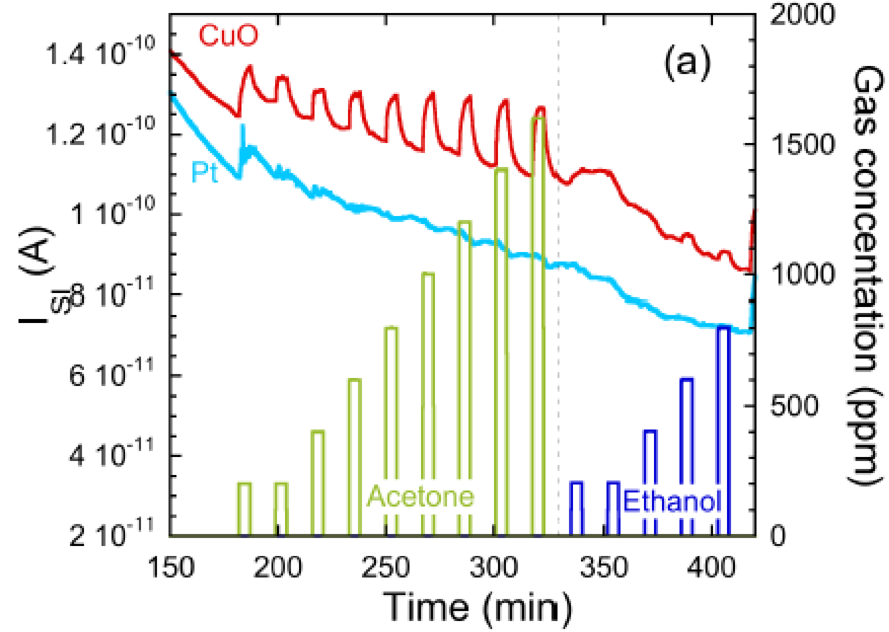
SURFACE IONIZATION GAS SENSOR (SIGS) (3/3)

A. Ponzoni et al., IMCS-2012 Proceedings (2012) 391-394

Bundle CuO Nanorods SIGS with a Planar Counter Electrode







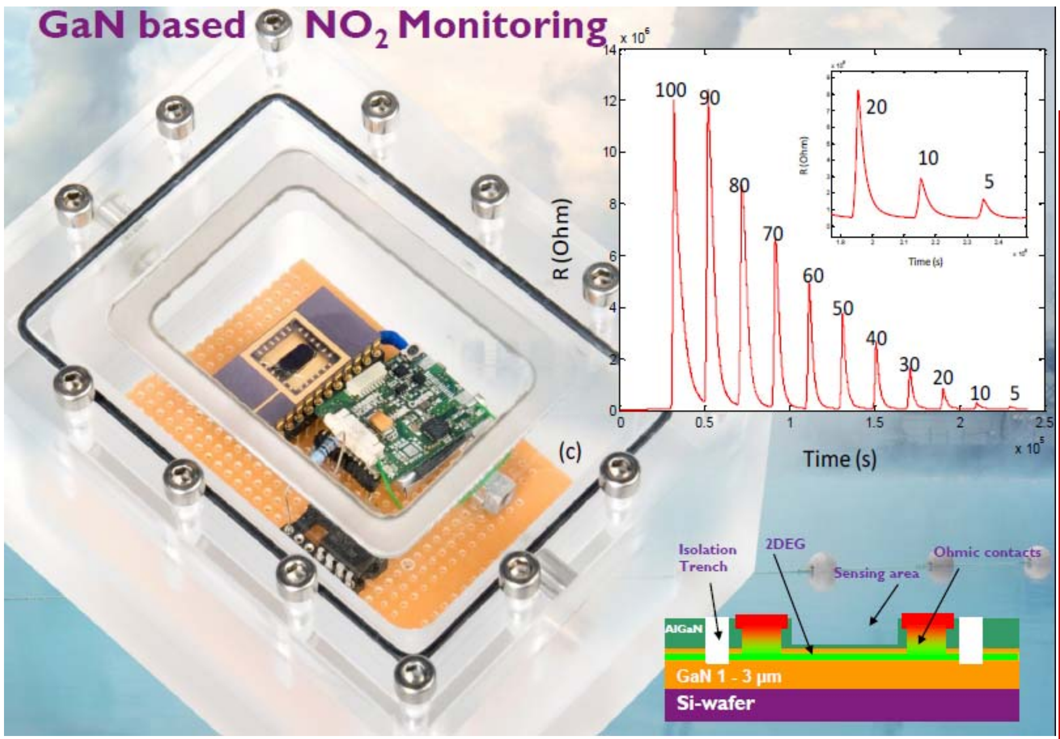
Courtesy from University of Brescia

Test Gases: 100-1600 ppm Acetone; 100-800 ppm EtOH
Electrode separation: ~ 10 μm
Breakdown Voltage: 10 - 50 V (~ 150 kV/m)
Sensor Operating Temperature: 200 - 400°C
Low Voltage Operation compared to other Planar SIGS
High Sensitivity and Enhanced Selectivity

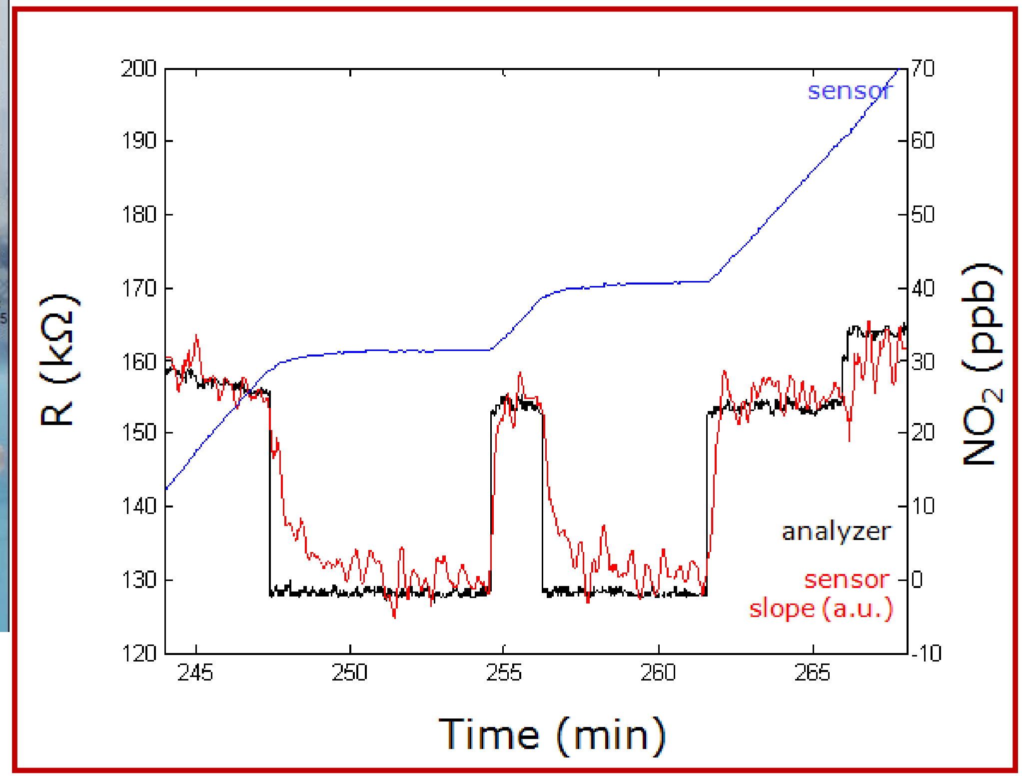
SENSOR TECHNOLOGIES: *Proofs-of-Concept*

GaN/AlGaN NO_x ppb GAS SENSOR

R. Van Schaijk et al., COST Brindisi Workshop, 25-26 March 2014



Comparison NO_2 Sensor with NO_x Chemiluminescence Analyzer



Courtesy from IMEC

Slope based detection allows FAST response: 20 sec. for 25 ppb NO_2

EUROPEAN COOPERATION IN SCIENCE AND

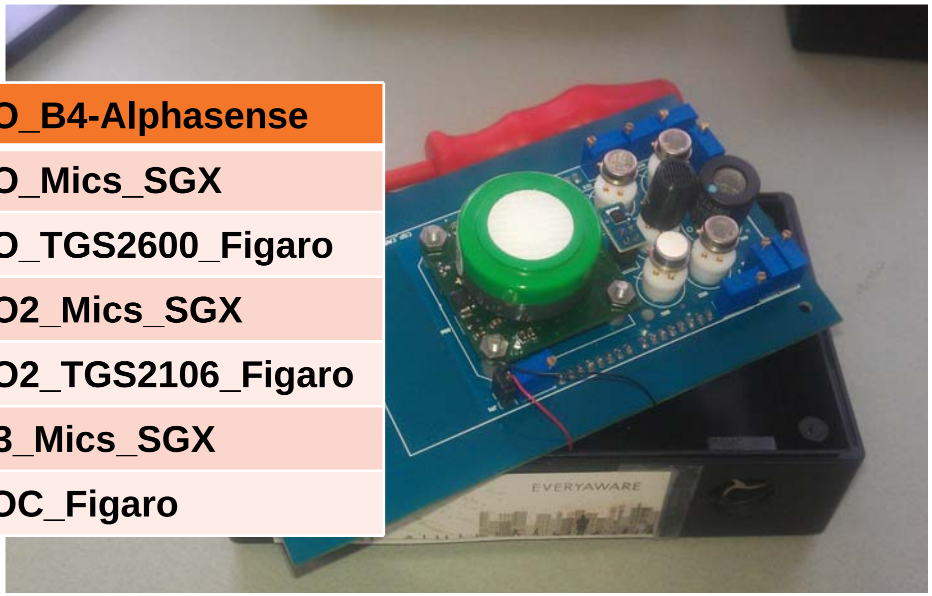
SENSOR TECHNOLOGIES: *Proofs-of-Concept*

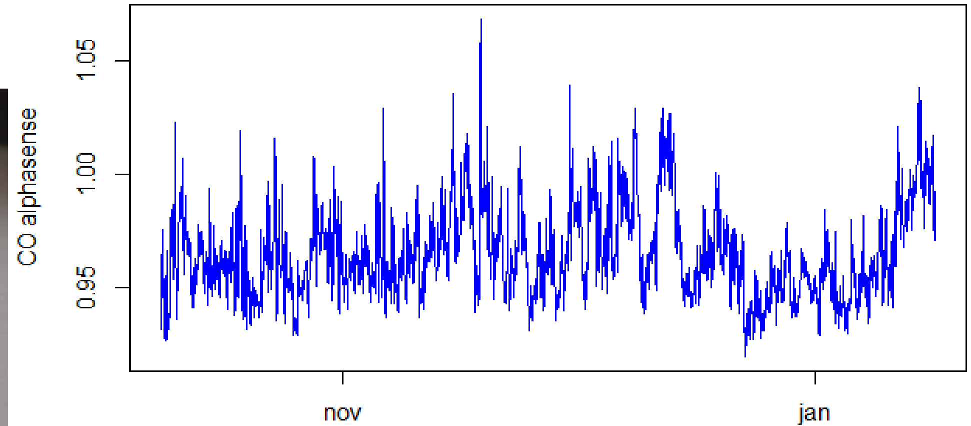
EveryAware GAS SENSOR BOX

J. Theunis et al., COST Barcelona Workshop, 20 June 2013

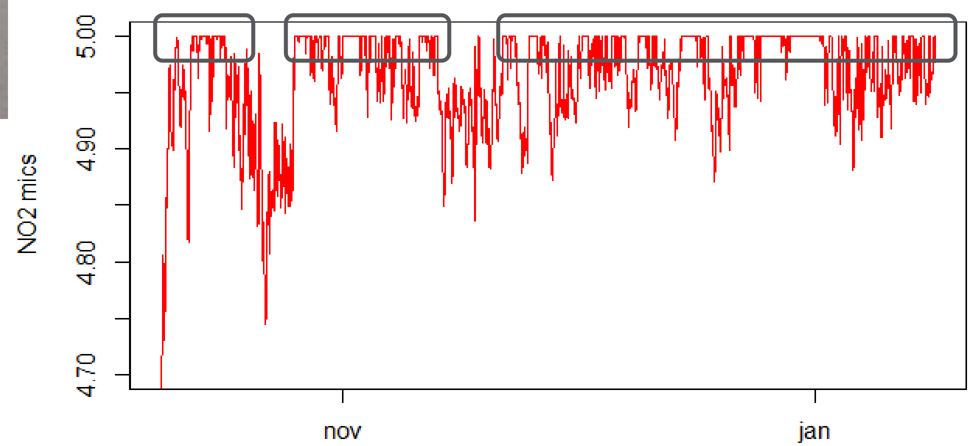
Courtesy from VITO

- **CO_B4-Alphasense**
- **CO_Mics_SGX**
- **CO_TGS2600_Figaro**
- **NO2_Mics_SGX**
- **NO2_TGS2106_Figaro**
- **O3_Mics_SGX**
- **VOC_Figaro**





