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

COST Action TD1105

2nd International Workshop *EuNetAir* on

New Sensing Technologies for Indoor and Outdoor Air Quality Control

Palazzo Nervegna-Granafei, Brindisi Municipality Headquarters

ENEA - Brindisi Research Center, Brindisi, Italy, 25 - 26 March 2014

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 2: 1 July 2013 - 30 June 2014

PRIORITIES of COST Action TD1105 *EuNetAir*

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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

Michele Penza

Function in the Action: Action Chair

ENEA - Brindisi, Italy

AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE

OUTLINE

- **WG1 PRIORITIES**: Sensor Materials and Nanotechnology
- **WG2 PRIORITIES**: Sensors, Devices and Systems for AQC
- **WG3 PRIORITIES**: Environmental Measurements and Air-Pollution Modelling
- **WG4 PRIORITIES**: Protocols and Standardisation Methods
- **SIG1-SIG4 PRIORITIES**:
  - ✓ **SIG1**: Network of Spin-offs
  - ✓ **SIG2**: Smart Sensors for Urban Air Monitoring in Cities
  - ✓ **SIG3**: Guidelines for Best Coupling Air-Pollutant & Transducer
  - ✓ **SIG4**: Expert Comments for Revision of Air Quality Directive

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

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

WG3 PRIORITIES: Environmental Measurements and Air-Pollution Modelling

WG3-Leader:	**Prof. Ole Hertel, Aarhus University, Denmark**
WG3 Composition:	**3 Sub-WG Leaders and 40 Members**

PRIORITY #1:	**Environmental Measurements**: ✓ Various portable sensor-systems to be explored as *personal sensors* and *wearable sensors* in the life of every day (e.g., bikes, pedestrians, cars, smart cities, etc.) ✓ Sensors for air quality monitoring at outdoor applications ✓ Sensors for air quality monitoring at indoor applications (e.g., green buildings, low CO_2 emissions, offices, schools, air-ventilation systems, HVAC devices, open spaces, indoor energy efficiency, etc.) ✓ Wireless sensors and wireless sensor networks
PRIORITY #2:	**Air Quality Modelling:** ✓ Air-pollution dispersion modelling at local, urban, regional and global range ✓ Chemical weather forecasting (gases, vapors and particulate matter)
PRIORITY #3:	**Synergistic Negative Health Effects of Human Exposure to Air-Pollution:** ✓ Smoke from domestic wood stoves ✓ Allergenic pollen from trees, grasses and new invasive species ✓ Airborne allergenic material (skin tissue, hair, etc.) released from livestock ✓ Fungal spores from agriculture and other sectors ✓ Airborne PM natural sources (sea spray, soil dust) ✓ Long-range transported organic & inorganic PM including agricultural emissions ✓ Pesticides applied in Europe farming ✓ Radon & ElectroMagnetic Field (EMF) in domestic buildings ✓ Toxic gases and VOCs as air-pollutants at indoor and outdoor level

WG4 PRIORITIES: Protocols and Standardisation Methods

WG4-Leader:	**Prof. Ingrid Bryntse, SenseAir SA, Delsbo, Sweden**
WG4 Composition:	**3 Sub-WG Leaders and 25 Members**

PRIORITY #1:	**Odorants**: ✓ H_2S and organic thiols (mercaptans) ✓ Odour monitoring
PRIORITY #2:	**Particulate Matter (PM)**: ✓ PM_{10}, $PM_{2.5}$, Ultrafine PM ✓ Black Carbon (BC)
PRIORITY #3:	**VOC, Indoor Air**: ✓ CH_2O methanal (formaldehyde) ✓ C_6H_6 (Benzene) and other BTX (Benzene, Toluene, Xylene)
PRIORITY #4:	**Inorganic Gases**: • NO_2 (nitrogen dioxide) & O_3 (ozone), analysed simultaneously • CO_2 (carbon dioxide) (ventilation indicator and greenhouse gas)
PRIORITY #5:	**Aiming at Low-cost Sensors**: ✓ Small sensor with simple PCB: **€100** (OEM manufacturer price to a customer which use in their system) ✓ Sensor modules: **€300**
PRIORITY #6:	**Laboratory and Field Testing at National Accredited Test Laboratories**

