EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

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

EuNetAir Newsletter

COST Action TD1105 Iss. 3/Dec. 2013

Editorial

M. Penza

Contents

This 3rd issue of Newsletter covers the Action grant period June-December 2013 to disseminate the networking activities and current research results in environmental science and technology from COST Action TD1105 (www.cost.eunetair.it) European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability - EuNetAir, edited half-yearly in the next four years (2012-2016) by an Editorial Board, chaired by Prof. Ralf Moos (University of Bayreuth, DE) with Editorial Board Manager Daniela Schönauer-Kamin (University of Bayreuth, DE).

The excellent teams of over 170 involved international experts such as scientists, researchers, technologists, modellers, SMEs managers from 28 COST Countries, 4 International Partner Countries (IPCs) and 3 Near Neighbour Countries (NNC) are working hard to contribute to the objectives and work plan of COST Action TD1105 in the air quality monitoring including environmental technologies, nanomaterials, gas sensors, smart systems, air-pollution modelling, measurements, methods, standards and protocols.

The concerted COST Action TD1105 is very pleased to present the networking/dissemination results of the national/international research from Action partnership to various international conferences/workshops such as 1st International Workshop on New Sensing Technologies and Transducers for Air-Quality Monitoring (June 20, 2013, Barcelona, Spain) as open satellite workshop to Transducers 2013 - Eurosensors XXVII and WG1-WG4 Meeting on New Sensing Technologies and Methods for Air-Pollution Monitoring (European Environment Agency, October 3-4, 2013, Copenhagen, Denmark). In these two meetings, over 80 Participants from at least 25 COST Countries were involved with a large participation and target audience. In this Newsletter we will give an update on the outcome of these workshops.

Special acknowledgements to the COST Office Director (Dr. Monica Dietl) for her Letter of Support received and read to the EEA meeting in Copenhagen. Many thanks for sharing the prestigious inputs on networking and "common brains" community to generate new knowledge for science, technology and innovation.

The COST Action TD1105 will hold the 2nd Scientific Meeting including Working Groups Meeting and 4th Management Committee Meeting at Queens' College, University of Cambridge, Cambridge (UK), December 18-20, 2013. The 3rd Management Committee Meeting of EuNetAir was held at IREC in Barcelona (Spain), June 21, 2013. This 3rd MCM decided to elect a new Grant Holder (GH) as Eurice GmbH, Saarbrücken (Germany). Special thanks to the old GH as University of Bari, Bari (Italy).

The First Training School of EuNetAir on Environmental Technologies and Air-Quality Monitoring was held at University of Barcelona, Electronics Department, Barcelona (Spain), June 13-15, 2013, with 39 trainees and 9 trainers from at least 20 COST Countries. This event was labelled as Green Week 2013 Satellite, by DG ENV.

EuNetAir supported 11 Short Term Scientific Missions (STSMs) in the Year 1 (July 1, 2012 – June 30, 2013) for visit and exchange of motivated Early Stage Researchers and experienced scientists from a laboratory to another one in order to start and consolidate new international research collaborations in the whole area of EuNetAir topics.

Finally, EuNetAir, represented by Action Chair, participated to the COST Annual Progress Meeting in Hannover (Germany), June 12-13, 2013, to report on progress of the Action TD1105 activities to the ESSEM Committee related to the first grant period (July 1, 2012 - June 30, 2013). The feedback from other Action Chairs and DC Rapporteur was highly positive and encouraging.

On behalf of Action Management Committee, I would like to thank ALL Action participants for their valuable scientific work, kind availability and great enthusiasm that will make our Action very successful as an excellent S&T platform to address the upcoming Horizon 2020!

Focus On

Wanted: Small, Inexpensive & Reliable Gas Sensors

J.-M. Suisse, M. Bouvet

Air pollution damages both our economic system and the environment. With estimates nearing hundreds of billions in dollars and millions in human lives, the cost has never been higher.

In an article entitled Effective Monitoring Urgently Needed To Fight Air Pollution on Mexican Cities published in June 2013, Eurasia Reviews reports on new requirements recently voted by the Mexican government, both in air quality monitoring (AQM) and air pollution reducing. In Mexican cities alone, the pollution generated by the economic activities and fossil fuel consumption is responsible for over 40 billion dollars of environmental costs (NISG) and the death of nearly 15 000 citizens each year (WHO).

In the USA, the Southeast Atmosphere Study (SAS) program, funded by the U.S. Environmental Protection Agency, the National Science Foundation and the National Oceanic and Atmospheric Administration has begun earlier this month with a $20 million investment on a short 6-weeks air quality monitoring research campaign (from June 1 to July 15, 2013), to find real solutions to America's energy challenges through innovation (sic).

Elsewhere, measures are taken that include updating regulations on clean fuels, reducing motor vehicle use in metropolitan areas, deploying air quality monitoring programs, etc. However, in Europe, air quality monitoring plans are strongly impacted by the economic situation and the fragile financial climate. In this context, new sensing technologies could help.

There is a need for reliable, high performance and low-cost sensors to support or to replace monitoring stations that currently use bulky and very costly equipment. Cheap devices built around small molecular material- or metal oxide-based sensors could be used in large numbers to provide widespread coverage. Inexpensive sensor arrays (ISAs) could be deployed in nets over cities for a fraction of the cost required by current air quality monitoring stations and could be used to track down in real-time the generation and evolution of the pollution in cities.

Information provided by ISAs could be used to study pollution pathways and help improve pollution forecasting. For example, air quality management areas (AQMAs) could be defined more accurately and in a more versatile way than they currently are. Getting fine-grained knowledge on local pollutant levels and their evolution in relation with the weather conditions will help in efficiently reducing pollution and in predicting foreseeable impact of considered air quality measures.

ISAs could also be of interest to the local population, by providing more up-to-date and more accurate information than estimates based on data collected on an AQM station far away. Many other applications to ISAs can be found, and the commercialization of first generation devices by companies such as AirBase Systems has already begun. There is still much room for research and improvement in areas such as accuracy, selectivity and connectivity (data transmission).

Evaluation of micro-sensors against standard methods for air quality control during field campaigns

C. Borrego[1], J. Ginja[1], A. M. Costa[1] and N. Moser[2]

Advanced air pollution control systems based on low-cost sensing technologies opened a new vision for air quality control. Their performances allow for a new strategy, resulting in fast responses, low operating costs and high efficiencies that cannot be achieved with conventional approaches.

Nevertheless, much research remains to be done to integrate these new technologies, particularly on the quality check of the sensors performance against conventional methods in field exercises.

In this context IDAD[1] - Institute of Environment and Development and SGX Sensortech[2] started a cooperation study to support the comparability between standardized methods and micro-sensors for air quality control during field campaigns. The application of new sensors side by side with standardized equipment in field studies will allow assessing the reliability and uncertainty of these low-cost sensors, especially regarding an accurate detection of pollutant concentration peaks.

The measurement campaigns of O_3, NO_2, CO/VOC are being conducted in two major Portuguese airports, Lisbon and Oporto, in 6 monitoring sites, from October 2013 to February 2014.

News from Working Groups

Working Group 2 - A. Schütze

Sensors, Devices and Systems for AQC

The EuNetAir meeting in Copenhagen, October 3-4, 2013, provided an excellent overview on the state-of-the-art for sensors, devices & systems for air quality control, for example with presentations on Low-Cost Metal Oxide Gas Sensors: State of Art, Perspectives and New Challenges (Prof. Juan Ramon Morante, IREC), CO_2 Sensor Applications for Saving Environment and Costs (Prof. Ingrid Bryntse, SenseAir SA) and Wireless Sensors Networks for Air-Pollution Monitoring in Cities (Vivien Bright, University of Cambridge). In addition to sensors for gas components, the importance of monitoring particulate matter was again stressed by several participants, for example in the talks Air Quality Status in Europe (Cristina Guerreiro, NILU) and Recent Trends in Measuring Particulate Metrics in Urban Air (Ulrich Quass, IUTA e.V.) One important aspect for the sensor community is the question of which parameter(s) should be measured, i.e. number, size distribution, surface area, composition or adsorbates. One recent health study showed a clear correlation between surface area of particulate matter and health effects, which could indicate that not the particles themselves are the problem but actually hazardous compounds adsorbed on their surface.Other presentations highlighted current EU projects in this field:

- MSP (Multi-Sensor Platform for Smart Building Management)
- INTASENSE (System to Control Indoor Air-Quality in Energy Efficient Buildings)
- OMNISCIENTIS (Odour Monitoring in Industrial Plants and Communities)
- CITI-SENSE (Development of Sensor-based Citizens' Observatory Community for Improving Quality of Life in Cities)

And, finally, recent developments in the field of sensors and sensor systems were highlighted in short talks and in the “posterless” poster session:

- Low-power and portable sensor-systems for Environmental Air-Monitoring (IMEC)
- Low-cost NDIR based sensor platform for sub-ppm gas detection (SenseAir SA)
- New VOC sensor system for Indoor Air Quality Monitoring (3S in collaboration with Saarland University)

SENSIndoor

- New commercial sensors for Outdoor Air Quality monitoring (AirBase Systems)
- Detection of hazardous VOC at ppb level with SiC GasFETs (preliminary results were obtained in the frame of an EuNetAir STSM based on a collaboration between Linköping University and Saarland University)
- Conductometric gas dosimeter for NO_2 detection (University of Bayreuth)
- Portable sensor-system for air quality monitoring (ENEA)

News from Special Interest Groups

Special Interest Group 1 - M. Alvisi

Research and Innovation Needs and Strategic Foresight on AQC

In order to develop a roadmap for future actions in the field of AQC (research, infrastructures, legislation) we propose to collect needs in research and innovation as well as in strategic foresight from each partner of the Action EuNetAir on AQC.