3 month campaign



7 sensors (<u>6 MOX+ 1 EC</u>) to detect traffic pollution (e.g., CO, NO_2, VOC) Ozone, T and RH

SENSOR TECHNOLOGIES: *Proofs-of-Concept*

NASUS GAS SENSOR BOX

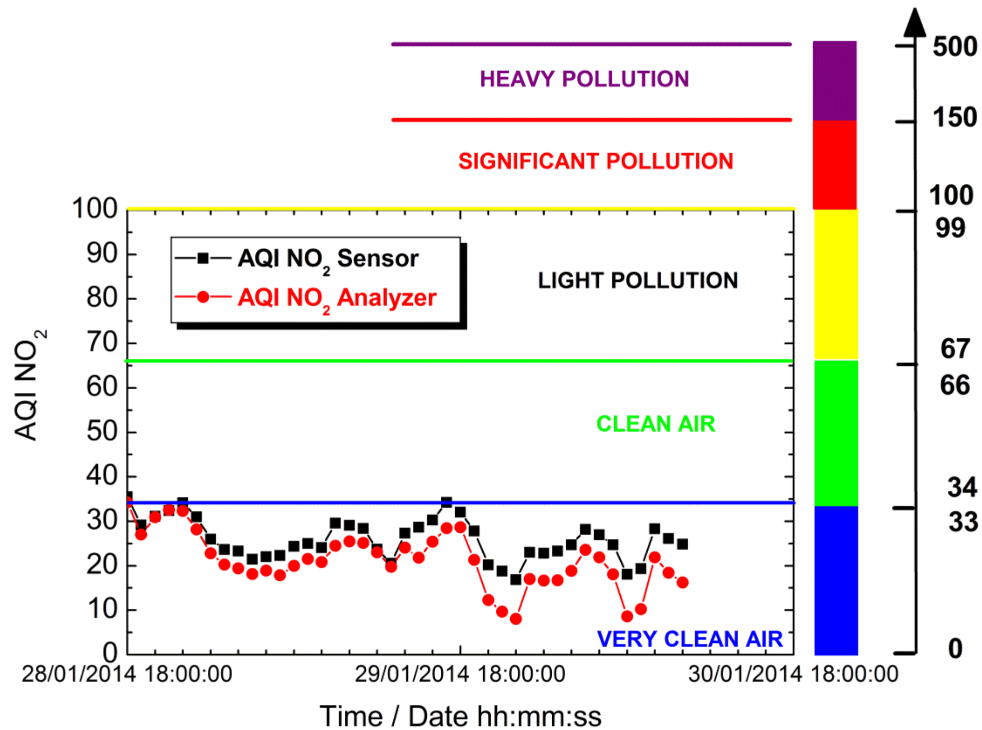
M. Penza et al., COST Brindisi Workshop, 25-26 March 2014

Courtesy from ENEA

- **COCX_A3_Alphasense**
- **NO2A1_A3_Alphasense**
- **SO2AF_A3_Alphasense**
- **H2SA1_A3_Alphasense**

4 sensors (Electrochemical) to detect air-pollutants (e.g., CO, NO_2, SO_2) H_2S, T and RH

Real Measurements in collaboration with JRC-IES, Ispra, Italy



Air Quality Index (AQI) by NO_2 Sensor And NO_x Chemiluminescence Analyzer

SENSOR TECHNOLOGIES

MARKET-ORIENTED OR COMMERCIAL DEVICES

- **Sensor-Systems for Air-Pollution Control in Smart Cities**
- **Gas Sensors for Indoor Energy Efficiency**
- **Sensors for Odour Monitoring**
- **Sensors for CO_2 Monitoring**
- **Sensors for Automotive Air Quality Measurements**
- **Particulate Counters/Sensors**

Sensor Technologies: Sensors for Smart Cities (1/2)

V. Bright et al., COST Brindisi Workshop, 25-26 March 2014

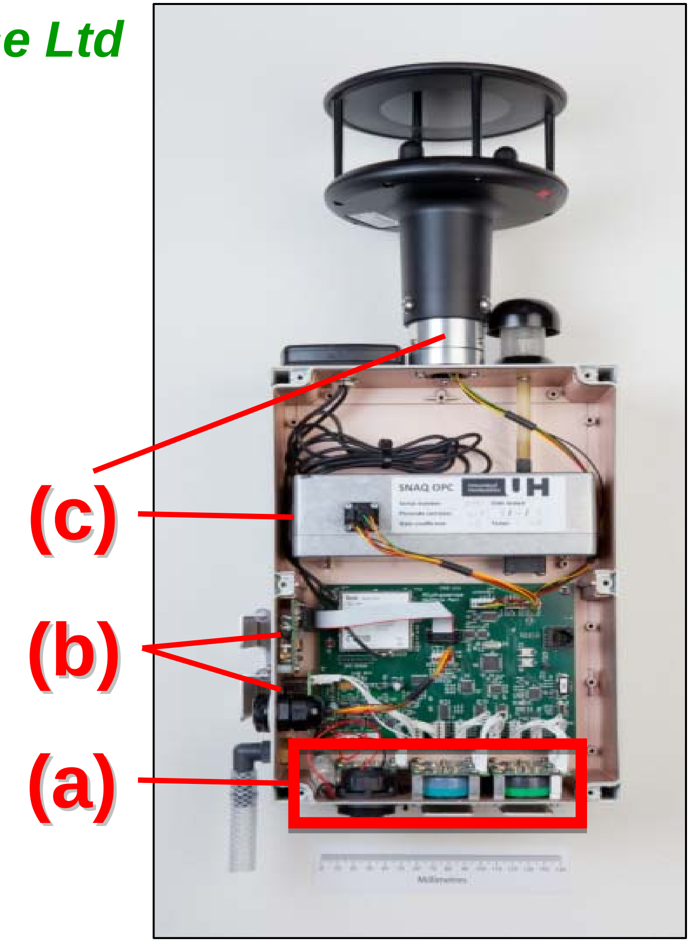
Courtesy from University of Cambridge and Alphasense Ltd
Prof. Rod Jones and Dr. John Saffell

- **Sensor Instrumentation**

Chemical species:

- **(a)** Gas phase species: CO, NO, O_3, SO_2, NO_2 – (electrochemical sensors (EC) at 2 s)
- **(b)** CO_2 & total VOCs (optical at 10 s).
- **(c)** Size-speciated particulates 0.38 to 17.4 µm, optical (OPC) at 20 s

SNAQ sensor node



~49 x 22 x 16 cm. ~2.8 kg

COST EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Sensor Technologies: Sensors for Smart Cities (2/2)

V. Bright et al., COST Brindisi Workshop, 25-26 March 2014

Courtesy from University of Cambridge and Alphasense Ltd
Prof. Rod Jones and Dr. John Saffell

- **Sensor Instrumentation**

Meteorology:

- **(d)** Wind speed and direction – Sonic anemometer.
- **(e)** Temperature and RH (probe).

Other:

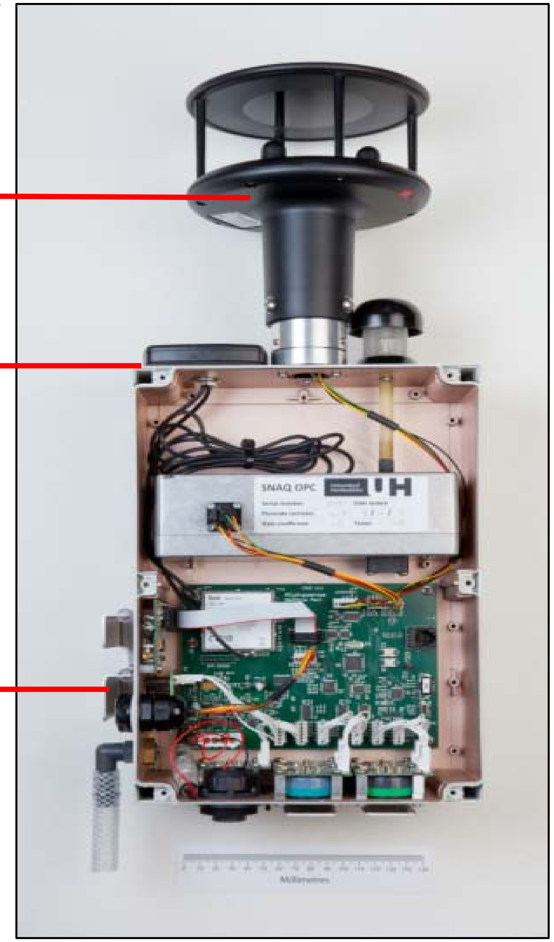
- **(f)** GPS and GPRS (position and near-real time data transmission).

SNAQ sensor node

(d)

(f)

(e)



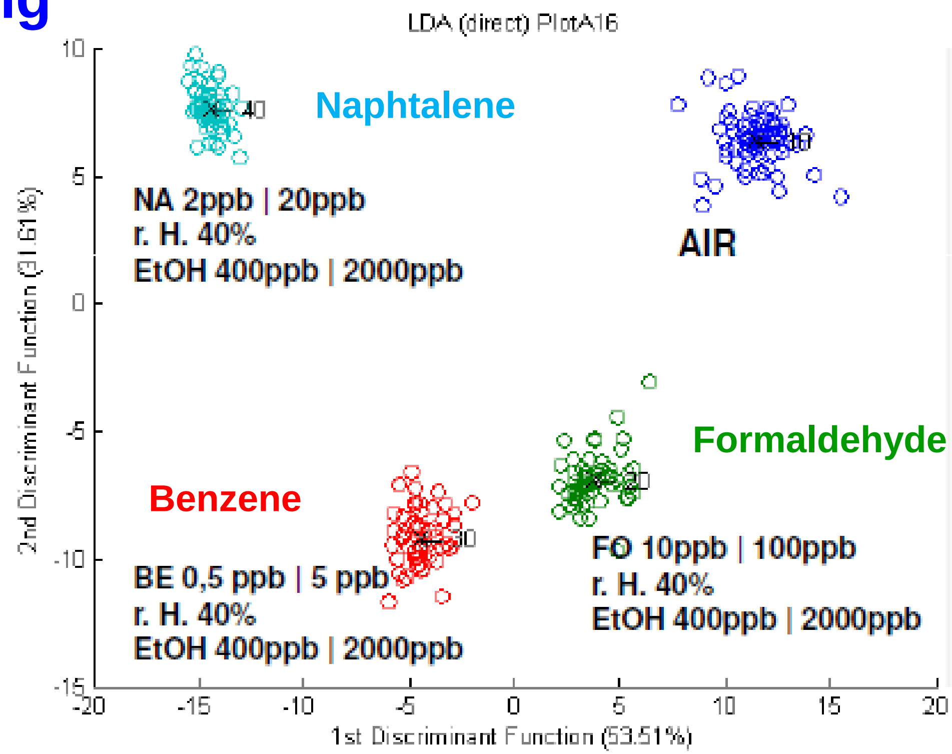
~49 x 22 x 16 cm. ~2.8 kg

Sensor Technologies: Gas Sensors for Energy Efficiency

T. Conrad et al., COST Copenhagen Workshop, 3-4 October 2014

VOCs Sensor-System for IAQ Monitoring

Courtesy from 3S GmbH



- IAQ Modular system based on **two commercial MOX gas sensors**
- **CO_2-sensor** and **RH-sensor** also incorporated
- SD-card for raw data collection in field tests
- Bus interface for ready results communication and power supply
- Application specific sensor systems