SIG1 PRIORITIES: Network of Spin-offs

SIG1-Leader:	**Dr. Marco Alvisi, ENEA, Brindisi, Italy**
SIG1 Composition:	**1 SIG1 Deputy and 20 Members**

PRIORITY #1:	Chemical and radiation environmental monitoring
PRIORITY #2:	Ozone sensors, NO_x, CO and SO_2 sensors for automotive applications
PRIORITY #3:	Improve stability of the available sensors, compatibility with CMOS microelectronics, soft CMOS post-processing methods for reproducible high throughput manufacturing
PRIORITY #4:	Toxic and explosive (hydrogen) gas leakage
PRIORITY #5:	Biosensor based on enzyme for dioxin and Persistent Organic Pollutants (POP), work on POP detection
PRIORITY #6:	VOC detection developing sensors modules and sensor systems
PRIORITY #7:	Indoor air quality control, leak detection
PRIORITY #8:	Odour monitoring system (odour-telephone)
PRIORITY #9:	Enhancement of the sensing properties by introducing functional receptive groups
PRIORITY #10:	Coupling different transduction modes in the same device

SIG2 PRIORITIES: Smart Sensors for Urban Air Monitoring in Cities

SIG2-Leader:	**Prof. Rod Jones, University of Cambridge, Cambridge, UK**
SIG2 Composition:	**1 SIG2 Deputy and 40 Members**
PRIORITY #1:	**Discussion of «*Smart*»**: ✓ Self-monitoring: e.g., fault detection ✓ Clever design/manufacturing: e.g., self-calibrating. *Ideally both needed*. ✓ Smart use of «*stupid*» (not educated) sensors
PRIORITY #2:	**Sensor Systems**: ✓ sensors + analysis/correction + archiving + data mining + mapping + interpretation/dissemination ✓ Deliver answers to: • General public (low pollution routes/traffic flow) • Legislature/compliance • Health impacts community • Activity goes way beyond *simple* sensor development
PRIORITY #3:	**Other Issues**: ✓ Transferring A/Q knowledge from one environment to another (do we have sensor networks everywhere ? Continuously deployed ?) ✓ Use of modelling ? Philosophy of testing models, combining model/sensor network outputs - Data assimilation - Applicability ✓ High cross-disciplinary, are all other communities represented here ?
PRIORITY #4:	**Roadmap issues** to be discussed more in SIG2

SIG3 PRIORITIES: Guidelines for Best Coupling Air-Pollutant and Transducer

SIG3-Leader:	• **Prof. Giorgio Sberveglieri, University of Brescia, Brescia, Italy** • **Prof. Eduard Llobet, Universitat Roviri I Virgili, Tarragona, Spain (*Rome and Cambridge Meeting SIG3 Chair*)**
SIG3 Composition:	**1 SIG3 Deputy and 20 Members**

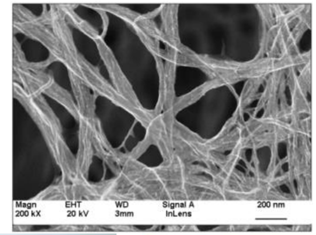
PRIORITY #1:	Identify which are the **physical parameters** being affected by gas/material interaction (for a rationale design of the transducer)
PRIORITY #2:	Continuous **measurements** *versus* exposure/recovery **measurements**
PRIORITY #3:	Study of the **best coupling** of the air pollutants associated to a given transducer
PRIORITY #4:	**Case-studies**: ✓ Common evaluation protocols for sensors (*sensor benchmarking*) ✓ Study the combination of *different transduction principles* to enhance selectivity ✓ Selection of *target applications* so specifications (i.e., sensitivity, selectivity, interference rejection, use of sample pre-treatment, response time, etc.) can be set