This activity is addressed to the following specific goals:

- to establish a Pan-European multidisciplinary R&D platform on new sensing paradigm for AQC contributing to sustainable development, green-economy and social welfare
- to investigate the best available technology for sensor deployment, communication, power supply and data storage, analysis and display
- to provide to the EU community and institutions a complete overview on the research and innovation needs in ACQ in Europe
- to provide the challenges and strategic foresight in AQC in Europe
- to propose a Roadmap for the implementation of infrastructures, legislation, technologies, education on AQC in Europe

A defined format for research and innovation needs collection has been presented during the last Workshop in EEA in Copenhagen and sent to MC members. Following the feedback and revisions received the format will be presented and discussed in each group during the meeting in Cambridge. Each leader should collect the contribution from each Working Group (WG) and Special Interest Group (SIG) during the Cambridge meeting in the specific WG and SIG.

A restricted group (Steering Committee) will be in charge of draft a final survey with all contributions together with the Editorial Board.

News from Special Interest Groups

Special Interest Group 3 - E. Llobet

Guidelines for Best Coupling Air Pollutants and Transducer

Recently teams from the Universitat Rovira i Virgili (Tarragona, Spain) and the University College London (United Kingdom) have reported the direct synthesis of single crystalline, metal nanoparticle functionalised tungsten oxide nanowires onto micromachined transducing microsensor platforms via Aerosol Assisted Chemical Vapour Deposition (relevant to SIG3). This co-deposition method is demonstrated to be an effective route to incorporate metal nanoparticles (NP) or combinations of metal NPs of reduced size and even distribution into nanostructured materials, resulting in an attractive way of tuning functionality in metal oxides (MOX). The results show variations in electronic and sensing properties of tungsten oxide according to the metal NPs introduced, which are used to discriminate effectively analytes (C_2H_5OH, H_2, NH_3, H_2S and CO). The method presented in this work has advantages over other methods of integrating nanomaterials and devices, of having fewer processing steps, relatively low processing temperature, and no requirement for substrate pre-treatment. Furthermore, Aerosol Assisted Chemical Vapour Deposition is a simple, cost-effective and scalable method for the production a direct integration gas sensitive nanomaterials in a wide spectrum of transducer platforms such as silicon, ceramic or polymeric. The paper was featured as inside front cover of the 23rd issue of Advanced Functional Materials (Adv. Funct. Mater. 2013, 23, 1313–1322).

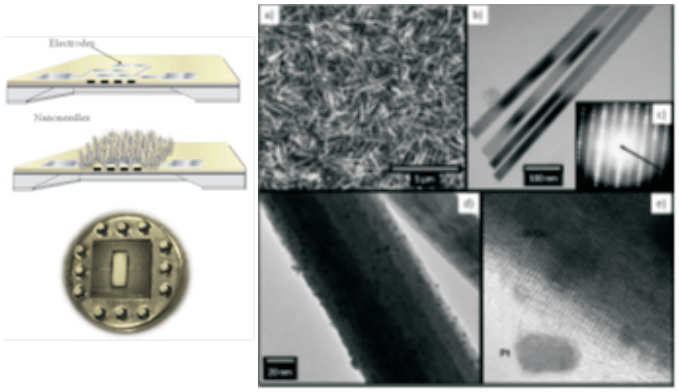


Figure: (Left) Main technological processing steps involved in the fabrication of an individual microsensor element: (Top) deposition of the platinum heater and interlevel oxide layer; deposition of the electrodes and rear side etching of the substrate, (Middle) self-catalysed growth of Pt functionalised tungsten oxide nanoneedles via AACVD and (bottom) packaging. (Right) Typical SEM (a) and TEM (b) imaging from non-functionalised and platinum- functionalised tungsten oxide films with NNs-like morphology. Selected area electron diffraction of a NN (c) and high magnification TEM from platinum functionalised tungsten oxide NNs (d and e).

Special Interest Group 4 - G. de Gennaro

Towards Italian guidelines about odour emissions …

Odour is an atmospheric pollutant that should require specific guidelines and legislative acts. Since it is strictly linked to human perception, its regulation represents a complex issue to solve. So, different regulatory approaches were adopted in international legislations, aimed to control the emissions, to evaluate the odour impact at receptors and to individuate air quality criteria. In Italy, there is no national legislation; to overcome this lack, some regions have adopted specific and different regulatory measures and guidelines. To the purpose of standardizing them and prepare a national odour emission guideline, a technical committee has been constituted, coordinated by ISPRA (Superior Institute for Environmental Protection and Research) with the collaboration of the major Italian domain experts. The work plan has started from a first recognition of the international normative approaches and judgments about cases of odour annoyance and of the methodologies for monitoring, control and impact estimation. After this preliminary phase, the technical committee will consider some waste treatment plants as case studies in which different methodologies will be compared and integrated to put in evidence their limits and advantage. In the last conference about odour emissions, occurred in Rimini during the 17th International Trade Fair of Ecomondo, the impact evaluation was the main topic proposed by the technical committee and the discussion was focused majorly on the use of dispersion models and the reliability of sensorial detection in field.

News from Ad-Hoc Groups

Gender Balance

I. Steinberga

In last meeting in Copenhagen (October, 3-4), a substantial number of female speakers participated. Sessions were chaired to almost 45 % by females, and 34 % of session presenters were female speakers. The highest numbers of female speakers were in sessions concerning Environmental Measurements and Modelling (Session 7) and Standardization of Methods for Air-Pollution Commercial Sensors (Session 9.

News from Ad-Hoc Groups

Short Term Scientific Missions (STSMs)

J. Theunis

A Call for short term scientific missions (STSMs) was launched on November 2012 to give opportunity to young researchers, PhD-students and graduated early-scientists to apply for scientific missions in host laboratories of Action partners who signed MoU of COST. In the first year, 11 STSMs of the Action were granted and have been carried out meanwhile (see details in Newsletter 2). Following the success of the STSM funding scheme in the first year, the budget for the second year was increased to accommodate 15 STSM. Until now 7 STSM have been granted and carried out. Two more applications have been submitted and are being evaluated.

Titles of approved STSM, Year 2:

- Improvement of atmospheric microsensor prototypes and software development for managing their operation
- Cambridge Air Pollution Sensor Network
- Test of LTCC-based devices for detection of content of particles
- Sensing and filtering properties of nanocarbonaceous materials for the development of relevant sensor-systems dedicated to environmental air monitoring
- Functionalized nanocarbonaceous materials for sensing and filtering properties towards VOCs
- p-type sensing metal oxides
- Environmental measurements and air-pollution modeling. PART II

The call for STSM proposals is open, and can be consulted on the EuNetAir website.

Deadlines for applications are 01/01/2014 and 01/04/2014.

News from Non-Cost and Near Neighbour Countries

High resolution laser engraving of microhotplates: A way for easy prototypization of gas sensors

N.N. Samotaev et al., National Research Center Kurchatov Institute

In our work, we a developed fast, cost and technology effective process for the production of MEMS microhotplates for gas sensors. This technology is orientated to the laboratory application. However, it can be used as well for pilot production of short thermal response time gas sensors based on MEMS platforms.

We used the substrates made of 30 micron thick boron-silicate glass with a transformation temperature of T_g = 720 °C. 400 nm thick platinum layers were deposited on the glass substrate by magnetron sputtering. For platinum patterning, glass substrate was processed using a compact high precision laser marker system based on 20 W fiber laser with a positioning accuracy of 2.5 μm and a spot size is of 50 μm (see Fig.).

By utilizing this technology, it is possible to fabricate low power consuming (< 100 mW at 450 °C) sensors with short thermal response times (approx. 80 ms). The width of the Pt lines is now about 40 μm. A resolution of about 20 μm can be obtained by laser optimization. Since it does not bend during heating, the cantilever type microhotplate is more stable against temperature cycling compared to the whole membrane. This improves the stability of highly selective metal oxide gas sensors that are operated in the temperature modulation mode.

Air Quality Issues in Ukraine

O. Turos, O. Ananyeva

According to the latest estimates and extensive health risk assessments, air pollution remains the priority issue of concern for Ukraine. Air Pollution and Risk Assessment Laboratory of O.M. Marzeiev Institute for Hygiene and Medical Ecology of NAMS of Ukraine is actively working in the field of air quality to minimize the effects of air pollution on human health and harmonize existent approaches and methodologies with those applied by international scientific community.

Recent health risk assessment estimates conducted by Laboratory for 163 industrial enterprises in 11 regions revealed that large proportion of population lives in areas, where risk levels attributed to industrial air pollution range from 10^{-4} to 10^{-3}. Apart from that, population residing within 50-300 meters from roadways appears to be exposed to higher concentration of NO_2, CO, CO_2, PM10, PM2.5, and PM1. Additionally, according to air monitoring campaign performed in school buildings, prevalence of synthetic materials and furniture in combination with poor ventilation was responsible for high concentrations of formaldehyde and BTEX in classrooms. Latest studies on the pollen pollution in Ukraine proved that pollen can be regarded as a factor aggravating the effects of the outdoor pollution. Therefore, a pollen monitoring network has been established in Kyiv city.

News from Non-Cost and Near Neighbour Countries

Towards outdoor olfactory pollution cartography in Moroccan urban areas

R. Leghrib , H. Lahlou

In agreement with air quality standards, the measurement of odour pollutants in Moroccan urban zones becomes a need, more particularly in touristic cities where the agglomeration zones are placed around landfill sites and industrial plants. These odours are on one side affecting the touristic reputation of the city without forgetting the negative impact of some specific odours on citizens' health such as NO_2, CO, Benzene, SO_2 and O_3. Nevertheless, the availability of gas measuring stations is limited by their high cost of installation and management.

This project will be conducted in conjunction with local industrial partners. It aims at developing miniaturized detectors that will be fixed in urban zones of pollution risk to effectively monitor the evolution of Moroccan air quality.

The first orienting measurements will aim to localize the target measurement points and the pollution sources within the urban zone of Agadir. This study will consist on the on-line detection of odours through a commercial measurement station based on automatic classical gas analysers that must allow modelling the spatiotemporal distribution of the odour pollution and its evolution in function of climate parameters. As a result, the development of a home-made electronic nose system based on a set of chemo resistive sensors will be realized in parallel, in collaboration between Moroccan and European research labs. The expected system shall be a more affordable alternative for building a larger air quality monitoring network.