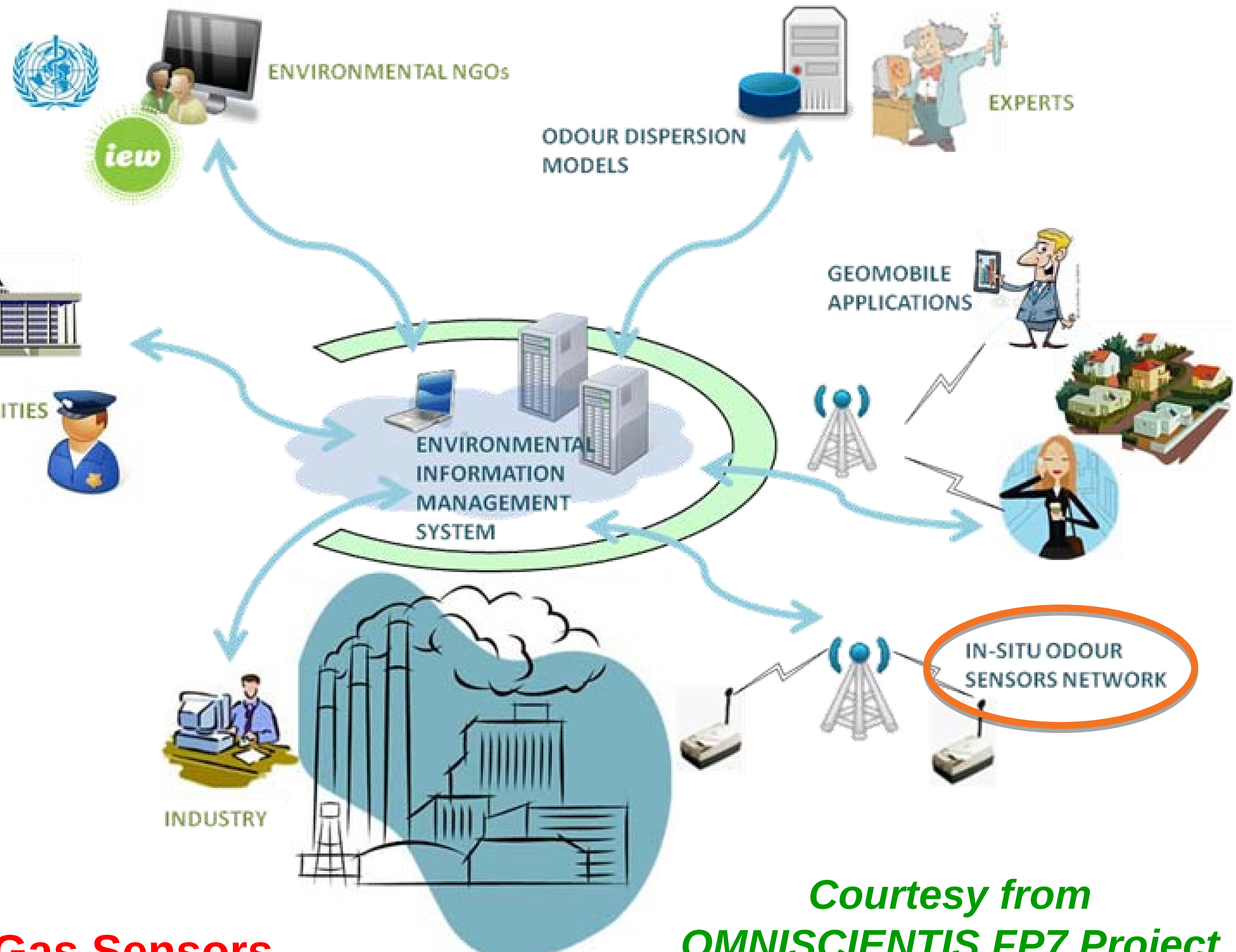
Sensor Technologies: Sensors for Odour Monitoring

A.C. Romain et al., COST Copenhagen Workshop, 3-4 October 2014

Odour Monitoring Information System (ODOMIS)

WEB-based PLATFORM: the heart of the Information and Monitoring System

CHALLENGE: integration of citizens as "community-based" observation providers



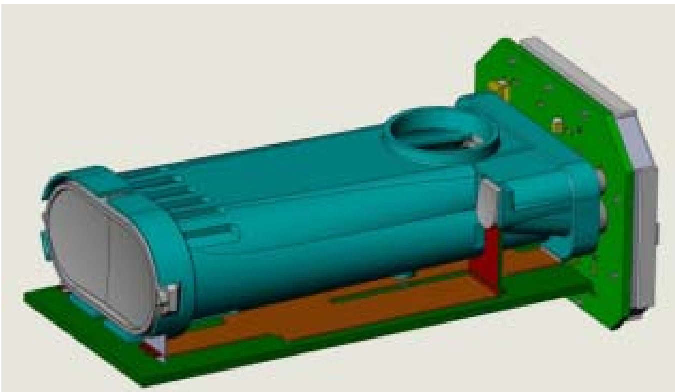
Odour Sniffing-System based on Commercial Gas Sensors

Courtesy from OMNISCIENTIS FP7 Project

Sensor Technologies: Sensors for CO_2 Detection

I. Bryntse et al., COST Copenhagen Workshop, 3-4 October 2014

NDIR CO_2 Platform for IAQ Monitoring

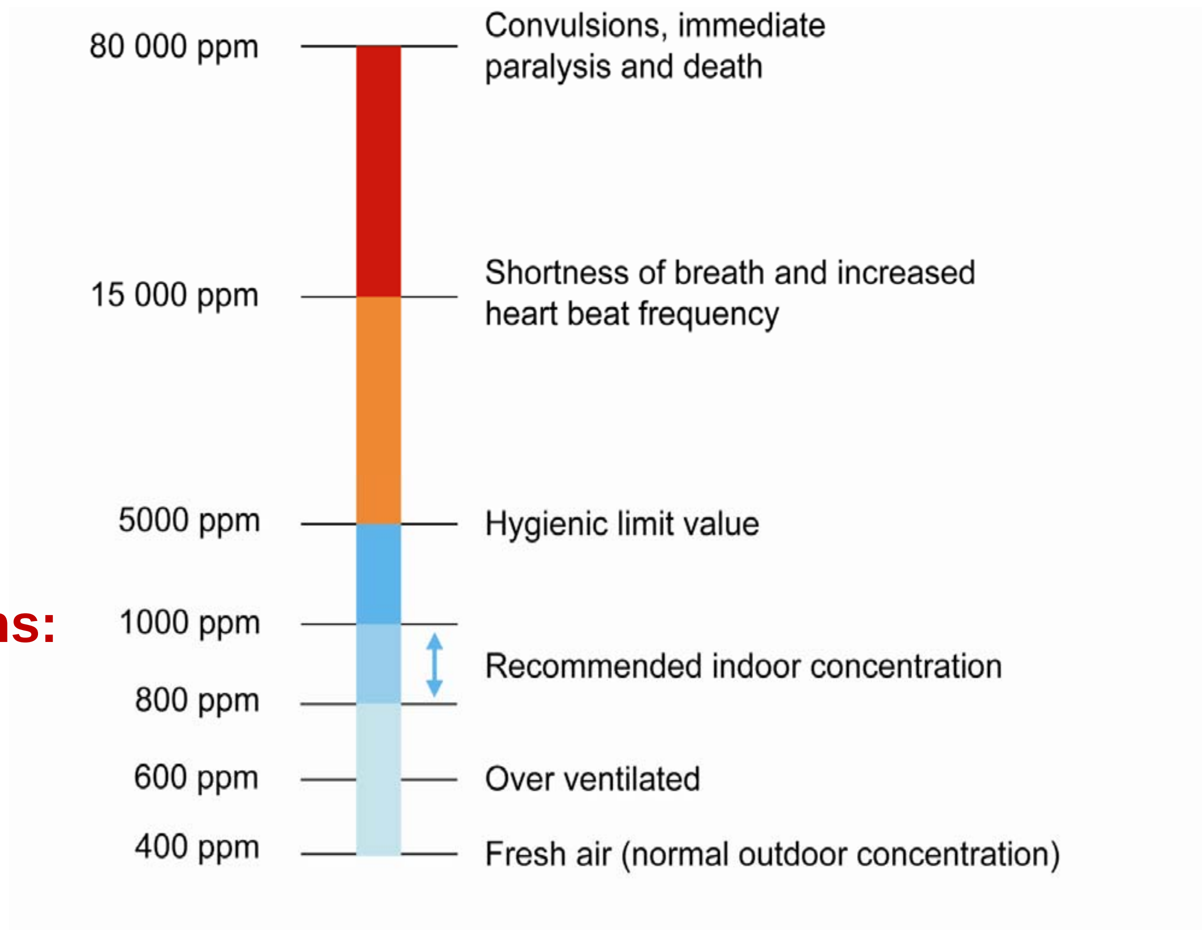


Courtesy from SenseAir AB

The main CO_2 sensor applications:

1. Alarm
2. Process control
3. Ventilation

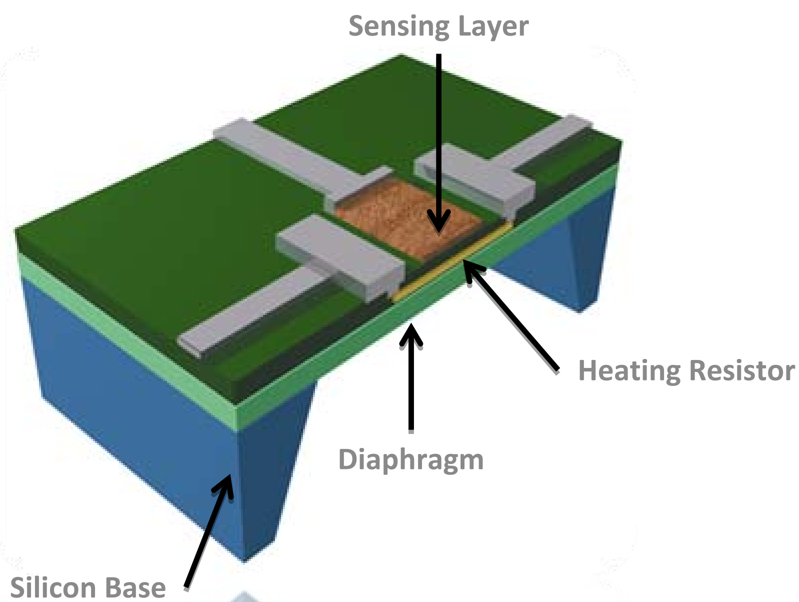
CO_2 impact on health

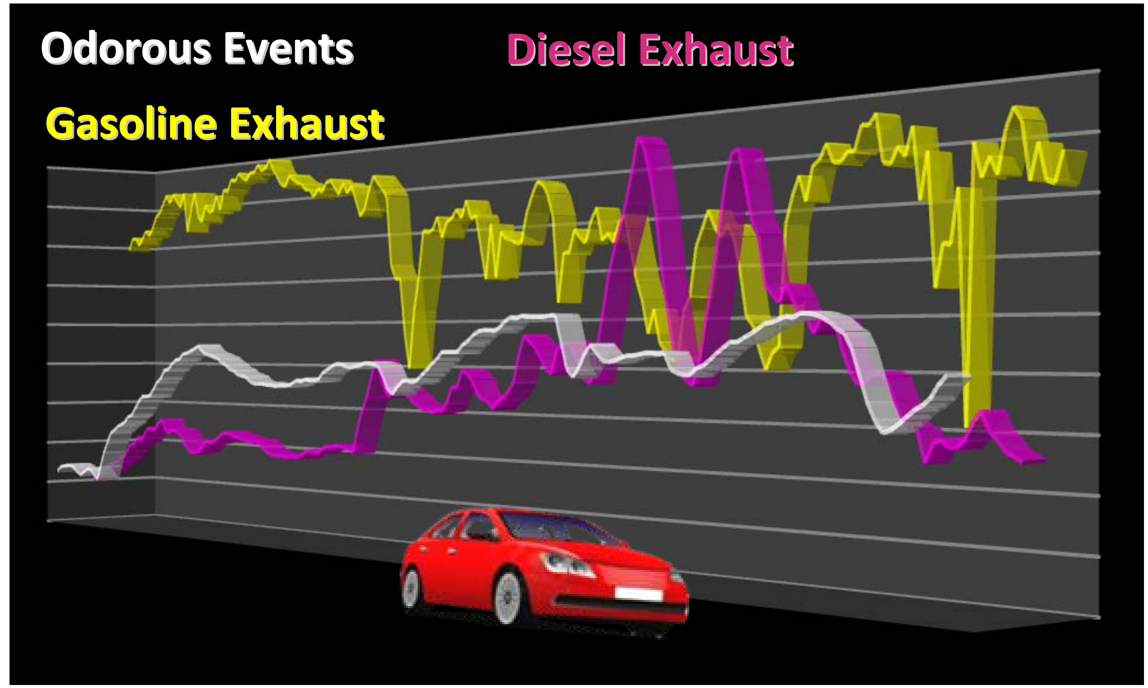


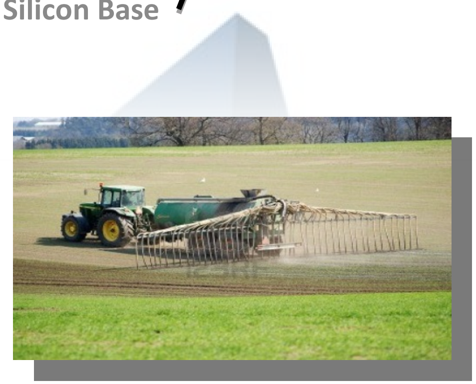
Sensor Technologies: Automotive Air Quality Sensors

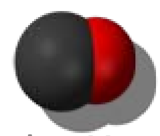
N. Moser et al., COST Barcelona Workshop, 21 June 2013

Courtesy from SGX-Sensortech Ltd

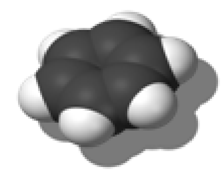




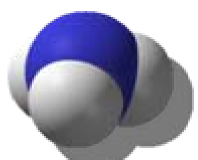




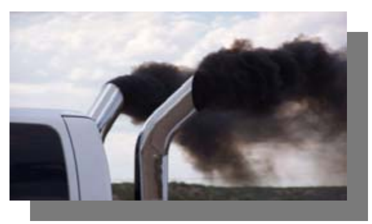
Carbon Monoxide

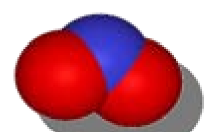


HydroCarbons

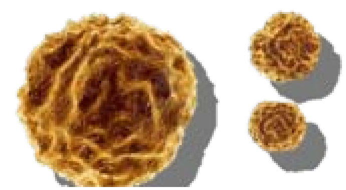


Ammonia





Nitrogen Dioxide



Particulate Matter

cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Sensor Technologies: Particulate Counter/Sensor (1/2)

M. Penza et al., COST Brindisi Workshop, 25-26 March 2014

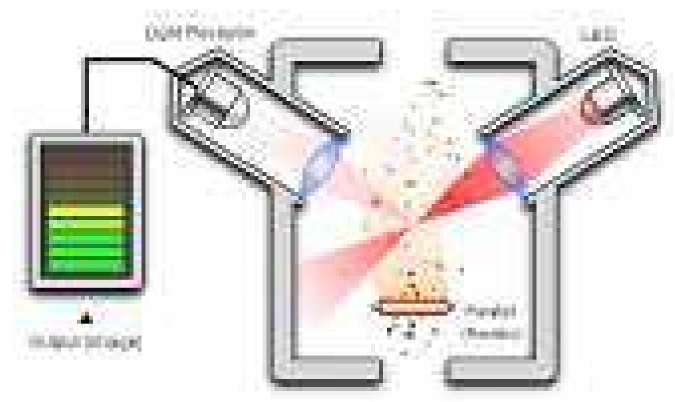
PPD20V

Low-Cost Optical Particle Sensor

by Shinyei Ltd, Japan

Detectable Particle Size: 1 - 5 μm

$$C(t) = A_0 + S \times V(t)$$



C(t) = PM Concentration [μg/m³]

A_0 = Bias Constant (3.2795 μg/m³)

S = Sensor Sensitivity (46.85 (μg/m³)/V)

V(t) = Sensor Output Voltage [V]

Sensor Technologies: Particulate Counter/Sensor (2/2)

M. Penza et al., COST Brindisi Workshop, 25-26 March 2014

E(t) = Error
$C_N(t)$: PM sensor concentration
$C_A(t)$: PM_{10} analyzer concentration

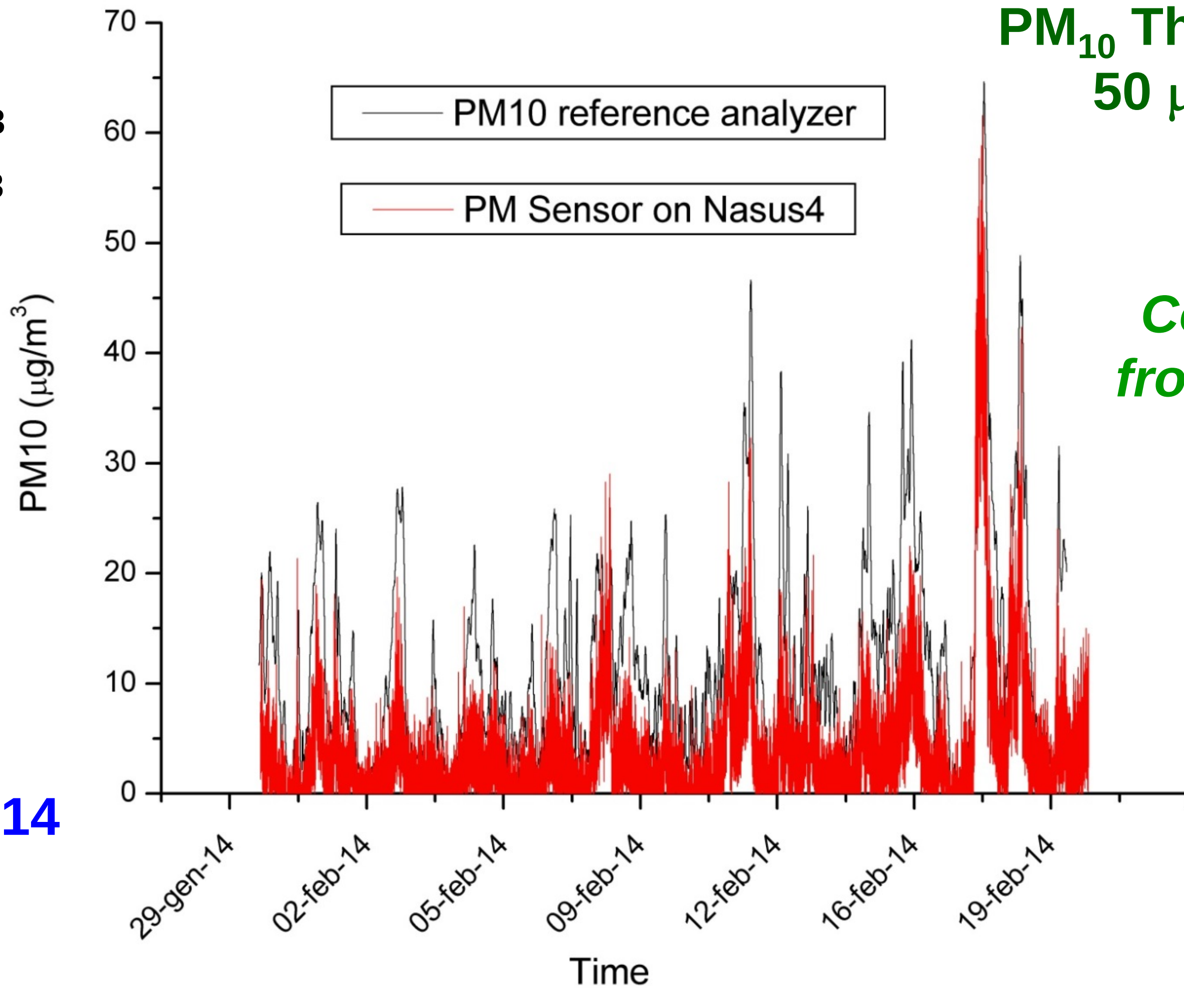
Real Measurements in collaboration with JRC-IES, Ispra, Italy

$E(t) = |C_N(t) - C_A(t)|$
Mean E(t) = 8.98 $\mu g/m^3$
Max E(t) = 41.76 $\mu g/m^3$

Very Good Accuracy !

Optical Particle Sensor PPD20V by Shinyei Ltd, Japan

Measurement Timing: 29 Jan 2014 - 19 Feb 2014



PM_{10} Threshold: 50 $\mu g/m^3$

Courtesy from ENEA

COST EUROPEAN COO

WG2 PRIORITIES: Sensors Devices and Sensor-Systems for AQC

WG2-Leader:	**Prof. Andreas Schuetze, Saarland University, Germany**
WG2 Composition:	**4 Sub-WG Leaders and 45 Members**

PRIORITY #1:	**Versatile μ-transducers for integration of various nanomaterials**: ✓Allow application specific adaptation and low cost ✓Low power (down to μW range for single nanowire)
PRIORITY #2:	**Dynamic operation of Sensors** to gain more than one signal from a single sensor for higher selectivity and stability as well possible self-monitoring at the sensor module level: ✓Well-know but not yet standard: temperature cycling, Electrical Impedance Spectroscopy (EIS) ✓New methods: RF, optical, excitation (gas sensitive solar cell), pulsed polarization, mass and dissipation in Quartz Crystal Microbalance (QCM) ✓Modelling of interaction of sensing layer and gas/dust/aerosol
PRIORITY #3:	**Selective filters** integrated in sensors or sensor modules
PRIORITY #4:	**Dosimeter approach:** integrating sensor response
PRIORITY #5:	**Nanoparticle detection** for dust and aerosols
PRIORITY #6:	**Intelligent Sensor Modules for NO_x, O_3, NH_3, H_2S, SO_2, VOC:** ✓Electronics combined with sensor elements
PRIORITY #7:	**Intelligent Sensor Nodes and heterogeneous networks:** ✓Data pre-processing and processing (in node and/or in network: parallel and distributed computing) ✓Energy efficient communication

SENSOR APPLICATIONS

INDOOR AND OUTDOOR SCENARIO

- **Regulation and Requirements for Air-Pollution Control:**
  - ✓ **EU Air Quality Directive 2008/50/EC**
- **Roadmap for Next Generation Air Monitoring:**
  - ✓ **US EPA Draft Roadmap NGAM**
- **Selected International Research Projects:**
  - ✓ **Indoor/Outdoor Applications**

EU Air Quality Directive 2008/50/EC: Requirements (1/4)

European Commission

Michel Gerboles, JRC-Ispra, IES

Fixed measurements: definition

'fixed measurements' means measurements taken at fixed sites to determine the levels in accordance with the relevant *Data Quality Objectives* (DQO);

Fixed measurements are mandatory in zones and agglomerations where the upper assessment thresholds are exceeded.