SIG4 PRIORITIES: Expert Comments for the Revision of the Air Quality Directive

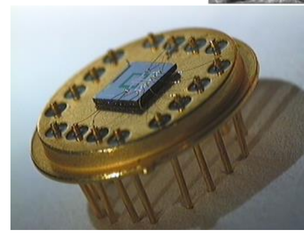
SIG4-Leader:	**Dr. Thomas Kuhlbusch, IUTA eV, Duisburg, Germany**
SIG4 Composition:	**1 SIG4 Deputy and 30 Members**

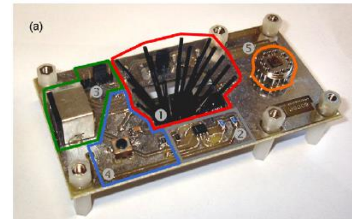
PRIORITY #1:	Sensor quality demands may be lower than those those of reference methods. Nevertheless, characterization is needed and **specific data quality requirements** have to be set
PRIORITY #2:	**Modelling** of urban air pollution and population exposure can be improved by sensors due to higher spatial resolution
PRIORITY #3:	**Ammonia** *being a precursor for PM* might be worth more attention: sensor networks could help in identifying sources; increasing controbutions from traffic and other sources in particular situations (e.g., garbage boxes)
PRIORITY #4:	Review of **AQD implementation problems** and proposals how these could be targeted by application of sensors
PRIORITY #5:	**Recommendations** on: ✓ New Metrics (e.g., Black Carbon) ✓ Data Quality Requirements ✓ Use for Model Improvements ✓ Specific Research Needed
PRIORITY #6:	**Guidelines** on *Data Quality Requirements* for sensors to be used in relation to AQD (e.g, support indicative screening or complementary modeling)
PRIORITY #7:	SIG4 addressing AQD revision planned for 2018 !

Challenges addressed by Action TD1105

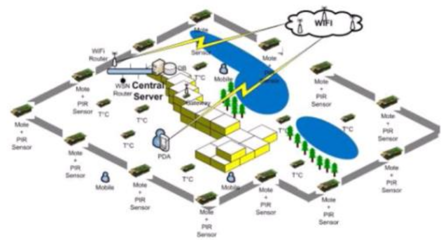


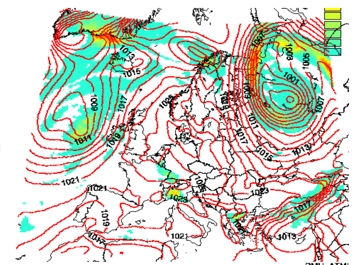
- Nanomaterials for AQC sensors
- Low-cost Gas Sensors



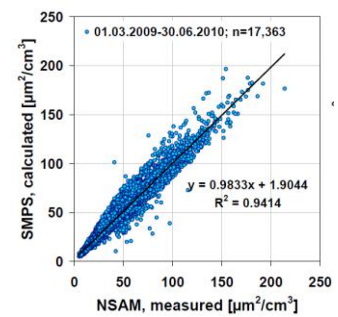


- Low-power Sensor-Systems
- Wireless Technology (*Environmental Sensors Network*)





- 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

Contact Details

- CSO Approval: 01 Dec. 2011
- Kick-off Meeting: 16 May 2012
- Start of Grant: 01 July 2012
- End of Grant: 30 June 2016

www.cost.eunetair.it

MC Chair:	Dr. Michele Penza, ENEA, IT michele.penza@enea.it
MC Vice Chair:	Prof. Anita Lloyd Spetz Linkoping University, SE spetz@ifm.liu.se
Grant Holder:	Dr. Corinna Hahn Eurice GmbH, DE c.hahn@eurice.eu
Scientific Secretary:	Dr. Annamaria Demarinis Loiotile annamaria.demarinis@uniba.it
Science Officer:	Dr. Deniz Karaca deniz.karaca@cost.eu
Administrative Officer:	Dr. Andrea Tortajada andrea.tortajada@cost.eu
Rapporteur ESSEM:	Prof. Kostantinos Kourtidis (GR) kourtidi@env.duth.gr
Rapporteur MPNS:	Prof. Joaquim Manuel Vieira (PT) jvieira@cv.ua.pt
Rapporteur CMST:	Prof. Antonio Lagana (IT) lagana05@gmail.com

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