Science & Tech Talk

CITI-SENSE: Participatory sensing for improving quality of life

H-Y. Liu, M. Kobernus, A. Bartonova and the CITI-SENSE consortium

In recent years, there has been a trend where a “Citizens' Observatory” (CO) is considered more and more an essential tool and a common perspective to better observing, understanding, protecting and enhancing our environment.

Involving citizens as active partners in environmental monitoring, and their ability to contribute to decision-making, is seen as central to effective CO implementation. The EU FP7 collaborative project CITI-SENSE (https://www.citi-sense.eu) aims to empower citizens to contribute to and participate in environmental governance, by developing Citizens' Observatories (CO) supporting a range of services related to environmental issues of societal concern with participatory sensing tools and methods being central

The main concept of the project is to link participatory sensing using own sensor platforms mainly related to air quality through GEOSS compatible data repositories with discovery and other services available. Aligned with GEOSS architecture, CITI-SENSE develops a service-oriented architectural approach, supporting multiple data stores both for sensor and for environmental/geospatial data, and multiple input and output formats and standards. Through the CO, we will provide environmental information tools which will combine traditional data sources with public contributions through the CO, and in this way enable public environmental governance. One of the issues of interest is how to use citizen-contributed data for scientific purposes, and how to combine them with other existing information sources.

Science & Tech Talk: STSM reports

Sensing and filtering properties of nanocarbonaceous materials for the development of relevant sensor systems

J. Brunet

Consecutively to its approval by the committee, my Short Term Scientific Mission (STSM) was the best opportunity to initiate a strong and ambitious cooperation with the host institution on carbonaceous nanomaterials and sensor developments for AQC. Achieved experimental activities have strengthened my skills and my knowledge on materials and transducers.

Sensitive materials had been previously developed at the Institute Pascal - Clermont-Ferrand (France), coatings on SAW transducers and experiments towards gaseous pollutants have been performed at ENEA - Brindisi (Italy). As depicted below, experimental results especially highlight the relevance of SAW-based sensing devices implementing functionalized single-wall carbon nanotubes by ttb-CuPc molecules as sensitive material for toluene detection as compared to raw carbon nanotubes. Its insensitivity to NO_2, CO and H_2S has been also established. Additional measurements are already planned.

Scientific exchanges with practitioners as well as local start-up managers, the visit of laboratories and a joint-seminar open to researchers and stakeholders of local institutions were the others key events of my mission.

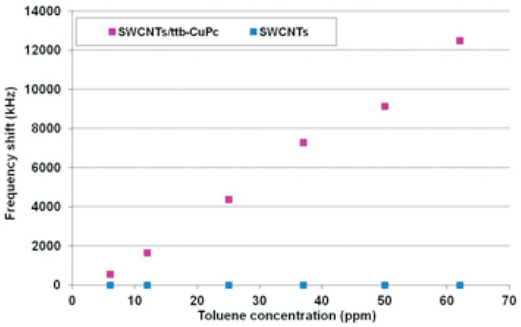


Fig. Raw SWCNTS and SWCNT/ttb-CuPc thin films on SAW transducers versus toluene concentration at room temperature. Experimental results were obtained at ENEA- Brindisi during this STSM.

Is STSM a relevant tool for young researcher and EuNetAir COST action dissemination? Undoubtedly!

Sensing and filtering properties of nanocarbonaceous materials for the development of relevant sensor systems

A. Ndiaye

I applied for a one week STSM in order to start a new collaboration with the ENEA team of Dr. Michele Penza in the field of sensors. After approval by the STSM committee, I was welcomed at ENEA for an experience oriented around these points: experimental activities, seminar and new future research activities. I could realize sensing experiments using others devices and others gases that are not available in my lab. I could present my activities and learn also about ENEA activities during a joint seminar. And finally, we have set up a guideline to follow for future activities.

Microstructured optical fibres (MOFs) as sensors for chemical trace detection

M. F. Danışman

The STSM visit to the Optoelectronics Research Centre (ORC) of University of Southampton aimed at establishing new collaborations between ORC and our research group (Middle East Technical University, Turkey) in the field of fiber loop ring-down (FLRD) spectroscopy and sensors. To this end, during the visit, ORC fiber optics fabrication and characterization facilities were visited and detailed discussions with ORC members, who are experts in the field, were made. It was agreed that ORC can provide custom designed optical fibers that we may need in the future and can provide technical help with fiber treatment preferably with man power provided by the Turkish side. It was also agreed that this could be in the form of a graduate student visiting ORC for at least three months to carry out the necessary work. In summary this visit was very helpful for progress of our research project on FLRD spectroscopy since it let us see the ORC facilities and determine what kind of collaborations/contributions by ORC may be possible in the future.

Science & Tech Talk: STSM reports

n- and p- type sensing metal oxides

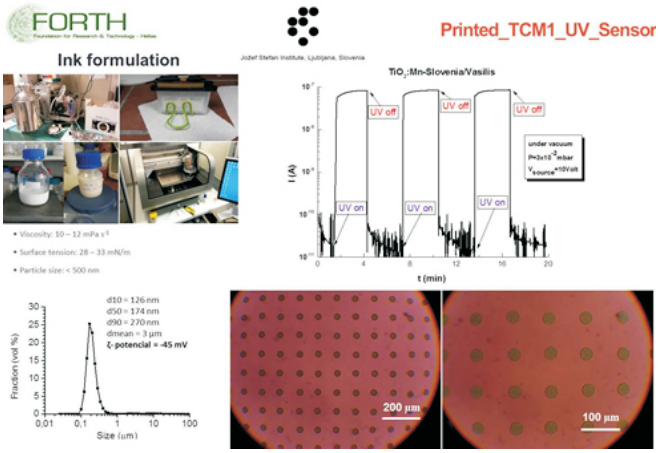
V. Binas

I am a post doc researcher at the Institute of Electronic Structure and Laser in Greece. A short term scientific mission in the framework of the COST Action TD1105 EuNetAir allowed me to visit the Electronic Ceramics Department at Jozef Stefan Institute on September with special focus on ink development of functional metal oxides for advanced gas sensors.

It was an excellent opportunity for me to deepen my knowledge and share experiences about characterization of materials and printable equipment which is essential for the further development of my research activities. This is a first visit in the Jozef Stefan Institute in Slovenia, and based on this, we have started to collaborate in this field. During my short term mission, I learned a lot about ink development (characterization of particle dispersions, formulation, and inkjet printing) and formulation of particle size dispersions for inkjet printing.

All I learned is very important to expand my research activities in new deposition and characterization techniques for n- and p- type metal oxide nanoparticles in different solutions and application of inkjet printing, in the next generation of gas sensor materials. When returning to Crete, I brought not only several printed surfaces on different substrates and know-how with me, but also a bunch of new ideas and many contacts that will be valuable for future cooperation.

Overall, the STSM was very successful. I am deeply grateful to COST Action TD1105 for making this fruitful STSM possible. I would also like to thank my hosts Prof. Barbara Malič, Danjela Kuščer, Oleksandr Noshchenko at JSI and my collaborator at FORTH, Prof. G. Kiriakidis. Snap-shots of my visit and results are presented hereby:



Evaluation of adour impact, caused by industrial sources, through an integrated approach

M. Brattoli

I am a researcher of the Chemistry Department of Bari University (Italy) and my research activity is focused on odor emissions and on all the aspects linked to olfactory pollution: monitoring and control, methodologies and technological solutions, impact evaluation and regulation. The opportunity to apply a STSM in the laboratory of Prof. Anne-Claude Romain at Liegi University and to visit Odometric s.a., the spin-off of the research group, was a great experience for my job training. In fact, during the STSM period, I deepened and learned about some aspects relating to my topic and I was involved in many activities regarding the research aspects and the direct applications of them on the territory. In particular, I focused my attention on electronic noses, developed by Prof. Romain's research group, and I had the opportunity to visit different installations there and to evaluate the scientific results obtained by their devices. Moreover, I was involved in the field inspection method for the evaluation of odor impact through sensorial detection and in olfactometric measurements, performed by an olfactometer that works with a different method related to that I use. Finally, the exchange of knowledge and experiences revealed several aspects for planning concrete collaborations between the two research groups, based on common projects.

Cambridge Air Pollution Sensor Network

M. Müller

I spent three weeks at the Department of Chemistry of the University of Cambridge, UK, in September 2013 (group of Prof. Rod Jones). This lab is strongly engaged in the development and operation of wireless sensor networks for atmospheric pollution monitoring.

First, the STSM provided me with additional insights into state-of-the-art sensor networks including aspects of technology and operation. Second, I initiated the work on a land-use regression (LUR) model utilizing CO data of a temporary sensor network in Cambridge. This network was in operation for two months in 2010. The modelling is still in progress. However, encouraging preliminary results have been achieved. An in-depth analysis of the obtained results is required in order to further improve the applied statistical modelling techniques and the incorporated explanatory variables.

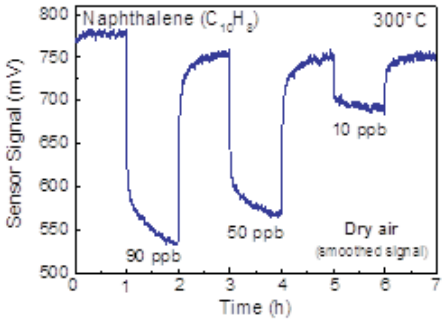
The visit in Cambridge was of great value for me. I especially appreciated the numerous discussions with the colleagues of the host institution and their support. The collaboration with the Cambridge group in the field of LUR modelling will continue.

Science & Tech Talk: STSM reports

SiC-FET sensors for sensitive detection of hazardous VOCs

D. Puglisi

I spent my two-week STSM at Saarland University, Germany, to test, for the first time, the response of new generation Ir-gated SiC-FET gas sensors to ultra-low concentrations of hazardous volatile organic compounds (VOCs). Formaldehyde, naphthalene, and benzene were used as typical VOCs at high temperature, in dry air and under different percentages of relative humidity. Gas tests were carried out using a single VOC at a time to study sensitivity, response and recovery times, temperature dependence, effect of relative humidity, detection limit, and long-term stability. Data evaluation confirmed the suitability of such devices for being used as highly sensitive gas sensors for indoor air quality monitoring and control. Results have been already presented at national and international conferences and meetings (Sweden, Spain, Japan). The STSM offered the possibility to consolidate the collaboration between the two research groups and put the basis for a targeted development of the project and improvement of sensor performance and characteristics.