AQD: European DIRECTIVE 2008/50/EC on ambient air quality and cleaner air for Europe, art. 2

EU Air Quality Directive 2008/50/EC: Requirements (2/4)

European Commission

Michel Gerboles, JRC-Ispra, IES

AQD: Data Quality Objectives (DQO)

	SO_2, NO_2/NOx, CO	Benzene	O_3
Uncertainty for **fixed measurements**	15 %	25 %	15 %
	Fluoresc., chemil., NDIR	automatic GC or pumped sampling	UV photometry
	demonstration of equivalence would be mandatory to use micro-sensors		

EU Air Quality Directive 2008/50/EC: Requirements (3/4)

European Commission

Indicative methods: definition

'indicative measurements' means measurements which meet *data quality objectives* that are less strict than those required for *fixed measurements*;

AQD: European Directive 2008/50/EC on ambient air quality and cleaner air for Europe, art. 2

Michel Gerboles, JRC-Ispra, IES

EU Air Quality Directive 2008/50/EC: Requirements (4/4)

European Commission

AQD: Data Quality Objectives (DQO)

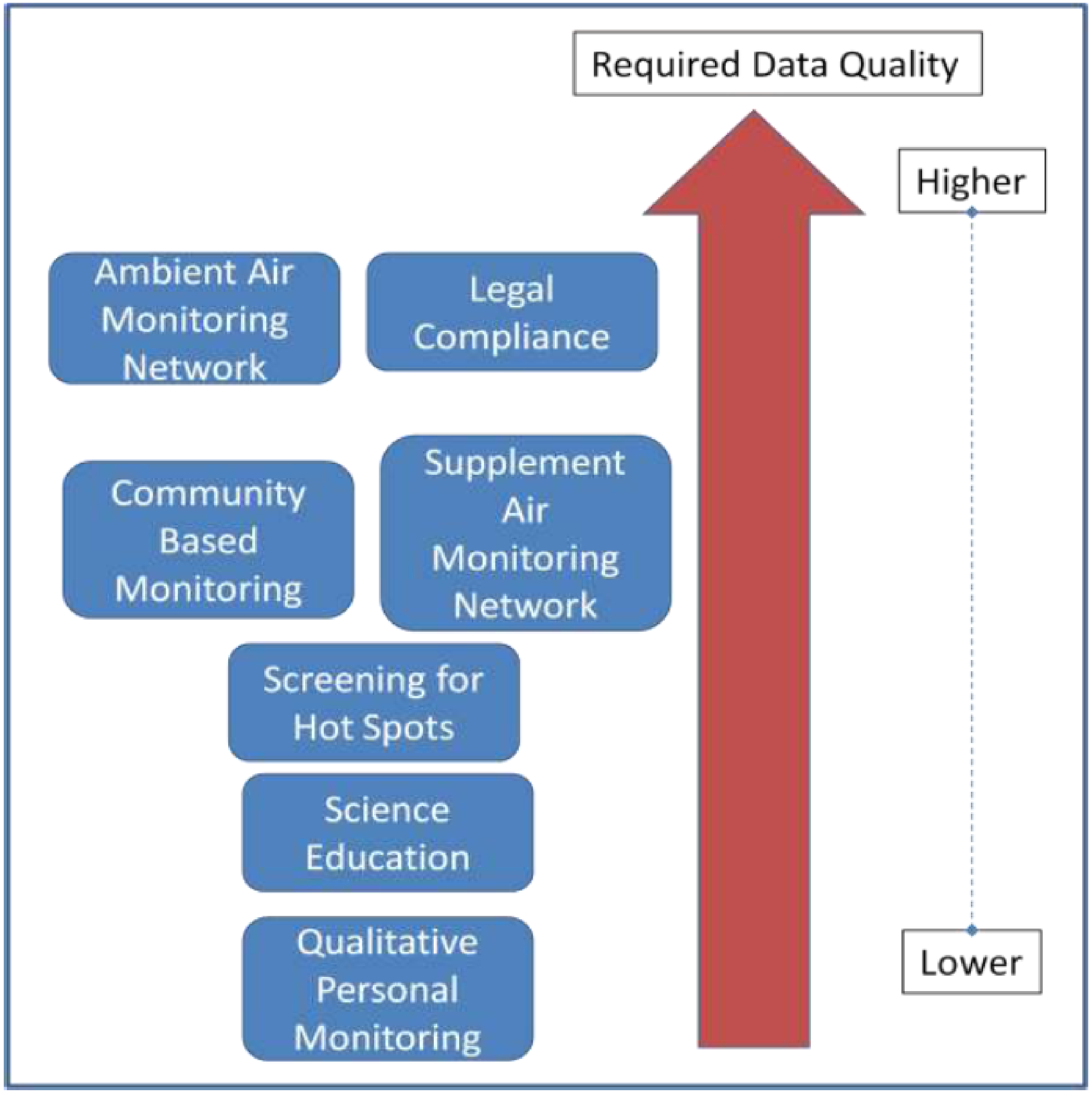
	SO_2, NO_2/NO /NOx, CO	Benzene	O_3
Uncertainty for **fixed measurements**	15 %	25 %	15 %
Uncertainty for **indicative measurements**	**25 %**	**30 %**	**30 %**
	diffusive samplers, ***micro-sensors***		

Michel Gerboles, JRC-Ispra, IES

Roadmap for Next Generation Air Monitoring

U.S. Environmental Protection Agency

Data Quality Requirements for the range of NGAM applications



US EPA, March 2013:

Tim Watkins, US EPA
Watkins.Tim@epa.gov

Viens Matthew, US EPA
Viens.Matthew@epa.gov

http://epa.gov/research/airscience/docs/roadmap-20130308.pdf

SOME FP-7 PROJECTS ON AIR QUALITY: OUTDOOR

Project Acronym	Title of Project / Coordinator / Email
CITI-SENSE FP7-ENV-2012	***Development of Sensor-based Citizens' Observatory Community for Improving Quality of Life in Cities*** **Coordinator**: *Alena Bartonova, NILU, Kjeller, Norway* **Email**: *alena.bartonova@nilu.no*
AIRMONTECH FP7-ENV-2012	***Air Pollution Monitoring Technologies for Urban Areas*** **Coordinator**: *Thomas Kuhlbusch, IUTA eV, Duisburg, Germany* **Email**: *tky@iuta.de*
OMNISCIENTIS FP7-ENV-2013	***A Living Lab Approach to Develop Sustainable Environmental Governance*** **Partner**: *Anne-Claude Romain, Universitè de Liege, Belgium* **Email**: *acromain@ulg.ac.be*
EVERYAWARE FP7-ICT-FET2012	***Enhance Environmental Awareness through Social Information Technologies*** **Coordinator**: *Vittorio Loreto, ISI Foundation, Torino, Italy* **Email**: *vittorio.loreto@isi.it*
MACPOLL FP7-EMRP-2012	***Metrology for Chemical Pollutants in Air*** **Coordinator**: *Annarita Baldan, VSL B.V., Delft, The Netherlands* **Email**: *abaldan@vsl.nl*

SOME FP-7 PROJECTS ON AIR QUALITY: INDOOR

Acronym	Title of Project / Coordinator / Email
SENSINDOOR FP7-NMP-2013	***Nanotechnology-based Intelligent multi-Sensor System with Selective Pre-concentration for IAQ Control*** **Coordinator**: *Andreas Schuetze, Saarland University, Germany* **Email**: *schuetze@lmt.uni-saarland.de*
MSP FP7-ICT-2013	***Multi-Sensor Platform for Smart Building Management*** **Coordinator**: *Anton Kock,* Materials Center Leoben, *Austria* **Email**: *Anton.Koeck@mcl.at*
INTASENSE EeB-ENV-2011	***Integrated Air Quality Sensor for Energy Efficient Environment Control*** **Coordinator**: *Robert Bell, C-Tech Innovation Ltd, Chester, UK* **Email**: *rob.bell@ctechinnovation.com*
CETIEB FP7-ICT-2011	***Cost-Effective Tools for Better Indoor Environment in Retrofitted Energy Efficient Buildings*** **Coordinator**: *Jurgen Frick, University of Stuttgart, Germany* **Email**: *Juergen.Frick@mpa.uni-stuttgart.de*
OFFICAIR FP7-ENV-2010	***On the Reduction of Health Effects from Combined Exposure to Indoor Pollutants in Modern Offices*** **Coordinator**: *John Bartzis, University of Western Macedonia,Greece* **Email**: *bartzis@uowm.gr*

COST Action TD1105 *EuNetAir*:

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

- ✓ **Results versus Objectives: *Significant Highlights***
- ✓ **Future Plans and Challenges: *Expected Impact***
- ✓ **Next *EuNetAir* Meetings and related Events**

Action's Objectives

MoU Main Objectives of COST Action TD1105:

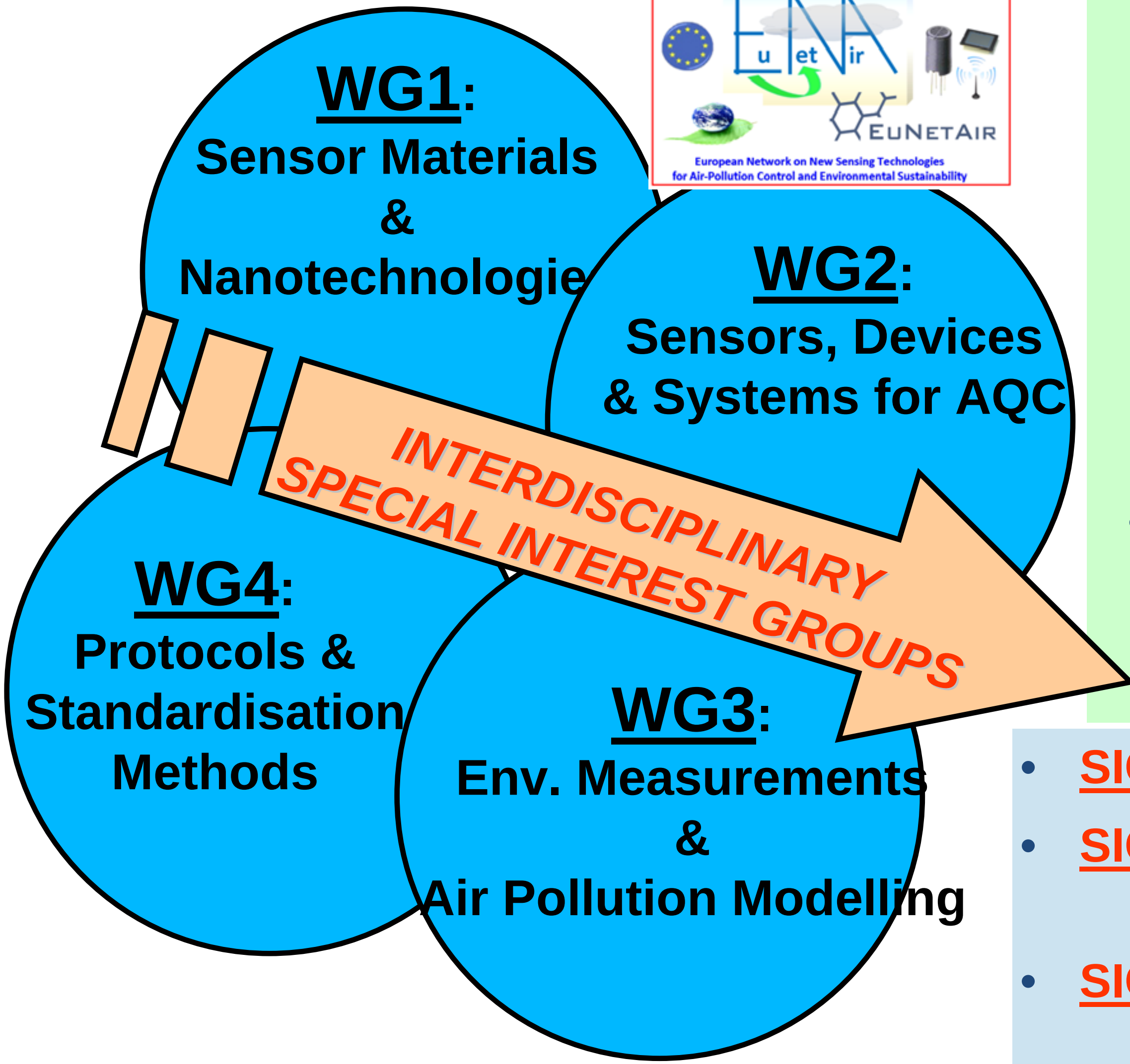
- ***To establish*** a ***Pan-European multidisciplinary R&D platform*** on new sensing paradigm for Air Quality Control (AQC) contributing to sustainable development, green-economy and social welfare.
- ***To create*** ***collaborative research teams*** in the **ERA** on the new sensing technologies for AQC in an integrated approach to avoid fragmentation of the research efforts.
- ***To train*** ***Early Stage Researchers (ESRs)*** and new young scientists in the field for supporting competitiveness of European industry by qualified human potential.
- ***To promote*** ***gender balance*** and involvement of ESRs in AQC.
- ***To disseminate*** ***R&D results on AQC*** towards **industry community** and policy makers as well as general public and high schools.

Action Research Directions: *Methodology*

DELIVERABLES of COST Action TD1105. MoU areas of S&T cooperation include:

- **Workshops** *on sensor materials and nanotechnologies, sensor-systems for AQC, environmental measurements, air-pollution modelling, chemical weather forecasting, distributed computing, wireless sensor networks, protocols and pre-standardisation*; organization of open conferences to improve knowledge transfer and dissemination.
- **Training Schools** on sensor materials, technologies, processes, methods, modelling, forecasting, applications, environmental certification and validation, project management.
- **International ESRs exchange** and Scientists Mobility (STSMs) between partners involved in Action and Non-COST partnership at incoming/outcoming level.
- **New collaborative research actions** and research projects providing synergies between partners capabilities.
- **Participation** in Conferences, Short Courses, Mutual Publications, Reports, White Papers, Position Papers, etc.
- **Outreach** activities
- Enforcement of the **Gender Balance** agenda
- Coordinated **Dissemination** of the networking activities towards Academia, Industry and General Public.

Action TD1105 *EuNetAir*: Working Groups



MANAGEMENT COMMITTEE:

CORE-GROUP & STEERING COMMITTEE

- *Editorial Board*
- *Dissemination*
- *Training Schools*
- *Gender Balance*
- *Early Stage Researchers (ESR)*
- *Short-Term Scientific Mission (STSM)*
- *Intellectual Property Rights (IPR)*
- *Local Organizing Committee (LOC)*

- SIG 1: *Network of Spin-offs*
- SIG 2: *Smart Sensors for Urban Air Monitoring in Cities*
- SIG 3: *Guidelines for Best Coupling Air Pollutant-Transducer*
- SIG 4: *Expert comments for the Revision of the Air Quality EU Directive*

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST Action TD1105 *EuNetAir*: 28 COST Countries (Parties) have already signed Memorandum of Understanding (MoU)

PARTIES:

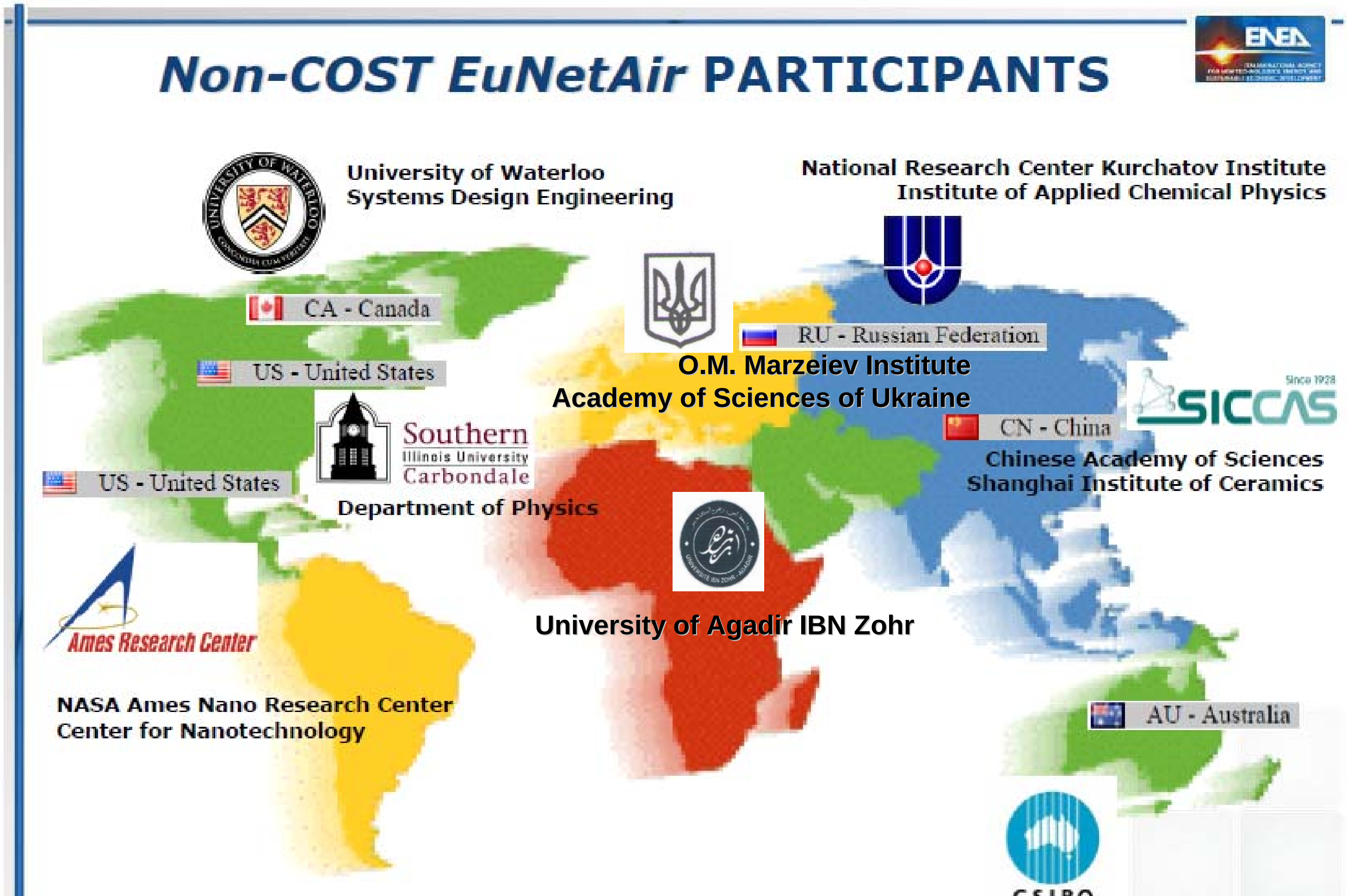
already accepted MoU: 28 Countries

Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, The Former Yugoslav Republic of Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

COST Action TD1105 *EuNetAir*:
7 Non-COST Countries and 8 Non-COST Institutions

Non-COST Countries:
Australia, Canada, China, Morocco, Russia, Ukraine, USA

Non-COST Institutions:
CSIRO (Australia); University of Waterloo (Canada); Chinese Academy of Sciences, Shanghai Institute of Ceramics (China); University of Agadir IBN Zohr (Morocco); National Research Center Kurchatov Institute (Russia); O.M. Marzeiev Institute for Hygiene and Medical Ecology of Academy of Science of Ukraine (Ukraine); Southern Illinois University Carbondale, NASA Ames Research Center (USA).



NNC - Near Neighbour Countries
IPC - International Partner Countries

EuNetAir PARTICIPANTS

AT - Austria	Materials Center Leoben Forschung GmbH
BE - Belgium	VITO, Universitè de Liège, Odometric S.A.
BG - Bulgaria	National Institute of Meteorology and Hydrology - BAS; Institute of Electronics - BAS
CH - Switzerland	Ecole Polytechnique Fèdèrale de Lausanne; e2v Microsensors S.A.; EnvEve S.A.; EMPA
CZ - Czech Republic	Academy of Sciences of the Czech Republic
DE - Germany	Institute of Energy and Environmental Technology; Saarland University; MPI for Biogeochemistry Univ. of Bayreuth; Univ. of Paderborn; Univ. Applied Sci. Ostwestfalen-Lippe; UST; Alfred Becker; 3S
DK - Denmark	Aarhus University; Technical University of Denmark - DTU
EL - Greece	Aristotle University; FORTH; Athena/ISI; University of Piraeus
ES - Spain	Catalonia Institute for Energy Research - IREC; Spanish National Research Council - CSIC; University Rovira i Virgili; University of Barcelona, Worldsensing S.L.
FI - Finland	University of Oulu; University of Helsinki; Tampere University of Technology
FR - France	University of Bourgogne; University Blaise Pascal; Ecole des Mines de Douai; CEA-CNRS; ETHERA
HU - Hungary	Hungarian Meteorological Service
IS - Iceland	Agricultural University of Iceland
MK - Republic of Macedonia	Ministry of Environment and Physical Planning
IE - Ireland	Trinity College Dublin; University College Cork
IL - Israel	AirBase Systems; TECHNION
RS- Serbia	Institute of Public Health of Belgrade; VINCA
IT - Italy	ENEA; ELETTRA; Univ. of Bari; Univ. of Brescia; Univ. of Trieste; Lenviros; Sensichips, ARPA-Puglia
LV - Latvia	University of Latvia Riga Technical University
NL - Netherlands	IMEC - Holst Centre; ECN
NO - Norway	NILU - Norwegian Institute for Air Research
PL - Poland	Silesian University of Technology; Warsaw University of Life Science
PT - Portugal	Univ of Coimbra; Instit. of Environment & Development; National Health Institute; Univ of Lisbon
RO - Romania	National R&D Institute for Nonferrous and Rare Metals; SC IPA SA - Research & Development
SE - Sweden	Linkoping University; Chalmers University of Technology; SenSiC AB; SenseAir AB
SI - Slovenia	University of Ljubljana; Aerosol d.o.o.
UK - United Kingdom	Imperial College London; Newcastle University; University of Manchester; Cambridge; University of Warwick; University of Edinburgh; Cambridge CMOS Sensors; Alphasense
TR - Turkey	GEBZE Institute of Technology; Middle East Technical University of Ankara