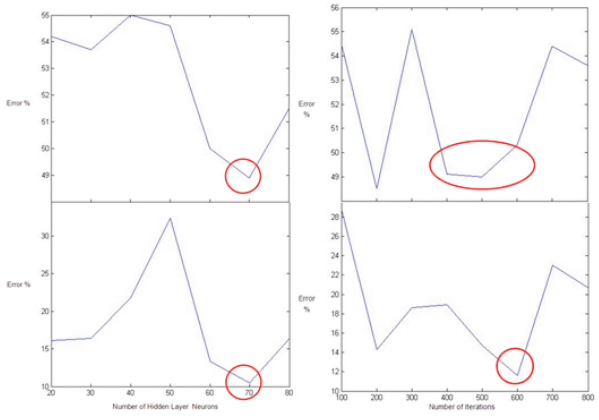


From a personal point of view, it was a really stimulating and joyful experience, for the high-quality professional environment, the very friendly welcome received from all people met, and the familiar atmosphere of the region, reminiscent of my home region.

Improvement of atmospheric microsensor prototypes and software development for managing their operation

S. Aram

Research on the topic "Improvement of atmospheric microsensor prototypes and software development for managing their operation" was carried out under the auspices of the Aristotle University of Thessaloniki within the frame of COST ActionTD1105 STSM. Its period spanned from Aug 26 – Sep 26, 2013. Principal research objections are outlined as follows: a) improving the application-level stability of Bluetooth-based temperature and humidity acquisition system and concerning sensor power consumption; b) participatory design and development of a pervasive parsing platform for Android-based environmental sensing applications; c) assessing the prospects to prolong the sensor's lifetime by flexible data gathering for battery-powered sensor networks using a smartphone with regard to power-aware buffering; using Bluetooth-based sensors to perform readings of environmental information in the AUTh's lab, having reduced the time of reading by 50%. d) In the course of research, neural-based data driven method (involving multi-layer perceptron) was applied to four air pollution parameters of Agsofias station data (temperature, humidity, PM10, O_3). Accordingly, the tests were conducted to check whether less communications and data transmitting could be performed by a lower rate of power. Besides, the sensor prototypes of Neuronica's LAB, their functionalities and related application were presented to the AUTh scientists.



70 hidden layer' neurons have about 49% of training error and 12% after undersampling. Moreover, increasing the number of iterations between 500 and 600 will decrease errors on training and after undersampling to about 50-48% and 12%, respectively. Analyzing the number of neurons in hidden layer (left) and iterations(right) in order the percentage of the error of training data and fitting after undersampling are shown in the Fig.

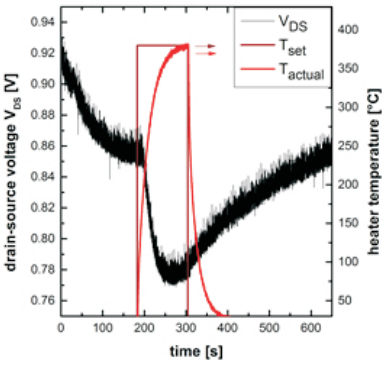
Science & Tech Talk: STSM reports

Test of LTCC-based devices for detection of content of particles

C. Bur

Particulate matter is a serious health risk and in addition to the size and the shape of the particles, their content and possible adsorbents are crucial. Earlier work with ammonia contaminated fly ash and a ceramic heater has shown that ammonia can be desorbed by heating up the ash to several hundred degrees. The desorbing molecules can then be measured by a gas sensor, e.g. silicon carbide based field effect transistors (SiC-FET).

During my STSM, I have tested new LTCC heaters which have been processed earlier and can be seen as a test structure and a platform for a comprehensive particle sensor system. Measurements with fly ash and synthetic contaminated particles have shown that the LTCC prototypes are in principle suitable for detecting the content of particles (Fig.). However, several new ideas with respect to the design of the heaters and the measurement setup have been developed and intensively discussed with my colleagues at University of Oulu. Thus, the STSM was a good platform to strengthen the collaboration between Oulu and Saarland University. In particular, thermal characterization of the next generation of LTCC heaters will be performed at Saarland University.

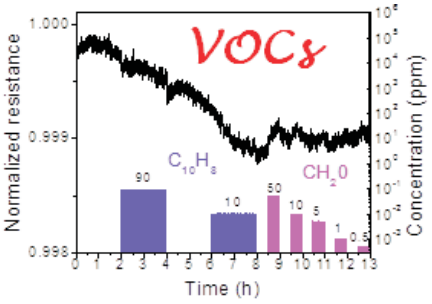


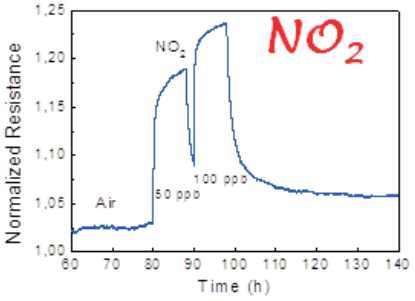
Graphene-based gas sensors for ultra-sensitive detection of NO_x and VOCs

J. Eriksson

Gas sensors on epitaxial graphene on silicon carbide are extremely sensitive to certain molecules, allowing detection limits below 1 ppb for nitrogen oxides. Moreover, different graphene modifications allow tuning the selectivity towards e.g. NO_2. Because of the extreme sensitivity and potential for selectivity tuning, these sensors could be highly interesting for detection of hazardous volatile organic compounds, VOCs.

During my STSM, sensors based on epitaxial graphene and modified epitaxial graphene were tested towards ultra-low concentrations of several VOCs, using a new gas mixing system developed at Saarland University. Pristine graphene and most modified graphene showed very little interaction with any of the tested VOCs. While discouraging for VOC detection, this result is promising for the further development of highly selective, ultra-sensitive NO_2 sensors. On the other hand, graphene modified with nano-porous platinum showed potential for this sensor technology in VOC detection (see figure), but also demonstrated that more suitable surface modifications are required.





In addition, the STSM deepened existing collaboration between the groups at Linköping University and Saarland University, in particular related to investigating electrical and structural changes in sensing layers upon exposure to gases and elevated temperatures.

Science & Tech Talk

Smart & cheap CO_2 sensors save environment

I. Bryntse, H. Martin

Low-cost smart sensor systems can exactly optimise the CO_2 concentration for any particular application, generally described as Alarm, Process Control and Ventilation.

Alarm

A high CO_2 concentration (>30 000 ppm) is fatal and has caused accidents for instance at restaurants, where the gas is used as a propellant for beer and soda. An undetected leakage in a small space leads to heart problems or death so people at these sites must be fully secured by using appropriate alarm systems. In total, safety applications for industries, food packaging sites and restaurants / pubs could avoid hundreds of accidents every year in Europe and in the same time save money thanks to decreased number of hospital intensive care days.

Process Control

An exactly tuned CO_2 concentration in processes increases not only the yield but also the quality. An obvious example is mushroom farming where a specific gas concentration gives a more nice and dense shape of a particular mushroom. For tomatoes and cucumbers the yield could be enhanced up to 10% using CO_2 controlled atmosphere. In large garbage burners continuous flue gas analysis does not only increase the effect of the process - it also yields a less dangerous exhaust.

Ventilation

A high CO_2 level, caused by many persons in a closed volume, could give input for people to open their windows, or automatically open the window for them. A more common way is that the fan speed or valve opening is tuned by the gas levels. An elevated CO_2 level is tiring, and better ventilation of course reduces that effect. At the same time, the amount of particles, viruses and other unhealthy air components decreases. On the other side is the risk of overventilating areas with fluctuating occupancy. CO_2 demand control ventilation gives a significant energy & cost reduction.

In conclusion, society would gain a lot from more usage of CO_2 sensor systems:

- Reduced energy consumption
- Decreased events of death and fewer intensive care days at hospitals
- Higher efficiency / quality for process applications

If Europe decides to implement mandatory CO_2 sensors in new industries, constructions, greenhouses, as well as after restoration of old buildings and plants, we would save more than 2 billions EU / year due to reduced energy consumption and in addition 200 human lives would be spared every year. The reduced energy usage will of course improve the out-door air quality, giving us an increased overall health status.

Overview on EuNetAir Events

Summary of 1st Training School in Barcelona

A. Romano-Rodriguez

On June 13-15, 2013, immediately prior to the Transducers 2013 conference, the 1st Training School on Environmental Technologies and Air-Quality Monitoring took place at the premises of Universitat de Barcelona in Spain. The topics taught in the school covered from materials, devices and systems for gas sensing applications, to signal treatment and environmental monitoring, showing the interdisciplinary nature of the EuNetAir COST Action. A visit and demonstration of an experimental environmental monitoring station at IDAEA-CSIC in Barcelona was included in the program immediately after the lectures.

30 trainees from 12 participating countries attended the school, from which 18 where financially supported by the COST Action and 2 additional ones could not attend the school due to strike. The lectures were given by 12 trainers, from which 8 were local and 4 came from abroad and were also financially supported by the Action. To close the school, the trainees were invited to dissert to their colleagues and to the trainers about their ongoing scientific and technical activities, which were aligned with the topics taught in the training school.