MANAGEMENT COMMITTEE

Kick-off Meeting at Brussels on 16 May 2012

MC Chair:	Michele Penza, ENEA, IT
MC Vice Chair:	Anita Lloyd Spetz, Linkoping University, SE
Grant Holder:	Eurice GmbH, Saarbrucken, DE

Country	MC Members (53): Male (72%) - Female (28%)
Austria	Dr. Anton KOCK
Belgium	Dr Jan THEUNIS; Dr Anne-Claude ROMAIN
Bulgaria	Dr Dimiter SYRAKOV; Dr Ivan NEDKOV
Czech Republic	Dr. Vera KURKOVA; Dr. Zdenek ZELINGER
Denmark	Prof. Ole HERTEL
Finland	Prof. Kaarle HAMERI; Prof. Jyrki LAPPALAINEN
France	Prof. Marcel BOUVET; Prof. Jerome BRUNET
Germany	Prof. Andreas SCHUETZE; Dr Corinna HAHN
Greece	Prof. George PAPADOPOULOS; Prof. Kostas KARATZAS
Hungary	Ms Krisztina LABANCZ; Dr Zita FERENCZI
Iceland	Dr Arngrimur THORLACIUS
Ireland	Dr. Francesco PILLA; Prof. John WENGER
Israel	Dr. Liad ORTAR; Prof. Hossam HAICK
Italy	Dr Michele PENZA; Prof. G. SBERVEGLIERI; Dr. G. DE GENNARO
Latvia	Dr Iveta STEINBERGA; Dr. Gita SAKALE
Macedonia Rep.	Dr. Igor ATASANOV; Dr. Ljupcho GROZDANOVSKI
Netherlands	Dr Sywert BRONGERSMA; Dr. Ernie WEIJERS
Norway	Dr Nuria CASTELL BALAGUER; Dr. Philipp SCHENEIDER
Poland	Dr Monika KWOKA; Prof. Janislaw GAWRONSKI
Portugal	Prof. Bernadete RIBEIRO; Prof. Carlos BORREGO
Romania	Dr Marcel IONICA; Dr Roxana Mioara PITICESCU
Serbia	Dr. Anka CVETKOVIC
Slovenia	Dr Grisa MOCNIK; Dr Rahela ZABKAR
Spain	Prof. Juan Ramon MORANTE; Prof. Eduard LLOBET VALERO
Sweden	Prof. Anita LLOYD SPETZ; Prof. Ingrid BRYNTSE
Switzerland	Dr Danick BRIAND; Dr. Nicolas MOSER
United Kingdom	Dr John SAFFELL; Prof. Roderic JONES
Turkey	Prof. Zafer ZIYA OZTURK; Prof. Mehmet Fatih DANISMAN

Country	MC Substitutes (30)
Austria	Dr Stefan DEFREGGER
Belgium	Dr Julien DELVA
Czech Republic	Dr. Roman NERUDA
Denmark	Dr. Lise Lotte SORENSEN
Finland	Prof. Jorma KESKINEN
France	Dr Jean SUISSE Prof. Alain PAULY
Germany	Dr. Daniela SCHONAUER-KAMIN Dr. Thomas KUHLBUSCH Dr. Juliane ROSSBACH
Greece	Prof. George KIRIKIADIS Dr. Christos KOULAMAS
Italy	Dr. Roberto SIMMARANO Dr. Marco ALVISI Dr. Saverio DE VITO
Macedonia Rep.	Dr. Beti ANGELEVSKA
Netherlands	Dr. Rene OTJES
Poland	Prof. Jacek SZUBER
Portugal	Dr. Joao Paulo TEIXEIRA
Romania	Dr. Cristina RUSTI Dr. Marcel Adrian IONICA
Slovenia	Prof. Andrej DOBNIKAR
Spain	Prof. Albert ROMANO-RODRIGUEZ Dr. Jordi LLOSA
Sweden	Dr Ulf THOLE Dr. Marina VOINOVA
Switzerland	Dr Christoph HUEGLIN
UK	Prof. Julian GARDNER Dr Robin NORTH Prof. Florin UDREA

OUTREACH ACTIVITIES from Action TD1105

Action website:

www.cost.eunetair.it

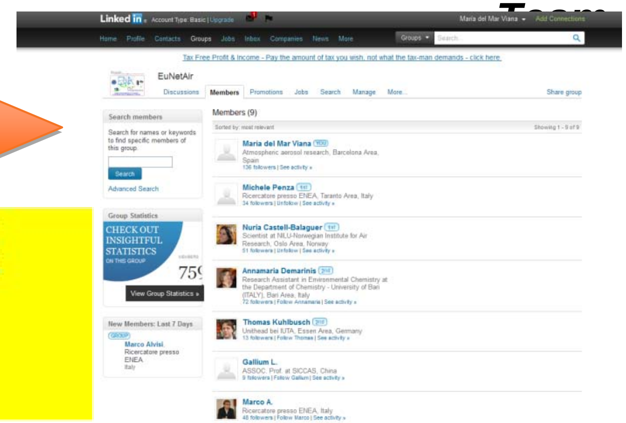
hosted by ENEA

Dr. Marco Alvisi, *Webmaster Coordinator*

Sebastiano Dipinto, Valerio Pfister, Gianfranco Zingarelli, *Webmaster Team*

Social Scientific ESRs Network (SSEN) by LinkedIn

Moderator(s): Mar Viana, Mariacruz Minguillon



3° CALL for Short Exchange Visits <u>launched on June 2014</u>
(STSM - Short Term Scientific Mission)

Dr. Jan Theunis, STSM Coordinator EuNetAir

Issue 1: published on Dec. 2012 ✓
Issue 2: published on June 2013 ✓
Issue 3: published on Dec. 2013 ✓
Issue 4: published on June 2014 ✓
Issue 5: planned on Dec. 2014

Prof. Ralf Moos, *Editor-in-Chief*

Dr. Daniela Schonauer-Kamin, *Editorial Board Manager*

Editorial Activities: WGs MEETING at EEA

New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

- **Special Issue Urban Climate** (***Elsevier***)

New Sensing Technologies and Methods for Air-Pollution Monitoring

Proceedings of the Action EEA Meeting open to external contributors.

*Peer-review process (***http://ees.elsevier.com/uclim/***)*

- ***Guest Editors***:

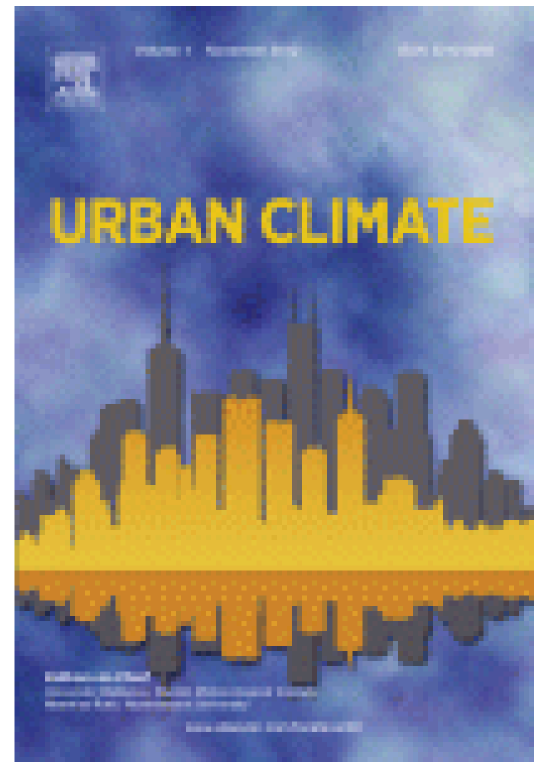
✓ Michele Penza, ENEA, Italy

✓ Anita Lloyd Spetz, Linkoping University, Sweden

✓ Ole Hertel, Aarhus University, Denmark

✓ Ulrich Quass, IUTA eV, Germany

- Deadline for submission: 28 February 2014 (**Close**)
- Number of Submissions: ***22 Manuscripts***
- Expected Publication: ***Fall 2014 (Nov-Dec 2014)***



Editorial Activities: Symposium at EMRS

New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

- **Special Issue *Journal of Sensors and Sensor Systems* (*Copernicus Publications*)**

Advanced Functional Materials for Environmental Monitoring and Applications

Proceedings of Symposium-B EMRS Spring Meeting 2014, 26-30 May 2014, Lille (FR)

*Peer-review process (***www.journal-of-sensors-and-sensor-systems.net***)*

- ***Guest Editors***:

✓ Michele Penza, ENEA, Italy

✓ Anita Lloyd Spetz, Linkoping University, Sweden

✓ Albert Romano-Rodriguez, Barcelona University, Spain

✓ Yongxiang Li, Chinese Academy of Sciences, China

✓ Meyya Meyyappan, NASA Ames Research Center, USA

- Deadline for submission: **31 July 2014**
- Expected Publication: ***Fall 2014 (Nov-Dec 2014)***

Aveiro Joint-Exercise Intercomparison & WG Meeting

13 October 2014: Starting Joint-Exercise (2 weeks duration)

14 - 15 October 2014: EuNetAir WG1-WG4 Meeting

EuNetAir Air Quality Joint-Exercise Intercomparison 2014
Local Organizers: Prof. Carlos Borrego and Dr. Ana Margarida Costa (IDAD)

Air quality campaign at Aveiro (Portugal) city centre 2014

Continuous measurements: CO, benzene, NOx, SO_2, PM_{10}, VOC
Temperature, humidity, wind velocity, wind direction, solar radiation, precipitation

COST partners (at least 8 teams joined) are invited to install their microsensors side-by-side to compare performance with referenced equipment in the Air-Quality Mobile Laboratory

THIRD SCIENTIFIC MEETING: WG & 6th MC Meeting

New Sensing Technologies for Indoor Air-Pollution

Bahcesehir University, Istanbul (Turkey), 3 - 5 December 2014

***PLENARY SESSION*:**
EU Projects Cluster on Indoor Environments Quality and Applications

Multidisciplinary Meeting:
International Experts and Coordinators of FP7 and H2020 research projects related to the IEQ Cluster are highly expected to participate

Local Organizers:

Prof. Zafer Ziya Ozturk,
GEBZE, Istanbul (Turkey)

Prof. Ali Gungor,
Bahcesehir University,
Istanbul (Turkey)

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COST Action TD1105: Related Upcoming EVENTS

New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

COST Transdisciplinary (TUD, ESSEM, ISCH, ICT) Strategic Event:

Cities of Tomorrow

Turin (Italy), 17 - 19 September 2014

Action TD1105 represented as **Invited Speaker** by **Prof. Anita Lloyd-Spetz**, *Action Vice-Chair*, Linkoping University, Sweden and Oulu University, Finland

NATO Advanced Research Workshop

NATO ARW on Nanotechnology to Aid Chemical and Biological Defense

organized by Prof. Terri A. Camesano, Worcester Polythecnic Institute, USA

Antalya (Turkey), 22 - 26 September 2014

Action TD1105 represented as **Invited Speaker** by **Dr. Michele Penza**, *Action Chair*, ENEA, Brindisi, Italy,

and **Prof. Giorgio Sberveglieri** (MC IT Member) as **Invited Speaker**.

COST Action TD1105: Related Upcoming EVENTS

New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

IEEE SENSORS 2014

2014 Edition of Conference Series: *Worldwide Forum*

Valencia (Spain), 2-5 November 2014

Technical Program Chair: Prof. Ignacio R. Matias

Action TD1105 represented as **Track Co-Chair for Europe/Africa**

- **Track 9: Materials, Processes, Circuits, Signals & Interfaces**
- **Special Session: Smart Cities Sensors**

by **Dr Michele Penza**, *Action Chair*, ENEA, Brindisi (Italy) as **Invited Speaker**,

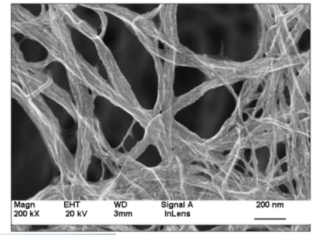
and **Prof. Eduard Llobet** (MC ES Member) as **Track Co-Chair for Europe/Africa** (**Track 2: Chemical and Gas Sensors**)

Other **Action Members** serve as Lecturer, Session Chair, TPC Member.