Overview on EuNetAir Events

Summary of 1st Action Workshop in Barcelona

E. Llobet

The 1st International Workshop on New Sensing Technologies and Transducers for Air-Quality Monitoring organized by the EuNetAir COST Action TD1105 took place in Barcelona (Spain) on 20 June 2013 as an open satellite event inside the Transducers 2013 - Eurosensors XXVII Conference. The Workshop comprised two Oral and one Poster Sessions and brought together speakers from the Action (from France, Italy, Spain, Switzerland and United Kingdom) and external international experts (from Australia and Russia). The Action chair opened the sessions by giving a short overview of the Action and plans for the future, and this was followed by presentations on recently achieved results on materials for chemical sensors and transducers (i.e., carbon nanomaterials, low-dimensional metal oxides, conducting polymers and hybrid nanomaterials). Additionally, the development and performance analysis of sensors and transducers for air quality monitoring systems was discussed as well. Special emphasis was given to low-cost (e.g., printed sensors on polymeric foil), mobile and wireless approaches for air pollution monitoring. This successful workshop helped disseminating the latest results achieved by the Action and contributed to increase its visibility, the latter provided by the Transducers - Eurosensors international environment.

Summary of WG1-WG4 Meeting in Copenhagen, hosted by EEA

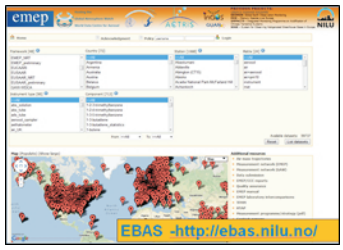
A. Lloyd-Spetz

The chairman, Michele Penza, is congratulated to a very interesting and up-to-date program with a large number of interesting speakers. We learned about how the maps of different pollutions in the world are generated and how to use them. We got reports of the pollution situation in different countries. A number of on-going EU projects were reported and we learned about unmanned airborne vehicles, with, for example, the application to investigate the sources of airborne allergens in urban areas. We heard about recent development in wireless sensor networks, gas sensors and particle monitoring systems. The “posterless” poster session, with 3 min talks by a large number of participants worked perfectly. A booklet with all abstracts can be found on our homepage.

Interactions with the EMEP monitoring program

W. Aas, K. Tørseth

The main objective of EMEP (European Monitoring and Evaluation Program (www.emep.int)) is to provide governments with information of the deposition and concentration of air pollutants, as well as the quantity and significance of the long-range transmission of air pollutants and their fluxes across boundaries. A comprehensive, state-of-the-art monitoring at rural sites, integrating all variables relevant to assess atmospheric composition change, atmospheric processing and effects is fundamental for EMEP. It consists of long term measurements with known quality and comparability over time and space. Comparability is essential, and an important task of EMEP is to establish manuals, QA/QC (quality assurance/quality control) procedures etc. Further on, the monitoring program has increased the interactions with the research communities in the past decade; it includes cooperation on scientific development as well as development of reference methods and reporting from infrastructure projects. The intensive measurement periods are an important part of this cooperation, and the next campaign aims for 2016. The topic not decided but one relevant issue is to get better spatial and temporal coverage of VOCs, and this may be something which could be of interest for the EuNetAir community.



Recent trends in measuring particulate metrics in urban air

U. Quass, T.A.J. Kuhlbusch

Monitoring of airborne particles in urban areas has experienced steadily increasing public and scientific interest, and the need to monitor and control PM mass concentrations in ambient air as laid down in corresponding legislation has led to the development of a variety of automated systems which are nowadays used worldwide in many governmental monitoring networks.

Besides the conventional mass concentration measurement, manufacturers of aerosol analysers have developed a variety of devices to quantify other particle metrics. Among these are

- Particle counting and sizing instruments using either optical or electrical particle characteristics,
- Particle surface monitors based on diffusive charging
- Instruments providing proxy signals connected to the fraction of carbonaceous compounds
- Multi-component chemical analysers which together allow quantifying the main chemical compounds as well as minor elemental and carbonaceous components.
- Devices that can discriminate biological from non-biological particles

The presentation summarized recent developments in particle measurement technologies with regard to the various metrics discussed to be of health relevance and their potential to provide new directions in air quality monitoring and research, an issue also taken up in the air quality review report published recently by the European Commission.

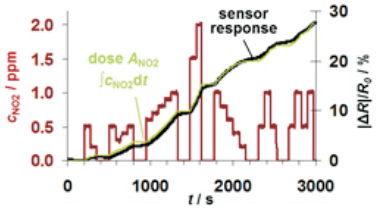
Overview on EuNetAir Events

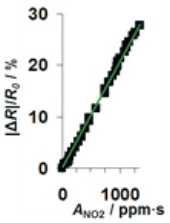
Conductometric Gas Dosimeters for NO_2 Detection

I. Marr, A. Groß, R. Moos

Gas sensors working in the accumulating mode are suitable for the direct determination of the analyte dose or the mean concentration in a defined period of time and the long-term detection of lowest analyte concentrations. The sensitive materials are able to change at least one electrical property by the selective accumulation of analyte molecules. During the sorption phase, the irreversible analyte accumulation can be caused either by a chemical reaction or a strong analyte sorption between the analyte molecules and the sensitive material. In case of a limited sorption rate of the sensing material or deterioration of the sensing characteristic caused by saturation effects, regeneration has to be conducted.

The dosimeter principle was exemplarily investigated for a carbonate-based NOx storing material. Due to nitrate formation, a resistance change can be measured. The sensor response, $|\Delta R|/R_0$, follows the characteristic behavior of a gas dosimeter with a concentration-dependent slope during exposure to NO_2 and remains at its level in absence of NO_2. The time integral of the concentration, $\int c_{NO2}(t)dt$, reflects the course of the accumulated NO_2 amount (dose), being in accordance with the course sensor signal.





The characteristic line gives a linear correlation between $|\Delta R|/R_0$ and the total NO_2 amount (dose) A_{NO2} (b).

The black carbon mapper: A platform to map black carbon exposure at street level with volunteers

B. Ellen

Pedestrians and cyclists are exposed to traffic pollution while moving around in urban environments. Their level of exposure can differ significantly from street to street. Fixed monitoring networks are unable to measure this spatial variability. Mobile air quality measurements are required. Due to significant temporal variations in black carbon (BC) exposure levels, a large amount of repeated measurements is needed. This can be collected in a cost-effective way by cooperating with volunteers and city personnel.

The “Black Carbon Mapper” (BCM) is a platform developed by VITO to collect the required large amounts of mobile BC measurements and to process them into street-level BC exposure maps. It contains two parts: user friendly measurement devices which allow city personnel and volunteers to collect mobile BC measurements, and an automated data processing infrastructure which constructs and updates the BC map. Processing steps include enhancement and validation of noisy second BC measurements and distorted GPS tracks, background correction and spatiotemporal data aggregation.

The BCM platform has been successfully tested in the cities of Antwerp and Ghent. It has proven to be a powerful platform which allows to get a detailed view on the street-level BC exposure of cyclists and pedestrians in urban environments.

Geriatric study in Portugal on Health Effects of Air Quality in Elderly Care Centers

J.P.Teixeira

The study of indoor air quality in homes of elderly persons is becoming an important issue to be addressed by clinical research due to the rising percentage of adults aged 65 years and older and the amount of time they spent indoors. In fact, older persons may be particularly at risk of detrimental effects from pollutants, even at low concentrations due to their common reduced immunological defense and multiple underlying chronic diseases.

In this sense, the GERIA Project (Geriatric study in Portugal on Health Effects of Air Quality in Elderly Care Centers) (www.geria.webnode.com) assesses 20 elderly care centers (ECCs) chosen among 60 in Porto and Lisbon. This study will provide crucial information about ECCs construction characteristics, indoor environment and prevalence of cardio-respiratory diseases for older persons in Portugal. Our preliminary results point out that: (i) PM2.5 are not within the reference levels; (ii) Prevalence of indoor sources for TVOC, Bacteria, CO and CO_2 in both seasons; (iii) Season significant differences for PM10, TVOC, Bacteria and CO_2; (iv) Bacteria and CO_2 show significant differences between the diverse indoor analyzed areas; (v) Fungi samples raise concern showing incidence of Aspergillus fumigatus that can cause invasive lung infections in susceptible individuals as elderly. Ongoing analysis is focusing on the interaction between IAQ variables, building and ventilation characteristics, as well as, the health outcomes.

GERIA
Geriatric Study in Portugal on Health Effects of Air Quality in Elderly Care Centers

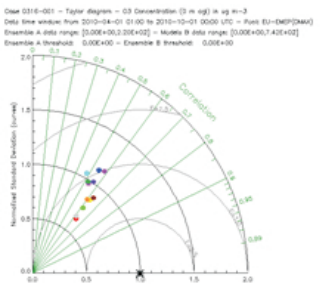
Overview on EuNetAir Events

Bulgarian participation in the AQ model Inter-comparison exercise AQMEII-p2

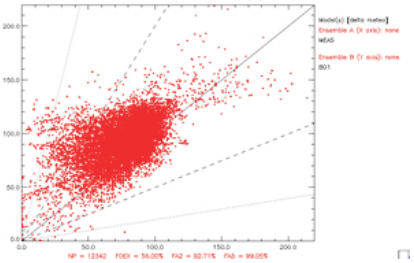
D.Syrakov, M.Prodanova, E.Georgieva, K.Slavov

AQMEII (http://aqmeii.jrc.ec.europa.eu/aqmeii2.htm) stands for Air Quality Modelling Evaluation International Initiative. It aims at promoting research on regional air quality model evaluation across the European and North American modelling communities. It is supported by the Joint Research Centre/IES, Environment Canada and US-EPA that act as regional focal points.

AQMEII phase2 exercise was devoted to simulation of year 2010. More than 20 modelling groups from EU and NA took part in it. As to make all model results available to all groups, it was decided to use the ENSEMBLE system for data archival and consultation. The system is a web-based platform for model inter-comparison and multi-model ensemble analysis with many built-in on-line statistics and graphical tools. The ENSEMBLE system accepts data in a customized format. Participating groups convert their data in the required format and deliver it to JRC via FTP. Technical Specification Documents (TDSs) are distributed with detailed instructions. Each group had to prepare and upload over 100 files containing modelled data for all year 2010 on hourly basis. Pollutants were interpolated to specific grids and observation points. The NIMH modelling archive overcomes 1 TB memory.



The figures (Taylor and Scatter Diagrams) show NIMH preliminary estimates for summertime Ozone daily maxima as produced by ENSEMBLE system.



CMOS-based capacitance measurements for cell adhesion sensing applied in evaluating the cytotoxicity of nanomaterials

N. Halonen

Nanomaterials are found in a variety of products on the market, including electronic, automotive, cosmetic, and medical applications. However, even though the biological effects of a bulk material might be well known, at the nanoscale the very same material may be harmful to health. Typically health effects are evaluated by cytotoxicity assays and animal testing, the latter posing ethical issues. Here, we introduce the use of charge-based capacitance measurements for sensing cell adhesion to the substrate surface to evaluate the cytotoxicity of nanoparticles. Adherent cells normally spread out and make close contact with the substrate on which they are cultured, but stressed cells “ball up”; this change in attachment can be sensed via a change in capacitance. The sensors were produced in a commercially available CMOS technology. The IC chips consisted of capacitance sensors arrays and readout circuitry. The capacitance sensors were fully differential to increase dynamic range and suppress noise. The technology was tested with TiO_2 nanowires, which have been reported to be cytotoxic. Adherent kidney cells of Cercopithecus aethiops were cultured on the surface of the CMOS sensor and exposed to nanowires. The cell viability after exposure was evaluated with both the CMOS chip and a commercial cytotoxicity kit. Preliminary results indicate that cell viability can be monitored by capacitance measurements.

Fiber Loop Ring-Down (FLRD) Spectroscopy for Trace Chemical Detection

M. F. Danisman

The method of fiber loop ring down (FLRD) spectroscopy is a technique that combines high sensitivity of cavity ring down spectroscopy and elasticity of fiber optic wires. FLRD is a time domain technique that measures optical losses of a light pulse in a fiber loop. In FLRD spectroscopy, leaking light at each trip within an optical cavity is measured. Intensity of leaking light has an exponential decay where it is reduced by absorption of sample and scattering of light. FLRD technique is utilized to characterize different chemicals and sensing various physical properties such as pressure, temperature, refractive index etc. via remote control. The use of FLRD spectroscopy with the aim of trace gas detection increases in recent years. Different FLRD systems are being improved with this aim in order to increase its sensitivity. It is the ultimate aim to be able to do trace detection at visible region where the chemical sensitivity is higher. Here we present an initial set-up that was designed at 1535 nanometer and its application on gas and liquid sample detection for trace chemical analysis. Ring down time was calculated as $\tau_0 \sim 2.257$ μs, and the total loss was 5.317 % at this time. We aimed a low loss and high efficiency in the set-up.

Overview on EuNetAir Events

CITI-SENSE: Participatory sensing for improving quality of life

H-Y. Liu, M. Kobernus, A. Bartonova, CITI-SENSE consortium

Involving citizens as active partners in environmental monitoring, and their ability to contribute to decision-making, is seen as central to protect and enhance our environment. The EU FP7 collaborative project CITI-SENSE (http://www.citi-sense.eu) aims to empower citizens to both contribute towards and participate in environmental governance, by developing Citizens' Observatories (CO) supporting a range of services related to environmental issues of societal concern with participatory sensing tools and methods being central. The main concept of the project is to link participatory sensing using own sensor platforms mainly related to air quality through GEOSS compatible data repositories with discovery and other services available. Through the CO, we will provide environmental information tools, developed by relating our own data to other data sources, including data from the public and tailored to the needs of different user groups. In this way, we enable direct input from the public to environmental governance. One of the issues of interest is how to use citizen-contributed data for scientific purposes, and how to combine them with other existing information sources.

The project raises the following questions:

- Is CO needed as a support system for community-based environmental governance?
- What is CO in environmental health context?
- What do citizens want from and what can citizens offer a CO?
- What products and services from a CO are useful for citizens' daily life?
- How to recruit and retain citizens to participate in environmental governance?
- Which tools can support citizens to report/upload their observations?
- Which tools can facilitate citizens getting environmental information?

Allied with GEOSS, the CITI-SENSE framework will be implemented in three empowerment initiatives; outdoor air quality, indoor air quality in schools and public spaces. These empowerment initiatives will address the questions above and will act as a medium for providing answers to them.

MSDI heterojunctions for reliable ammonia sensing in moist environment

J.-M. Suisse, M. Bouvet, P. Gaudillat

Cheap conductometric sensors built around an MSDI heterojunction are capable of detecting and quantifying ammonia even under moist atmospheres. These sensors are made of two thin layers of molecular materials deposited onto comb-shaped electrodes. The sensors are small-sized (1 cm^2), energy-efficient (1 µW) and cost effective. The MSDI sensor is built using an n-type molecular semiconductor as sub-layer (fluorinated phthalocyanine) and a p-type intrinsic molecular semiconductor as top-layer (lutetium bisphthalocyanine). This sensor was successfully tested for ammonia concentrations in the 10–90 ppm range under 10–70 % RH. It exhibits a stable response to ammonia and a low current drift, not almost independent from the moisture level.

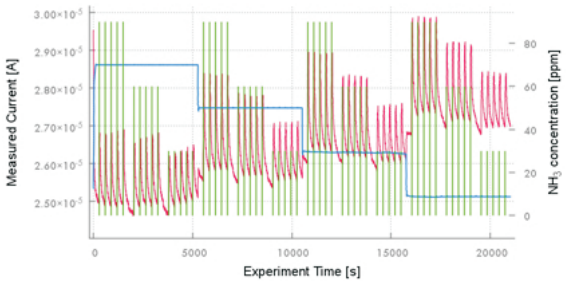


Figure: Current response (red) of the sensor exposed to several ammonia concentrations (green) under moist atmosphere (blue) at 70, 50, 30 and 10 %RH

Ambient air measurements of PM and black carbon at air quality stations in Spain

M.C. Minguillón, A. Alastuey, M. Cusack, M. Pandolfi, N. Pérez, A. Ripoll, C. Reche, M. Viana, X. Querol

Particulate matter (PM) is one of the key air quality parameters in Europe according to the last European Environment Agency report. Whereas PM2.5 concentrations are similar across Europe, PM10 (mainly its mineral fraction) and sulfate concentrations are higher in the south than in the north of Europe. The decrease in PM2.5 concentration observed in the past years across Spain may be partially due to the economic crisis. Carbonaceous materials typically account for 10 to 50% of the PM10 mass concentration. The influence of secondary organic carbon (OC) with respect to primary OC is relatively higher at the background areas due to aging of the aerosol. Elemental carbon (EC, sometimes used as an equivalent to black carbon, BC) is exclusively of primary origin (incomplete combustion of carbon containing fuels), and its main origin in Spain is road traffic, although in industrialized cities it is also influenced by such facilities. The influence of biomass burning on EC is low in Spain. The particle number concentration follows the same trend as BC in central and north Europe, whereas in Spain there is a clear increase around midday, pointing at the influence of nucleation processes due to the intense photochemical activity.

Overview on EuNetAir Events

Wireless sensor networks for air pollution monitoring in cities

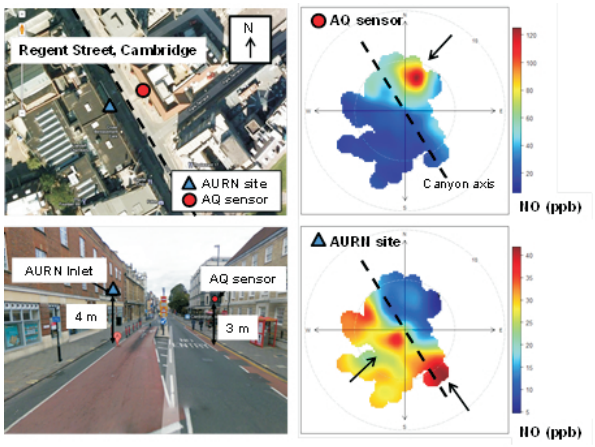
V. B. Bright

Air quality within urban areas is highly heterogeneous in both time and space. Whilst modelled pollutant levels on the local scale often suggest high degrees of spatial and temporal variability (particularly on the micro-scale), relatively sparse fixed site automated urban networks only provide low spatial resolution data that do not appear adequate in detecting such small scale variability.

Wireless sensor networks for air quality monitoring which utilise a variety of measurement techniques, including electrochemical have the potential to provide valuable insights into pollutant variability inherent on the local or micro-scale and improve air pollution characterisation (Mead, M.I., et al., The use of electrochemical sensors for monitoring urban air quality in low-cost, high-density networks. Atmospheric Environment 70 (2013) 186-203).

Results obtained from two sensor network deployments that provide high spatial and temporal (ranging from 2 to 20 s) resolution observations transmitted in near real time were presented. The first of these included measurements of CO, NO, NO_2, temperature and humidity obtained from 46 sensor nodes located in and around Cambridge. The second, currently deployed (40 nodes) at London's Heathrow Airport, provides additional observations of O_3, SO_2, VOCs, CO_2 as well as size-speciated particulate matter (0.38 to 17.4 µm), wind speed and direction.

For the Cambridge deployment the use of a network in permitting the discrimination between near-field and far field emissions was demonstrated. The utility of the sensor network in determining the spatial variability in pollutant levels (e.g. within street canyons) within a city was also shown with comparison made between network observations and model output simulated using the atmospheric dispersion model ADMS-Urban.



The polar bivariate plots below show that elevated levels of NO are observed for the AQ sensor when the wind direction is north to north-easterly (i.e. perpendicular to the canyon axis) in comparison to the AURN site on the opposite side of the street where NO mixing ratios are considerably lower (~ 100 ppb). These observations may be attributed to street canyon effects where, under such conditions, the AQ sensor is located down-wind of the vehicle emission source at street level (transporting emissions towards the sensor) whilst the AURN sensor is up-wind (pollutants carried away from the sensor).

When the wind is south to south-westerly in direction however, whilst perpendicular to the canyon axis, the reverse is true with the highest NO levels now observed at the AURN sensor when compared to the AQ sensor (albeit a smaller difference between sensors evident). In addition, for the AURN sensor when the wind is south-easterly (i.e. parallel to the canyon axis) an additional pollutant source is now evident where pollutants may be transported at higher wind speeds from a busy junction located toward the end of the street.

Announcements

Upcoming Events

International Meeting on Chemical Sensors
16-19 March 2013, Buenos Aires (Argentina)
http://www.imcs2014.org/

2nd Action Workshop
25-26 March 2014, Brindisi (Italy)

2nd Training School
9-11 April 2014, Saarbrücken (Germany)

Sensor + Test 2014
The measurement fair
3-5 June 2014, Nuremberg (Germany)
http://www.sensor-test.de

17. ITG / GMA-Fachtagung „Sensoren und Messsysteme“
3-4 June 2014, Nuremberg (Germany)
http://www.sensor-test.de

E-MRS 2014, including EuNetAir Action Symposium
26-30 May 2014, Lille (France)
http://www.emrs-strasbourg.com/index.php

5th MC Meeting
30 May 2014, Lille (France)

Publications of EuNetAir participants

List of publications related to EuNetAir

[1] A. Vásquez Quintero, B. van Remoortere, E. C. P. Smits, J. van den Brand, D. Briand, H. F. M. Schoo, N. F. de Rooij, *Microelectronic Engineering* **2013**, 110, 52–58.

[2] T. H. Nguyen, E. Chevallier, J. Garcia, T. D. Nguyen, A. M. Laurent, C. Beaubestre, P. Karpe, T. H. Tran-Thi, *Sensors and Actuators B: Chemical* **2013**, 187, 622–629.

[3] J. Rossignol, G. Barochi, B. De Fonseca, J. Brunet, M. Bouvet, A. Pauly, L. Markey, *Sensors and Actuators B: Chemical* **2013**, 189, 213–216.

[4] A. Lloyd Spetz, J. Huotari, C. Bur, R. Bjorklund, J. Lappalainen, H. Jantunen, A. Schütze, M. Andersson, *Sensors and Actuators B: Chemical* **2013**, 187, 184–190.

[5] J. Huotari, J. Lappalainen, J. Puustinen, A. Lloyd Spetz, *Sensors and Actuators B: Chemical* **2013**, 187, 386–394.

[6] M. Bouvet, J. M. Suisse, T. Sizun, A. Kumar, G. Barochi, B. De Fonseca, J. Rossignol, *Sensors and Actuators B: Chemical* **2013**, 187, 204–208.

[7] M. I. Mead, O. A. M. Popoola, G. B. Stewart, P. Landshoff, M. Calleja, M. Hayes, J. J. Baldovi, M. W. McLeod, T. F. Hodgson, J. Dicks, et al., *Atmospheric Environment* **2013**, 70, 186–203.

[8] J. Hue, M. Dupoy, T. Bordy, R. Rousier, S. Vignoud, B. Schaerer, T. H. Tran-Thi, C. Rivron, L. Mugherli, P. Karpe, *Sensors and Actuators B: Chemical* **2013**.

[9] R. Beelen, G. Hoek, D. Vienneau, M. Eeftens, K. Dimakopoulou, X. Pedeli, M.-Y. Tsai, N. Künzli, T. Schikowski, A. Marcon, *Atmospheric Environment* **2013**.

[10] M. Eeftens, M.-Y. Tsai, C. Ampe, B. Anwander, R. Beelen, T. Bellander, G. Cesaroni, M. Cirach, J. Cyrys, K. de Hoogh, et al., *Atmospheric Environment* **2012**, 62, 303–317.

[11] M. N. Descamps, T. Bordy, J. Hue, S. Mariano, G. Nonglaton, E. Schultz, T. H. Tran-Thi, S. Vignoud-Despond, *Sensors and Actuators B: Chemical* **2012**, 170, 104–108.

[12] H. Haberl, D. Sprinz, M. Bonazountas, P. Cocco, Y. Desaubies, M. Henze, O. Hertel, R. K. Johnson, U. Kastrup, P. Laconte, et al., *Energy Policy* **2012**, 45-222, 18–23.

[13] C. Bur, P. Reimann, M. Andersson, A. Lloyd Spetz, A. Schütze, *Microsyst Technol* **2012**, 18, 1015–1025.

[14] J. Courbat, D. Briand, L. Yue, S. Raible, N. F. de Rooij, *Sensors and Actuators B: Chemical* **2012**, 161, 862–868.

[15] O. Hertel, C. A. Skjøth, S. Reis, A. Bleeker, R. M. Harrison, J. N. Cape, D. Fowler, U. Skiba, D. Simpson, T. Jickells, et al., *Biogeosciences* **2012**, 9, 4921–4954.

[16] C. Bur, P. Reimann, M. Andersson, A. Schütze, A. L. Spetz, *IEEE Sensors J.* **2012**, 12, 1906–1913.

[17] D. Baumgardner, O. Popovicheva, J. Allan, V. Bernardoni, J. Cao, F. Cavalli, J. Cozic, E. Diapouli, K. Eleftheriadis, P. J. Genberg, et al., *Atmos. Meas. Tech.* **2012**, 5, 1869–1887.

Monitoring Progress Report

Executive Summary on Monitoring Progress Report

The main objective of the COST Action TD1105 EuNetAir is to develop new sensing technologies for air quality control at integrated and multidisciplinary scale by coordinated research on nanomaterials, sensor-systems, air-quality modelling and standardized methods for supporting environmental sustainability with a special focus on small and medium enterprises. The main event for the reporting period has been the 1st scientific meeting with 60+ participants in Rome on 4-6 Dec 2012, including Working Groups and Special Interest Groups, and followed by the 2nd MC meeting. The Rome meeting was a great scientific success with international S&T networking and the results presented are on tracks towards the EuNetAir objectives by defining the priorities for future activities of the WGs and SIGs. The next joint scientific meeting held in Duisburg on 4-6 March 2013 with 40+ participants was successful with a special session COST Action inside FP7-ENV AirMonTech project workshop devoted to air-pollution monitoring technologies for urban areas. Dissemination activities have been performed as special sessions (IMCS-2012, 20-23 May 2013, Nuremberg, Germany; SGS-2012, 11-15 Sept 2012, Cracow, Poland), open tutorial (ISQL-2012, 27-30 Sept 2012, Halkidiki, Greece) and open satellite workshop (TCM-2012, 21-26 Oct 2012, Hersonissos, Crete, Greece) with 30+ involved speakers and session chairs from Action and coming from 20 COST countries. 11 STSMs are already approved and other 1-2 STSMs are planned more depending on budget. Training school (13-15 June 2013) and Action workshop (June 20, 2013) are planned at Barcelona in conjunction to Transducers/Eurosensors 2013. The 3rd MC meeting was scheduled on June 21, 2013 at IREC (Barcelona). The Action website was setup (www.cost.eunetair.it). New collaborations emerge from the network, as exemplified by the list of published papers or in press, submitted research joint-proposals and ongoing projects. In summary, the project is progressing according to approved plan.

The Action Agenda with main activities of Year1 (July 2012 - June 2013) are shortly summarized:

- Kick-off Meeting, May 16, 2012, COST Office, Brussels (Belgium).
- 2nd Management Committee Meeting and WGs Meeting, December 4-6, 2012, ENEA, Rome (Italy).
- Joint Working Groups (WG3-WG4) Meeting, March 4-6, 2013, Duisburg (Germany).
- 1st Action Workshop on New Sensing Technologies and Transducers for Air Quality Monitoring, June 20, 2013, Barcelona (Spain).
- 3rd Management Committee Meeting, June 21, 2013, IREC, Barcelona (Spain).
- 1st Training School on Environmental Technologies and Air Quality Monitoring, June 13-15, 2013, Universitat de Barcelona (UB) and CSIC-IDAEA, Barcelona (Spain). This event was labelled as Green-Week Satellite Event by EC DG-ENV.
- STSMs: 11 short-term scientific missions approved, planned and in progress; other potential 1-2 missions assessed and depending on remaining 1st Year budget.

Monitoring Progress Report

Executive Summary on Monitoring Progress Report

Main Dissemination Events:

- 2 Special Sessions COST Action TD1105 EuNetAir inside International Meeting on Chemical Sensors (IMCS-2012), May 20-23, 2012, Nuremberg (Germany).
- Open Special Session COST Action TD1105 EuNetAir inside Semiconductor Gas Sensors (SGS-2012), September 11-15, 2012, Cracow (Poland).
- Tutorial Session COST Action TD1105 EuNetAir inside 3rd Intelligent Systems for Quality of Life Information Services (ISQL-2012), September 27-30, 2012, Halkidiki (Greece).
- Open Satellite Workshop COST Action TD1105 EuNetAir inside International Symposium on Transparent Conductive Materials (TCM-2012), October 21-26, 2012, Hersonissos, Crete (Greece).
- Invited Talk of Action Chair on Overview of COST Action TD1105 EuNetAir inside XVII Italian National Meeting of Italian Association on Sensors and Microsystems (AISEM-2013), February 5-7, 2013, Brescia (Italy).

Outreach and Dissemination:

- Newsletter - Issue 1 (published on Dec 2012); Issue 2 (published on June 2013).
- Leaflet/Brochure - Issue 1 (published on January 2013).
- Interview on Nanotechnologies and Nanosensors for Air Quality Monitoring from Action Chair (M. Penza, ENEA, Italy) with Meyya Meyyappan (Chief Scientist, NASA Ames Research Center, USA) (www.cost.eunetair.it; Video-Audio section).
- News on COST Action TD1105 EuNetAir in ENEA Web-TV (www.enea.it/it; www.youtube.com/eneanews; www.facebook.com/pages/ENEA-WebTV/107480772614976; https://twitter.com/ENEAWebTV)
- Setup of Action website: www.cost.eunetair.it

Examples of cooperative original research and significant breakthroughs as part of the COST Action TD1105 partnership are shortly referenced as:

- Development of a portable sensor-system based on a single nanowire of metal oxides at low powered (sub-micro Watt) for air pollution detection (CO, NO_2). Universitat de Barcelona (Prof. A. Romano-Rodriguez, Dr. J. D. Prades, Spain) and IREC (Prof. J. R. Morante, Spain).
- Development of p-type metal oxide gas sensing elements for the detection of H_2 and aldehydes. FORTH (Prof. G. Kiriakidis, Greece) and University of Brescia (Prof. G. Sberveglieri, Italy) in close collaboration with University of Tübingen (Dr. N. Barsan, Germany).
- Miniaturized sensor based on CMOS-SOI technology with USB-port and microstructured active material for ubiquitous air quality measurements and portable methods. Cambridge University (Prof. F. Udrea, UK) and Warwick University (Prof. J. Gardner, UK).
- A low-cost modular sensor platform combining IR spectrometry based on microstructured Fabry-Perot Filters and MOX gas sensors for indoor air quality monitoring (CO_2, VOC) and medical applications. Prof. A. Schütze (Saarland University, Germany).
- Air Quality Bike (Aeroflex) for mobile air quality measurements developed by VITO (Dr. J. Theunis, Belgium) including participatory sensing by City-Guards measuring air quality in Antwerp during six months by a portable gas sensor-system.
- Wireless sensor network for air-quality monitoring around Heathrow airport (London, UK) based on at least 50 nodes consisting of gas sensors (CO, CO_2, NOx, O_3, SO_2, VOC), particulate matter (PM10, PM2.5) detectors and environmental parameters monitoring (temperature, humidity). University of Cambridge (Prof. R. Jones, UK) and Alphasense Ltd (Dr. J. Saffell, UK).
- Consultation on assessing human exposure to air pollution in health assessment studies in Europe from Prof. O. Hertel (Aarhus University, Denmark) to a request of European Environment Agency.
- Software Tool applied to air quality modelling at local and large scale for real case-studies in Europe. University of Ljubljana (Prof. R. Zabkar, Slovenia).
- Development of commercial miniaturized low-cost sensor-systems for air quality monitoring. Dr. N. Moser (SGX-Sensortech Ltd, Switzerland).
- A low-cost NDIR platform for sub-ppm gas detection and CO_2 sensing for indoor/outdoor monitoring. Prof. I. Bryntse (SenseAir SA, Sweden).

Additional new members joining the Action during its life:

As of April 22, 2013, a total of 25 COST Countries have now signed the MoU of the Action TD1105 EuNetAir, with additional two Countries (the former Yugoslav republic of Macedonia, Serbia) on the waiting list (intentions to participate). This grand-total of 27 COST Countries is to be compared with the original 21 Countries (Parties) at Kick-off Meeting (Brussels) on May 16, 2012, and the already-signed MoU of 25 Countries at 2nd MC Meeting (Rome) on December 6, 2012.

The total number of MC Members is 48; total number of male: 35 (73%) and total number of female: 13 (27%). Also, the total number of MC Substitutes is 26; total number of male: 22 (84%) and total number of female: 4 (16%).

Total number of individual participants involved in the Action work:

The total number of participants is about 150, of which about 120 (80%) are active with about 25% females.

Some researchers contribute to more than one of the WGs and SIGs. About 30% of the participants are Early Stage Researchers.

Monitoring Progress Report

Executive Summary on Monitoring Progress Report

Involvement of Early Stage Researchers in the Action, in particular with respect to STSMs, networking activities, and Training Schools.

- STSMs: ESRs are being deeply involved in the Action's related scientific activities, including MC members/substitutes. A Call for STSMs was launched on November 2012 to give opportunity to young researchers, PhD-students and graduated early-scientists to apply for scientific missions in the host laboratories of the Action partnership from the COST Countries (MoU-signed). 11 STSMs have been approved in the referenced period (10 STSMs were used by ESRs).
- Training School: The 1st Training School on Environmental Technologies and Air-Quality Monitoring has been planned at Barcelona on 13-15 June 2013 under coordination of Universitat de Barcelona (Department of Electronics, MIND group) and in collaboration with CSIC-IDAEA. At least 20 reimbursed trainees (most largely ESRs) from Action partnership and MoU-signing countries, including at least 4 reimbursed outstanding trainers and other local trainers and experts, will be involved. An exchange of knowledge and research experiences from senior teachers to young trainees is highly expected. A Call for recruitment of the young trainees has been opened in the Action partnership. Further, this 1st training school has been labeled as Green-Week 2013 Satellite Event in Europe regarding the 2013 as the European Year of Air, as declared by EC DG-ENV.

Involvement of researchers from outside of COST Countries:

Six institutions from 5 Non-COST Countries have been accepted to participate to the Action TD1105 EuNetAir based on mutual benefit. They are classified as 1 Institute (CSIRO, Australia) from Reciprocal Agreement Country; 1 Institute (National Research Center Kurchatov Institute, Russian Federation) from Near-Neighbour Countries; 4 Institutes from the Rest of the World (Chinese Academy of Sciences, Shanghai, China; University of Waterloo, Canada; Southern Illinois University Carbondale, USA; NASA Ames Research Center, USA).

The detailed description of mutual benefit of these Non-COST participants can be found in their "Request for Participation" forms filled and submitted to the COST Office and approved by Action MC at the starting point of activities.

Advancement and promotion of scientific knowledge through publications and other outreach activities:

The advancement and promotion of scientific knowledge was realized by joint-publications from several Action partners, peer-reviewed publications from individual participants and/or single teams, invited talks and oral/poster presentations in the most important international/national conferences devoted to Action issues. Action TD1105 is also involved in dissemination to manage satellite events, open tutorials, special sessions and workshops related to outstanding scientific events of large international target-audience. Significant outreach activities have been realized by Action partners.

- At least 17 published/submitted joint-publications in peer-reviewed international journals
- At least 62 talks/orals/communications in international conferences and workshops
- At least 17 items of outreach activities

These publications are indicative of the increasing capacity of the different partners of the consortium to interact with each other. Other manuscripts are currently under preparation. Special mention is for WG4, lead by Prof. Ingrid Bryntse (SenseAir SA, Sweden), able to produce a report on CO_2 application summary, as a collaborative output at high-quality in science and technology of interest for research community, SMEs, stakeholders and policy-makers.

Activities and projects with COST network colleagues.

Several research activities and S&T projects within COST EuNetAir network are running or planned in the near future. At least 23 recorded new research collaborations are ongoing and further initiatives are in progress and in preparation. Moreover, several international research proposals (at least 8 records) have been submitted from COST partnership. An intensive exercise is being setup together with other FP7 projects (e.g., AirMonTech, AQUILA network, MACPoll, Citi-Sense, etc.) that involved many Action partners as well. We cite also the organization of 2 MC/WG meetings, 1 Action workshop, 1 Joint-WGs meeting, 1 Training School, at least 11 STSMs, 4 disseminations events - special sessions, open tutorials, open satellite workshop - planned in the first year of the Action TD1105. Most notably, we mention as collaborative activities and international networking:

- Start-up WG4 meeting at SenseAir SA, Delsbo (Sweden), October 29-30, 2012, including a laboratory visit at Laboratory for Sensory & Chemical Analysis at Strömsbruk (Iggesunds Bruk, Holmen, SE), an accredited sensory analysis laboratory. This WG4 meeting, chaired by Prof. Ingrid Bryntse (WG4 Leader) was visited by about 10 partners from Action SMEs and Early Stage Researchers. The WG4 was strictly connected in the next period by telephone conferences intra-WG in order to produce reports and summaries on standards and protocols for selected classes of toxic gases, individual air-pollutants and greenhouse gases.
- 1st Action workshop entitled New Sensing Technologies and Transducers for Air-Quality Monitoring in Barcelona (Spain), June 20, 2013: this workshop is organized as an open satellite workshop inside Transducers 2013 - Eurosensors XXVII, held at Barcelona on June 16-20, 2013 with General Chair Prof. Juan Ramon Morante (IREC, Spain) and Action WG1 leader. This is an important international conference on solid-state sensors, actuators and microsystems. The workshop program relied on the opportunity for COST EuNetAir speakers to disseminate research results from national projects and international cooperation in the Action issues of sensor materials, gas sensors, transducers, systems, sensor networks, wireless technology, intelligent computation, signal processing towards a broader international world-class audience. 10 Invited Speakers and 3 Session Chairs from 8 COST Countries and 1 Non-COST Country are involved and 1 poster Session is planned as well for early stage scientists.

Monitoring Progress Report

Executive Summary on Monitoring Progress Report

- EMRS 2014 SYMPOSIUM entitled Advanced Functional Materials for Environmental Monitoring and Applications, accepted as one of the International Symposia to be held at Lille (France) on May 26-30, 2014 (extension of Strasbourg EMRS events) as Spring Meeting 2014 of the European Materials Research Society. This is an important success of the networking application of Action symposium selected by the Board of Directors of the EMRS on competitive basis for the good science quality proposed by symposium organizers from Action TD1105 (Michele Penza, Anita Lloyd-Spetz, Albert Romano-Rodriguez, Yongxiang Li, Meyya Meyyappan) including the Invited Speakers and Scientific Committee coming largely from Action TD1105 EuNetAir as well. This successful application was born during Rome meeting of the Action on Dec 4-6, 2012.

The capacity of the Action members to raise research funds:

The Action partnership has a good capacity to address research funding both at national level (at least 25 records) and international level (at least 23 records for ongoing FP7 projects and 8 records for submitted FP7 projects). Moreover, national COST offices (e.g., Czech Republic, Switzerland) are referenced funding agencies for national projects as well. Several activities of proposals for research funding are expected and will be submitted in the future Horizon 2020 Calls. It remains a major goal of the Action to increase the size of this collaborative funded research and provide every possible support for such joint-applications but the administrative burden to coordinate remains as high and it will be very difficult to find somebody volunteering for coordination and management.

More details on the Monitoring Progress Report (Year 1) can be found at the link in Action webpages (www.cost.eunetair.eu), Section Homepage - APC 2013.

EuNetAir

Newsletter COST Action TD1105 EuNetAir

Action Chair	Dr. Michele Penza, ENEA, IT - michele.penza@enea.it
Editor-in-Chief	Prof. Ralf Moos, University of Bayreuth, DE - functional.materials@uni-bayreuth.de
Editorial Board Manager	Daniela Schönauer-Kamin, University of Bayreuth, DE
Graphic design	Dr. Jaroslaw Kita, University of Bayreuth, DE