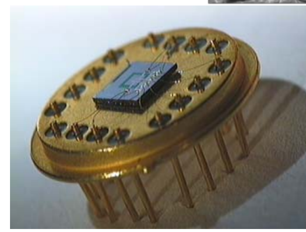
Expected Impact by Action TD1105

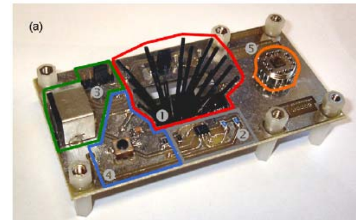
- European Leadership on AQC Science & Technology
- Development of Green-Economy
- Support to Sustainable Development
- Support to Monitoring System of Clean Air for Europe
- Fostering Research & Innovation on New Sensing Technologies for Environmental Monitoring

Challenges addressed by Action TD1105

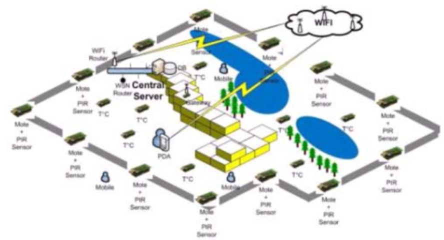


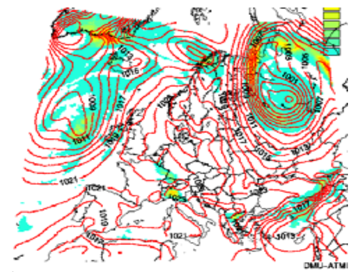
- **Nanomaterials for AQC sensors**
- **Low-cost Gas Sensors**





- **Low-power Sensor-Systems**
- **Wireless Technology (*Environmental Sensors Network*)**



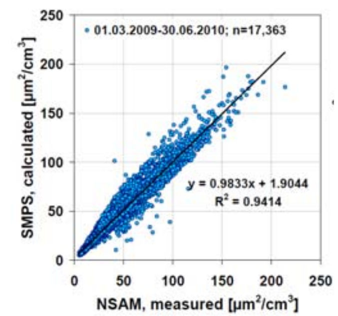


- **Air Quality Modelling**
- **Environmental Measurements**
- **Standards and Protocols**

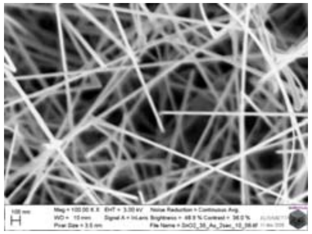
European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability - EuNetAir

EuNetAir

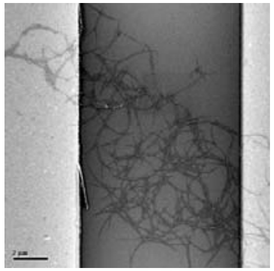
European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability



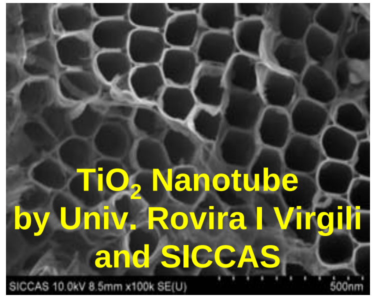
Selected Examples of Gas Sensors and Sensor Systems



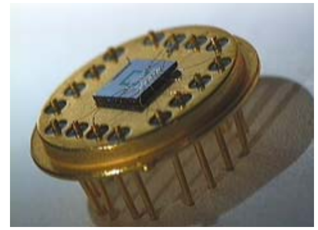
Metal oxide (SnO_2) Nanowires nets by Univ. of Brescia



Carbon Nanotubes by Ames NASA



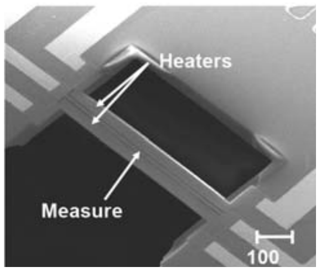
TiO_2 Nanotube by Univ. Rovira I Virgili and SICCAS



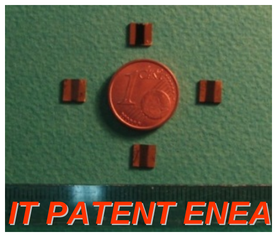
GasFET by EPFL, CH

UNITEC srl, ETL3000
multi-component outdoor air quality monitor

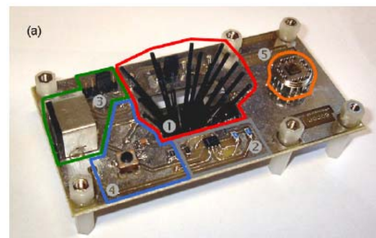
AEROQUAL, AQM 60
Air Quality Sensors Station



Cantilever Sensor by DTU, DK

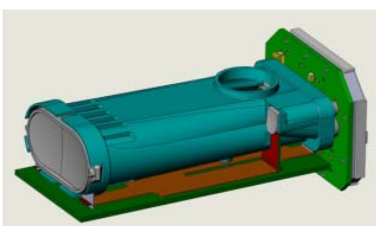


Carbon Nanotube Gas Sensors



Autonomous Gas Sensor System by IREC and Univ. of Barcelona

An **Octocopter**, the first platform on which we (*Max Planck Institute for Biogeochemistry, Jena, Germany*) tested a measurement sensor package for air quality sensors.



SenseAir SA,
A Robust Low-Cost NDIR Sensor Platform for sub-ppm Gas Detection

Sensor units components

Satellite navigation

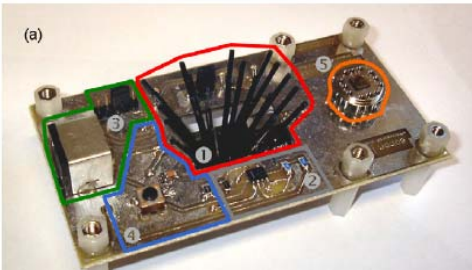
Mobile phone

Gas sensors

Simple operation!

400 gm (incl. batteries)

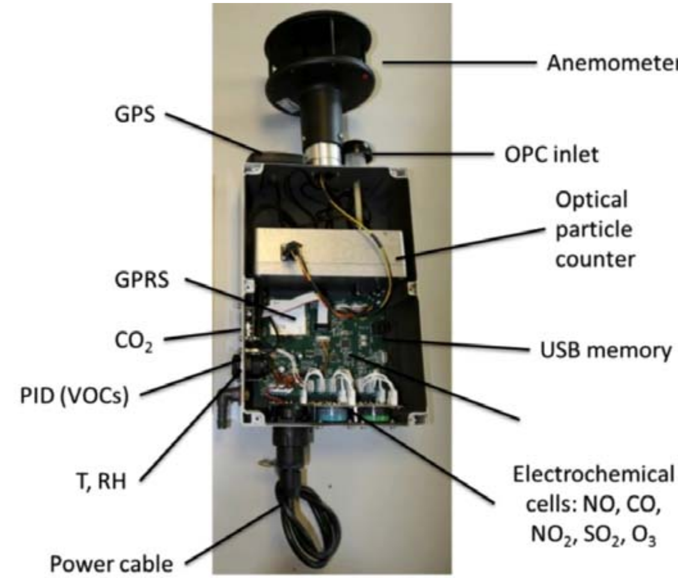
EuNetAir INNOVATION on AIR QUALITY MONITORING

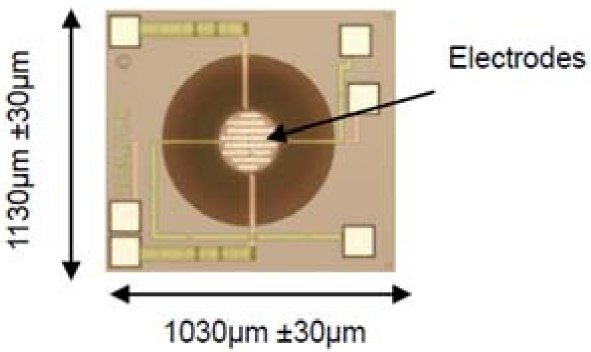


Autonomous Gas Sensor System
by IREC and Univ. of Barcelona

Autonomous EC Gas AQ Sensor System
by ENEA, Italy

Wireless sensor network for air-quality monitoring
around Heathrow airport
by University of Cambridge and Alphasense Ltd, UK



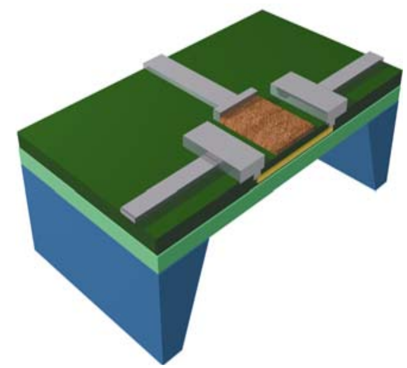


Miniaturized CMOS Sensor
by CCMOS Sensors Ltd and Warwick University

Air Quality Bike (Aeroflex) for Mobile AQ Measurements
by VITO, Belgium

A low-cost modular sensor platform combining IR spectrometry and MOX gas sensors for IAQ monitoring (CO_2, VOC) and medical applications
by 3S GmbH and Saarland University, Germany

Non-Dispersive Infra Red (NDIR) Gas Sensors (CO2) by SenseAir, Sweden



SGX-Sensortech MOX Gas Sensors
for Automotive AQ Measurements
by SGX-Sensortech, Switzerland

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PRIORITIES & ROADMAP

- What do we want to provide on the long-term in relation to **routine monitoring** and **public information** ?
- **Micro-sensors should not substitute but supplement routine monitoring devices**
- **Future routine networks** may look very different from today and **include low-cost and accurate sensors** ?
- The **green routes through the city** or access to information about **air-pollution load** at specific local address **might be future goals**
- **Pervasive low-cost microsensors for indoor energy efficiency should be a must for future green-buildings**

CONCLUSIONS

The COST Action TD1105 *EuNetAir* is proposed to solve problems in the area of:

- Air Quality Control
- Environmental Sustainability
- Indoor/Outdoor Energy Efficiency
- Climate Change Monitoring
- Health Effects of Air-Pollution

cost
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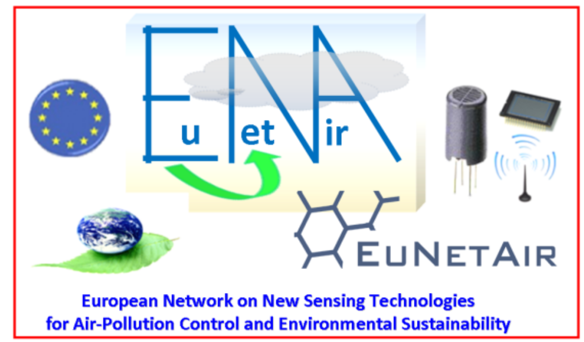

ACKNOWLEDGEMENTS

KICK-OFF MEETING of Action TD1105
COST Office, Brussels, 16 May 2012

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Rapporteur CMST:	Prof. Antonio Lagana (IT) lagana05@gmail.com

THANK YOU VERY MUCH FOR YOUR KIND ATTENTION !

TD1105 MANAGEMENT COMMITTEE

www.cost.eunetair.it

Link of COST Action TD1105 EuNetAir:

http://www.cost.eu/domains_actions/essem/Actions/TD1105?

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY