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. 5/Dec 2014

Editorial

M. Penza, Action TD1105 Chair, ENEA, Italy

Contents

This fifth issue of Newsletter covers the Action grant period July-December 2014 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 by Dr. Daniela Schönauer-Kamin (University of Bayreuth, DE).

The excellent teams of over 180 involved international experts such as scientists, researchers, technologists, modelers, SMEs managers from 28 COST countries, 4 international partner countries (IPCs) and 3 near neighbor countries (NNC) are working hardly to contribute to the objectives and workplan 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 EUROSENSORS 2014 (7-10 September 2014, Brescia, Italy) with a COST Session focused on New Sensing Technologies for Air Quality Monitoring; and WG1 - WG4 Meeting on New Sensing Technologies and Modelling for Air-Pollution Monitoring (13-15 October 2014, Aveiro, Portugal) with a special focus on 1st EuNetAir Air Quality Joint-Exercise Intercomparison Sensors-versus-Analyzers. In this successful meeting, over 50 Participants from at least 17 COST countries were involved with a large participation and target audience. The joint exercise was very successful with at least 15 teams, coming from research centers, universities and industry/SMEs/spin-offs, from at least 12 COST countries that installed their sensor-systems side-by-side to compare sensing performance with reference equipment by Air Quality Mobile Lab, provided by IDAD, Aveiro (Portugal), parked in the Aveiro city center for urban air quality monitoring.

Also, COST Action TD1105 managed a Special Session Smart Cities Sensors, chaired by Dr. Michele Penza, at IEEE SENSORS 2014 (2-5 November 2014, Valencia, Spain) with an invited talk from Action chair on EuNetAir networking topics addressing smart and sustainable cities including additional 4 contributed speakers from Italy, Spain, Japan and JRC-Ispra. This special session was well-attended by at least 150+ world-class international experts.

Currently, EuNetAir has already financially supported at least 7 short term scientific missions (STSMs) in the period year 3 (1 July 2014 - 30 June 2015) for visit and exchange of motivated early stage researchers (ESR) 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 for fruitful networking in S&T cooperation. The Action management committee (MC) invites ESRs to use this efficient tool for starting collaborations in the international networking.

On behalf of Action MC, 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 in collaborative research teams the challenges of Horizon 2020!

Focus On

US EPA Air Sensors Workshop

T. Watkins, US EPA, USA

The United States Environmental Protection Agency (US EPA) conducted a workshop, Air Sensors 2014: A New Frontier Monitoring Technology for Today's World, on June 9-10, 2014.

The workshop included app and sensor developers, citizen scientists, air quality officials and environmental scientists from across the United States and 10 countries, including Dr. Michele Penza, chair of COST Action TD1105 under EuNetAir program. Approximately 500 people registered to participate either in-person or via live webcast.

This was the fourth installment in EPA's Next Generation Air Monitoring (NGAM) workshop series. The workshops are part of a continuing discussion with sensor developers; environmental interests groups; and representatives from communities, industries, academia, national, state and local governments; and others interested in understanding more about how app and sensor technologies can be used in collecting environmental data. Topics discussed included new sensor technology and advances, citizen science opportunities and low-cost sensor use. Information and materials from the workshop are available at the following website: https://sites.google.com/site/airsensors2014/home.

Cities of Tomorrow, The Challenges of Horizon 2020

A. Lloyd Spetz, Action TD1105 Vice-Chair,
Linkoping University (Sweden) and University of Oulu (Finland)

A number of COST networks related to “Cities of Tomorrow” were reported in this workshop covering a wide topic area. We heard about smart cities and growing as well as shrinking cities and the special challenges connected to that. Challenges in urban transport and new service hubs instead of railway stations were reported and even innovative new transport vehicles like bikes with a cover for weather protection. A growing elderly population gives business possibilities like setting up ICT connected homes. For sustainable cities abandoned areas in the city as well as roof space should be used for gardening. Furthermore, safety aspects were covered and it was pointed out that green areas like a park should be placed such that people are constantly walking through, for example to and from work. For health and comfort clean air and clean water are inevitable and requires smart gas sensor control systems and smart water recirculation systems.

Can planning and design contribute to safer cities?
(From talk by Prof. Clara Cardia, with kind permission). www.eunetair.it (COST strategic events, Cities of Tomorrow 2014)

Focus On

New project for outdoor odor monitoring

A. Schütze, MC Member & WG2 Leader, Saarland University, Germany
T. Conrad, 3S GmbH, Germany

Saarland University´s Lab for Measurement Technology and 3S Sensors, Signal Processing, Systems GmbH are currently working on a joint project for the Saarland Ministry of the Environment addressing odor exposure in residential areas caused by, presumably, industrial sites. Also involved in the project are Anne-Claude Romain (Université de Liège) and Julien Delva (Odometric SA) as advisors. Contact between these groups was established through the COST action EuNetAir.

The motivation of the project lies in consistent complaints by residents of the Warndt region, a wooded area with a number of small villages on the German-French border, concerning unpleasant and sometimes obnoxious “chemical” odors which might result from the operation of a chemical plant on the French side of the border in Carling. As there is currently no technology available to monitor and identify these odors in a time and spatially resolved manner, the nature and severity of the exposure is difficult to assess by the authorities. In the current project, 3S has installed a number of sensor systems based on highly sensitive gas sensors and in parallel has established a human odor network, i.e. a website where several residents report the observed odors at least twice a day. The first goal of the project is to establish if the employed sensor technology – tested in the lab with (sub-)ppb VOC concentrations – is sufficiently sensitive to detect the odor occurrences. Then, based on advanced signal analysis of sensor response patterns obtained with temperature cycled operation (TCO) the partners will try to map the observed odor exposures and correlate these with additional environmental data, especially wind direction and speed for source attribution.

Eight sensor systems have been installed since the end of September and will monitor the region for at least four months in parallel to the human odor network. The partners hope to demonstrate the feasibility of using sensor systems for time and spatially resolved odor monitoring allowing improved immission control.

EUROSENSORS 2014 Conference: a Full Success

G. Sberveglieri, MC Member & SIG3 Coordinator, University of Brescia, Italy

• EUROSENSORS 2014 in Brescia (http://www.eurosensors2014.eu) has been a successful event, with nearly 500 attendees from Europe and the world. EUROSENSORS 2014 started on Sunday Sept. 7 in San Faustino Cloister with the pre-conference event of the Eurosensors School. The number of attending students was 55 with a well-balanced combination of attendants from academia, research centers and industry. The tutorials were held on the following topics:

• A Way to Follow for the Sensor Science Development (A. D'Amico, C. Di Natale)

• Silicon-based Micro Mechanics: Applications, Technology and Device Principles (Fredrik Creemer)

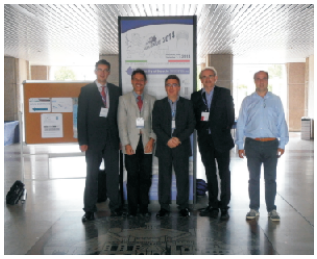
• Flexible and Printed Sensors and Sensing Systems (Danick Briand)

• Microelectronic Technology from Solid State to Flexible Substrates: Tactile Sensors as a Case Study (Leandro Lorenzelli)

Prof. Giorgio Sberveglieri from University of Brescia, member of the COST Action TD1105 steering committee and MC Italy member, was the General Conference Chair, while Prof. Vittorio Ferrari from University of Brescia was the program chair. The technical program was organized in 2 plenary sessions, 25 lecture sessions with up to 4 parallel sessions, and 13 poster sessions grouped in 2 blocks. 402 contributions were given in total, composed of 145 oral and 257 poster presentations. Thanks to the excellent arrangement of the 4 plenary lectures and the 11 invited talks, the attendants could listen to all invited speakers.

All posters remained on display for the entire duration of the conference to maximally promote discussion and networking.

The number of submissions was 525. The contributions accepted in the program were 402 (145 lectures + 257 posters), a rejection rate of 23% of the submissions.



Abstracts were received from 47 Countries. Accepted contributions came from all over the world, with a clear focus on Europe: 85.3% from Europe, 10% from Asia/Pacific, 2% from North America, 1.5% from Latin America, and 1.2% from Middle East/Africa. 77.6% of the contributions came from academia, 12.9% from research centers and/or institutes, 3.2% from government, 5.2% from industry, and 1.1% from other affiliation types.

The technical program was complemented by satellite events including the lunch workshop by Gefran S.p.A. on Monday, and the open session of the COST Action TD1105 EuNetAir on Wednesday chaired by Dr. Michele Penza, Action chair of EuNetAir. This COST Session was composed by 5 Speakers from 5 COST countries and 1 Speaker from JRC-IES, Ispra, Italy. The session was well-attended by at least 50+ persons.

News from Working Groups

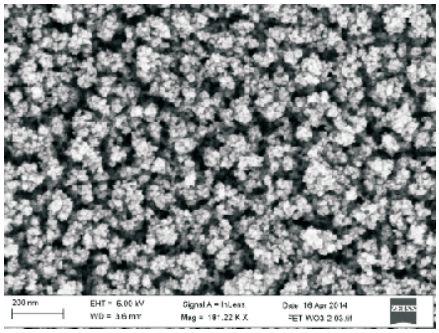
Working Group 1 - Sensor Materials and Nanotechnology

Room Temperature PLD Growth of Metal Oxide Nanoparticles for Detection of Volatile Organic Compounds

J. Lappalainen, MC member, University of Oulu, Finland

J. Huotari, University of Oulu, Finland

As a part of FP7 project SENSIndoor, which has the goal to detect volatile organic compounds (VOC) for indoor air quality control, pulsed laser deposition (PLD) has been utilized to manufacture porous metal oxide nanoparticle layers for gas sensing applications. Depositions were conducted at room temperature and in relatively high O_2 gas background pressures. The deposited materials so far were tungsten trioxide (WO_3), vanadium pentoxide (V_2O_5), and tin dioxide (SnO_2), the latter also decorated with platinum (Pt) nanoparticles. Both conventional MEMS microheaters and silicon carbide (SiC) GasFET structures were used as substrates and sensor platforms. The layers consist of small metal oxide nanoparticles below 50 nm in diameter. The size of the nanoparticle agglomerates is clearly dependent on the amount O_2 gas background pressure applied during depositions. On the other hand, crystal structure of the nanoparticles was strongly dependent on post-annealing procedures. The first VOC sensing measurements have shown very promising results, i.e. good selectivity and response. For instance, 20 ppb naphthalene have been detected with the WO3 nanoparticle layer sensors.



The figure shows the SEM micrograph of a porous layer of WO3 nanoparticles deposited by PLD.

Working Group 2 - Sensors, Devices and Systems for AQC

A. Schütze, MC member & WG2 leader, Saarland University, Germany

The members of EuNetAir´s Working Group 2 (Sensors, Devices & Systems for AQC) – together with WG1 (Sensor Materials & Nanotechnologies) – strongly contributed to Symposium B (Advanced functional materials for environmental monitoring and applications) at this year's spring meeting of the European Material Research Society (E-MRS) in Lille, May 26 – 30. In addition to many materials oriented presentations, several contributions addressed sensors and systems for air quality applications also using new approaches, for example optical gas sensors as well as sensors for VOC or particle detection. Among many outstanding contributions especially by early stage researchers, the oral presentation by Manuel Bastuck, was most notable: he received the Young Scientist Award at the 2014 E-MRS Spring Meeting for his outstanding contribution "Increasing the selectivity of gas sensitive field effect transistors by dynamic operation", a joint effort between the Applied Sensor Science group at Linköping University and the Lab for Measurement Technology at Saarland University.

Similarly, sensor systems for air quality monitoring played a major role during the EuNetAir open session in Brescia, September 10, a satellite event to this year's EUROSENSORS conference. Presentations spanned a wide range: Performance Analysis of Low-Cost Gas Sensors for Air Quality Control by Michel Gerboles of JRC, Ispra, Italy, Gas and Particle Sensors for Air Quality Monitoring by Anita Lloyd Spetz, Linköping University, Linköping, Sweden, Highly Sensitive and Selective VOC Detection for Indoor Air Quality Applications by Andreas Schütze, Saarland University, Saarbrücken, Germany. A special highlight was the presentation by Julian Gardner of Warwick University, GB, on Smart Sensors in Mobile Phones for Environmental Monitoring Applications which addressed the future of very low-cost and low-power sensors for ubiquitous environmental sensing.

A recent development of large interest for WG2 and the entire EuNetAir community is the formation of several clusters in the field of NMP (nanotechnologies, advanced materials and production) by the European Commission linking different research projects to achieve a higher impact overall as well as obtain input for future EU calls. Three clusters with relevance to EuNetAir are Engineering and Upscaling, Material Modelling and Characterization. Especially the latter cluster characterization will be of interest as plans include a sub-cluster on sensors with a strong focus on (bio)chemical sensor for environment and health. Michele Penza, EuNetAir chair, and Andreas Schütze, WG2 coordinator, are invited to contribute input talks to the cluster kick-off meeting in Brussels, Nov. 27. One aim will be to link EuNetAir with the cluster activities to avoid duplication of effort and achieve a larger impact.

News from Working Groups

Working Group 4 - Protocols and Standardization Methods

Calibration of gas sensors

I. Bryntse, MC member & WG4 leader, SenseAir AB, Sweden

H. Martin

Manufacturers of gas sensors / analyzers can only deliver accurate products if they are correctly calibrated and verified after being assembled. SenseAir, a center of excellence for all kinds of IR gas measurements, has recently finished a project focusing on smart calibration of alcohol sensors supported by Vinnova (Sweden´s Innovation Agency). This was a joint project together with Autoliv Research, Hök Instrument, and the Technical Research Institute of Sweden (SP), directed towards a future high-volume Alcolock production for automotive applications.

Regardless of the target analyte, there are some general areas which must be optimized in any gas sensor calibration process:

- Correctly chosen materials for chamber and tubes
- Tight construction & stable pressure
- Fast and accurate temperature and gas control systems
- Homogeneous and stable temperature and gas distribution in calibration volume
- Reduced disturbance from sensors and equipment
- Careful process control and data analysis
- Minimized process time
- Batch size in relation to chamber volume
- Sensor carrier and communication platforms
- Reference sensor development
- Reference gas supplier evaluation

Smart solutions and a careful optimization indicate that a complete Alcolock calibration including a verification module can be made within 2 h at SenseAirs´s Research Laboratory. The process includes two species at various concentrations, ethanol vapor and carbon dioxide, both of which are implemented at three different temperatures. The current calibration model will be further improved before a pilot plant facility can be realized.

News from Ad-Hoc Groups

Short Term Scientific Missions (STSMs)

J. Theunis, MC member & STSM coordinator, VITO, Belgium

A third Call for short term scientific missions (STSMs) was launched in June 2014 to give young researchers, PhD students, and graduated early-scientists the opportunity to apply for scientific missions in host laboratories of Action partners in COST countries that have signed MoUs. By now, 4 STSM have been carried out, and two more are planned in November and December. This newsletter contains short reports of 4 of them. Over the entire period of the Action, participants from 11 countries made use of an STSM grant to visit host institution in 13 different countries.

STSMs carried out in year 3:

- Saverio De Vito, Computational Intelligence for Multisensing Device Calibration
- Jolanda Palmisani, Ozone-initiated reactions with selected fragrance products
- Federica Rigoni, CNT-MDSI heterojunction as ammonia gas sensor in moist environment
- Tobias Baur, Study of PLD for MOX sensors
- Marco Schüler, Advanced impedance measurements on MSDI ammonia sensors
- Mario Catalano, Developing forecasting techniques and low-cost sensing technologies for urban air pollution control

Applications for STSM in 2015 are welcomed. The next deadlines for applications are 1st of December for STSM in the first three months of 2015, and 1st of March for STSM from April to June 2015. Applicants are requested NOT to wait until the final deadline to submit their application. Details of the call can be obtained from the EuNetAir website (http://www.eunetair.it/cost/documenti/COST_Action-TD1105_Call-STSM__Year3_V4.pdf).

Gender Balance

I. Steinberga, MC member & GB coordinator, University of Latvia, Latvia

During the last (13-15 October, 2014) workgroup meeting at IDAD, University of Aveiro (Portugal) within 9 sessions totally 27 scientific presentations were presented. The overall balance between female and male presenters reflects the dominating male situation in this COST action - 26 % presentations were given by female action members. In general, the tendency is positive – during the last half-year, new female members from Latvia joined the actions and a female representative from Croatia is in the acceptance process.

Science & Tech Talk

Activities of Croatian group in TD1105

I. Ciglenečki-Jušić, Rudjer Boskovic Institute,
Department for Marine and Environmental Research, Zagreb

In the frame of the nationally founded project „The Sulphur and Carbon Dynamics in the Sea- and Fresh-water Environment"(SPHERE)", the Croatian group that just joined TD1105 is studying sulphur (S) and carbon (C) dynamics between different environmental compartments (atmosphere, water, sediment, biota) of sea- and fresh-water environment. Our main focus is on the distribution between organic, inorganic, dissolved, colloidal, and nanoparticulate fraction. An important part of the project focuses on the characterization of aerosols by electrochemical and chromatographic methods. The main proposed research questions are: properties and deposition processes of atmospheric organic matter (OM) and Sulphur species in gas and particles of the atmosphere in the coastal Adriatic regions of Croatia (SPHERE „hotspots"); atmospheric OM distribution and removal in relation to rainwater OM and aerosol water soluble organic carbon (WSOC) fraction; main compounds of atmosphere volatile organic compounds (VOCs), including DMS, organosulphates and oxygenated organic compounds; atmospheric aerosol deposition and inputs of trace micronutrients (Fe,Mn, nitrate) and anthropogenic-related trace metals (Pb, Cd).

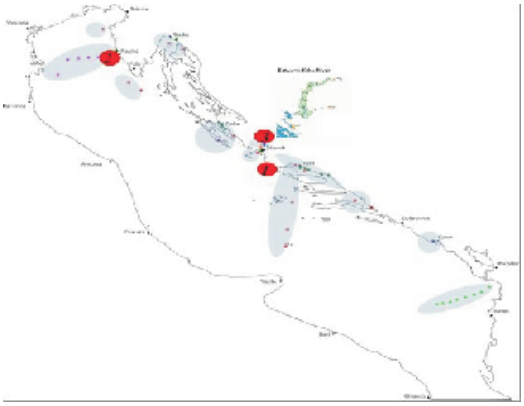


Figure: Map of the Adriatic Sea with indicated SPHERE «hotspots» marked with red shapes and corresponding numbers: 1) Rogoznica Lake as a unique euxinic seawater environment; 2) North Adriatic as a semiclosed and potentially eutrophic seawater basin; 3) Krka river estuary as salt-wedge-stratified and potentially eutrophic environment. The map also includes marked stations where in monitoring programs DOC and POC among other basic parameters are measured (grey shapes with marked colored dots inside).

The GERIA Project - Geriatric study in Portugal on Health Effects of Air Quality in Elderly Care Centers (ECC)

Ana Sofia Mendes, João Paulo Teixeira, Environmental Health Department
National Institute of Health, Portugal

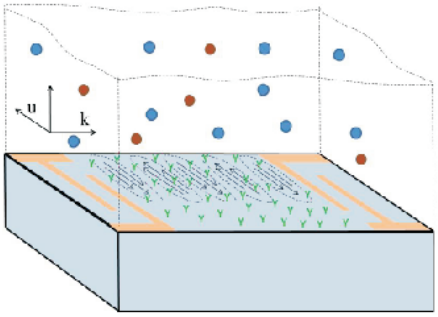
Older people have a decline in immune defenses and respiratory function, resulting in a higher predisposition to respiratory infections. The GERIA Project - Geriatric study in Portugal on Health Effects of Air Quality in Elderly Care Centers (ECC) [www.geria.webnode.com] is an ongoing study providing crucial information about indoor environment and prevalence of cardio-respiratory diseases of older persons in Portugal. Our main results until this date are the following: (i) Cough and sputum were the major respiratory symptoms, and allergic rhinitis the main self-reported illness in older people living in ECC; (ii) Overall PM2.5 median concentration was above reference levels both in winter and summer season; (iii) Peak values of PM10, TVOC, CO_2, bacteria and fungi exceeded the reference levels, compromising indoor air comfort and exacerbating older residents' respiratory chronic diseases; (iv) Older people exposed to PM10 above the reference levels have higher risk of allergic rhinitis.

Science & Tech Talk

Theoretical modeling of SAW-, BAW- and graphene-based resonators

M. Voinova, Chalmers University of Technology, Sweden

Acoustic piezoelectric resonators are precise instruments for the real time monitoring of a negligible amount of surface-attached mass, such as adsorbed gas molecules, vapors, dust and biological components. The (SAW)-based sensors and the quartz crystal microbalance (QCM) compared in our work belong to the leading group due to their considerable advantages. These piezoelectric resonators are considered now as high resolution analytical tools discriminating between components due to the selective polymer coating on the resonator surface. Our contribution is the analysis of the resonators coated with the soft (polymeric) and biological materials, where the viscous losses of energy can essentially influence characteristics. The theoretical modeling performed in our group provides a general theory of SAW and QCM devices in gases and liquids. The theory is important for the quantitative analysis and correct interpretation of the environmental and biosensors measurements.



Our new project is focused on theoretical modelling of graphene-based nanoresonators.

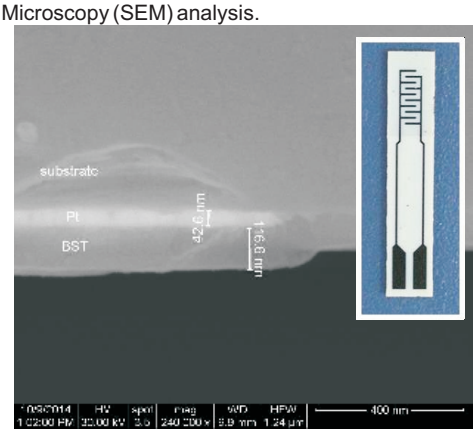
Electrical properties of barium strontium titanate thin films obtained by RF-Sputtering technique deposition

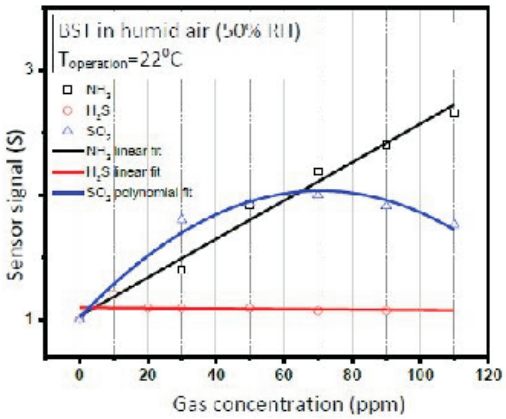
C.F. Rusti, National Institute for Non-Ferrous and Rare Metals – IMNR, Romania

This study was presented, as poster, at the Transparent Conductive Materials Conference 2014.

The aim of the experimental work was to optimize RF-Sputtering technique to obtain thin film on alumina/Pt substrate starting from BST nanostructured powders, hydrothermally synthetized.

The thickness of the BST based thin film is about 116 nm, as revealed by Scanning Electron Microscopy (SEM) analysis.





The sensor signal with respect to NH_3, SO_2, and H_2S was investigated. The sensor response was high for NH_3 and SO_2. For H_2S the sensor signal was not sensitive. Cu, Cr and La doping of the BST nanostructured powder lead to an increased sensitivity and made the material more selective.

The Figures show the SEM image of BST/alumina/Pt substrate, the sensor structure and the sensor signal measured in 50% relative humidity conditions (50% RH); $T_{operation} = 22\,°C$.

Ref.: Tuned sensitivity towards H_2S and NH_3 with Cu doped barium strontium titanate materials, C. E. Simion et al., AIP Conference Proceedings 1627, 92 (2014); doi: 10.1063/1.4901664

Science & Tech Talk: STSM reports

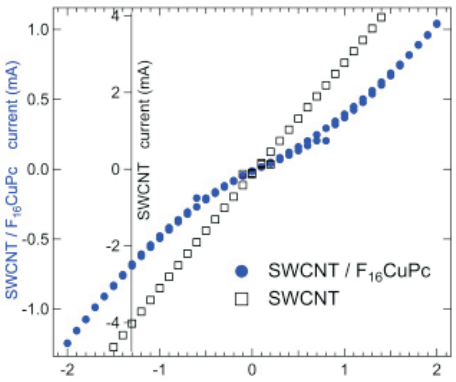
Study of PLD for SiC-FETs and MOX sensors used in SENSIndoor

M. Bastuck, Saarland University, Germany

My STSM brought me to Oulu University, Finland, for one week during summer, following Jyrki Lappalainen's invitation. In his group, I learned a lot about Pulsed Laser Deposition (PLD), a technique which is able to produce well-defined, structured layers of almost arbitrary materials. Such layers are important to enhance the stability and reproducibility of gas sensors. This again is crucial for the EU project SENSIndoor, since its ultimate goal is to quantify hazardous Volatile Organic Compounds (VOCs) in very low concentrations (sub-ppb) and thus control ventilation in indoor environments more efficiently. SENSIndoor is the project I am now working on as a PhD student and in which, amongst others, Oulu University is involved as a partner. Hence, the STSM was not only useful for gaining technical knowledge, but also for getting to know the very nice people in Oulu who made this week a very pleasant one.

CNT-MSDI heterojunction as ammonia gas sensor in moist environment

F. Rigoni, Università Cattolica del Sacro Cuore, Italy



The idea of my STSM came after the eMRS Spring Meeting 2014 in Lille (France), where I met J.-M. Suisse and M. Bouvet and we started to discuss about ammonia gas sensing experiments and the interfering effect of water vapor. The following STSM at ICMUB in Dijon (France) gave me the possibility to prepare new devices based on MSDI (Molecular Semiconductor / Doped Insulator) heterojunctions based on carbon nanotubes and phthalocyanines, to investigate their gas sensing properties and to increase my experience in gas sensors research. The ICMUB Electrochemistry, Molecular Materials and Devices Laboratory set-up allowed to perform several and fast measurements of ammonia gas sensing at different concentrations (10 to 90 ppm) and different values of relative humidity (0 to 80%) and I had the opportunity to carry out measures on samples analyzed in Brescia (Italy) at Università Cattolica in order to check inter-laboratory reproducibility of gas sensing measurements.

Ozone-initiated reactions with selected fragrance products

J. Palmisani, University of Bari, Italy

Objectives: Monitoring of ozone-initiated reaction products, such as oxygenated and poly-oxygenated Volatile Organic Compounds (VOCs) and secondary organic aerosols, in indoor simulated conditions with a selected fragranced consumer product. Obtained experimental data will allow an improved comprehension of the impact of this kind of products on indoor air quality in order to carry out a risk assessment.

Short note of the experimental activity:

The main objective of the experimental activity was the evaluation of the emissions of VOCs and ultrafine particles from a carpet deodorizer under near-realistic user conditions. The formation of ozone-initiated products of terpenes was investigated carrying out emission testing inside a full scale walk-in climate chamber at low (~5 ppb) and high (~50 ppb) ozone concentrations. Emission testing was carried out applying a defined amount of the selected product both onto a steel surface and onto a carpet. Characterization of VOCs (primary) and ozone-initiated VOCs (secondary) emissions was performed by air sampling on Tenax TA followed by thermal desorption-GC/MS analysis and by air sampling on DNPH cartridges followed by liquid extraction and HPLC/UV analysis. Particle formation (total number concentration and size distribution) was monitored simultaneously by means of high-time resolution instruments. The experimental results showed the decay of initial compounds and their transformation to oxidation products as well as an increase of ultrafine particles, concurrent with the consumption of ozone.

Science & Tech Talk: STSM reports

Study of PLD for MOX sensors

T. Baur, Saarland University, Germany

Some VOCs present in indoor air may cause cancer. Thus, it is important to measure very low concentrations of VOCs. For a more effective improvement of sensor performance and characteristics, I have developed a model of a semiconductor gas sensor in TCO.

During the STSM, I have learned to prepare granular SnO2 films with PLD, which is the expertise of Oulu University. I have prepared sensor samples with different grain sizes and metal decoration. The main aim is to study the influence certain structural and morphological properties of the films to the model parameters. Knowledge about the influence can be used for tuning the sensing layer.

In addition, the STSM was a good platform to strengthen the collaboration between Oulu and Saarland University. From a personal point of view, it was a really exciting and joyful experience and a great opportunity for me to start research in this field.

Overview on EuNetAir Events

Summary of 1st Air Quality Joint-Exercise Intercomparison

C. Borrego, M. Coutinho, A. M. Costa, J. Ginja, Campus Universitário, Portugal

The EuNetAir Air Quality Joint-Exercise Intercomparison & Working Groups Meeting of COST Action TD1105 – EuNetAir was organized by IDAD - Institute of Environment and Development in Aveiro (Portugal), on 13-15 October 2014.

The first day was dedicated to the presentation of the technical features of the each team's sensor-systems. It was joining the 1st EuNetAir AQ Joint-Exercise Intercomparison Sensors-versus-Analysers (13-27 October 2014) and the installation of the sensors at IDAD Air Quality Mobile Laboratory that was equipped with standardized equipment and referenced analyzers of the following polluting and non-polluting compounds and other data: CO, NO_x, O_3, SO_2, PM10, PM2.5, Benzene, VOC, temperature, humidity, wind velocity/direction, solar radiation, precipitation.

15 teams from research centers, universities and companies coming from 12 COST countries of the COST Action TD1105 were involved in the two-week experimental campaign at Aveiro city center for the Joint-Exercise Intercomparison.

The WG1-WG4 meeting was held on 14-15 October 2014 and it was devoted to the discussion on new sensing technologies and models for air pollution monitoring, harmonization of the environmental measurements and experimental campaigns, exchange of best practices, quality assurance, quality control, data quality, methods and protocols, development of new sensing technologies, and modeling of air pollution.

Air Quality Mobile Laboratory of IDAD

C. Borrego, M. Coutinho, A. M. Costa, J. Ginja, Campus Universitário, Portugal

The 1st EuNetAir Air Quality Joint-Exercise Intercomparison, organized in Aveiro, Portugal, from 13-27 October 2014, focused on the evaluation and assessment of environmental gas/PM microsensors versus standardized air quality referenced methods through an experimental urban air quality monitoring campaign.

The IDAD air quality mobile laboratory was placed at an urban traffic location in Aveiro city center in the scope of the experimental urban air quality monitoring campaign to conduct continuous measurements with standardized equipment and referenced analyzers of the following variables: CO, NO_x, O_3, SO_2, PM10, PM2.5, Benzene, VOC, temperature, humidity, wind velocity/direction, solar radiation, precipitation.

The benchmarking of the sensor data, generated by different sensor-systems installed side-by-side on the top of IDAD AQ Mobile Lab, with reference analyzers data will contribute to assess the accuracy of the low-cost and low-power sensor-systems in the real-world context of the Indicative Measurements, as defined by the Ambient Air Quality EU Directive 2008/50/EC.

Overview on EuNetAir Events

Summaries of presentations at 1st Air Quality Joint-Exercise Intercomparison

Parallel Measurements of Pollen and Particulate Matter in Berlin

H.-G. Mücke, Umweltbundesamt/UBA, Dept. of Environmental Hygiene, Germany
K.-C. Bergmann, Allergy-Centre-Charité, Germany

Pollen allergy currently affects up to 20% of the European population. Primary bioaerosols (pollen) are natural air pollutants, but their measurements have not been legally regulated in Europe yet. Thus, a study was conducted by the German Umweltbundesamt (UBA) in co-operation with the Foundation German Pollen Information Service (PID) to investigate the spatial distribution and burden of grass pollen and fine particulate matter (PM10). Parallel measurements of both have been carried out as 24h samplings for a six weeks period in May and June 2011 at three monitoring sites (distinguished by vegetation and traffic influences) in Berlin. Grass pollen and PM10 are significantly highly correlated between the sites. Concentrations are influenced by maximum temperatures. On several days, grass pollen concentrations in densely populated parts have reached health relevant threshold values that are required to initiate allergenic symptoms. The highest burden of grass pollen and PM10 were measured at an inner-city traffic hot-spot.

The table shows the concentrations of grass pollen [pollen counts/m³ air per 24h] and PM10 [µg/m³] measured in Berlin in May/June 2011 (43 daily samplings per station).

Stations (type)	Mean	Max.	Std. dev.
Tiergarten (city park) - grass - PM_{10}	 7.9 18.9	 33 34.4	 7.9 6.6
Adlershof (suburban) - grass - PM_{10}	 11.8 15.2	 65 29.5	 15.6 5.2
Stadtautobahn (traffic) - grass - PM_{10}	 17.2 22.6	 83 35.5	 18.2 7.5

Sensor Networks for Air Quality: SNAQ box

O.A.M. Popoola, V.B. Bright, R.L. Jones, P.D. Smith, University of Cambridge, UK

In Aveiro, we installed two of our SNAQ instruments fitted with Alphasense electrochemical (EC) sensors for O_3, NO, NO_2, CO, SO_2, and total VOC. In addition, a SenseAir NDIR CO_2 sensor was fitted as well as sized-specified particulates (0.38 to 17.4 µm) measured using an optical particle counter (OPC) designed by the University of Hertfordshire, UK.

Apart from the OPC, all the sensors were of a passive design. Meteorological data including temperature, relative humidity, wind speed and direction were also recorded. Data from all the sensors were logged at 20 sec intervals, and stored on USB. Optional data relay via mobile network was available.

SNAQ provided data useful for validation of air quality models, generation of emission inventories, as well as pollution source attribution, e.g 'Hot Spots'.

The figure shows the interior of SNAQ box.

The Aveiro inter-comparison exercise provided a great opportunity to share knowledge and data, which can be utilized to improve future designs of small sensor systems.

Development of AirBox (NO_2, PM10, PM2.5) and its Application as Network in City of Eindhoven

Renè Otjes, Action WG Member, ECN, The Netherlands

ECN developed high quality sensors for pollutants in ambient air. Currently developed sensors for PM2.5, PM10 and NO_2 are applied by third parties. Fields of application are urban air quality and emission monitoring from transit storage and handling of dry bulk, e.g., like ore and coal.

The sensors are placed in a weatherproof enclosure, the AirBox. The sensors for PM and NO2 are very well suited for ambient air monitoring. The AirBox communicates by GPRS every 10 minutes with a server to upload the data and to accept new firmware if requested.

The first urban air quality network was installed in October 2013 in Eindhoven. The network represents 35 locations at relevant places like hospitals, traffic hotspots, construction sites, railways and back ground stations.

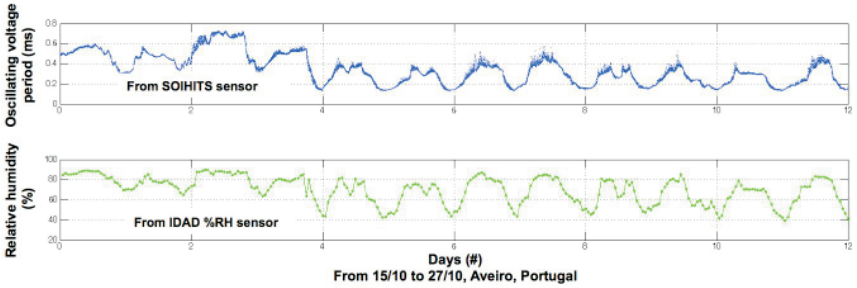
Overview on EuNetAir Events

Summaries of presentations at 1st Air Quality Joint-Exercise Intercomparison

A Silicon-On-Insulator (SOI) Platform Functionalized by Atomic Layer Deposition (ALD) for Humidity Sensing

N. Andrè, Universitè Catholique de Louvain, Belgium

In the frame of the FP-7 EU SOIHITS project, UCAM, UCL and CCMOSS developed a SOI sensing micro-hotplate platform with an integrated electronics interface for applications from room temperature to above 200°C. It is able to operate in harsh environments. The sensing microsystem is a hybrid integration of a 1 mm2 micro-hotplate and a 1.5 mm2 electronic interface, with a total power consumption of approximately 0.2 mW. For water vapor measurements, the interdigitated electrodes (IDE) of the SOI micro-hotplates were functionalized with 25 nm–thick Al_2O_3 deposited by ALD. The sensor response was logged during the 14 days-long intercomparison air quality joint-exercise, hold in the city of Aveiro (Portugal). The transducer measurements showed up to a 5 times oscillating voltage period increase, from 0.15 to 0.7 ms, at ambient temperature and for 40% to 90%RH variation. Data analysis and post-treatments are currently under work.



A Silicon-on-Insulator micro-hotplate Platform for Humidity Sensing and Air Quality Monitoring

F. Chowdhury, CCMOSS Ltd, UK

As a part of EU-funded project called SOIHITs, Cambridge CMOS Sensors (CCMOSS) successfully demonstrated application of MEMS, CMOS-SOI, micro-hotplate (MHP) platform for miniature humidity sensor. For the specific detection of water vapor, a special alumina (Al_2O_3) material was developed and grown on the MHP, by ICTEAM, UCL, Louvain-la-Neuve (Belgium). CCMOSS

is also using this MHP platform to develop metal oxides-based (MOX) sensors to monitor indoor air quality (IAQ) such as CO, alcohol and VOC gases. The photograph shows an example of an IAQ monitoring data logger, which is operated by small coin-type battery. The MOX sensor is packaged on tiny 2x3x1mm3 SMD housing, and designed for smartphones and wearable devices application. For more information visit www.ccmoss.com

EveryAware SensorBox (NO_2, O_3, CO, Black Carbon)

B. Elen, J. Theunis, VITO, Belgium

VITO participates in the EuNetAir air quality sensor intercomparison in Aveiro with multiple groups of sensors. First, there are the first generation NO_2 and VOC gas sensors of the MSP FP7 project. VITO evaluates the sensor properties for sensor developers both in its lab and under field conditions. Second there is the EveryAware SensorBox which VITO designed in the EveryAware FP7 project as a low-cost solution to detect personal exposure to traffic pollution. It contains 10 low cost sensors whose sensor signals are combined with machine learning techniques. Third, for intercomparison purposes, VITO added a number of commercially available electrochemical gas sensors for which promising results recently appeared in literature.

VITO's final aim with the Aveiro measurement campaign is to evaluate the performance, sensitivity to meteorological conditions, and cross interferences of its low cost gas sensors in an urban traffic environment. Also, it wants to compare their performances with other low cost gas sensors.

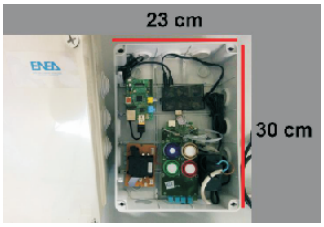
Overview on EuNetAir Events

Summaries of presentations at 1st Air Quality Joint-Exercise Intercomparison

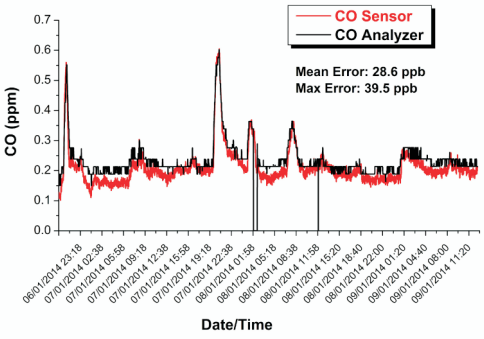
Air Sensor-Box for Air Quality Control Measurements

D. Suriano, M. Prato, G. Cassano, M. Penza, ENEA, Italy

Environmental monitoring is strongly required to protect the public health and save the environment from toxic contaminants and pathogens that can be released into air. Air-pollutants include carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), that originate from various sources such as vehicle emissions, power plants, refineries, industrial and laboratory processes. However, current monitoring methods are costly and time-consuming. Also limitations in sampling and analytical techniques exist.Clearly, a need exists for accurate, inexpensive long-term monitoring of environmental contaminants using low-cost solid-state gas sensors [1-3] that are able to operate on-site and real-time. Calibrated cost-effective gas sensors are a very interesting solution for networked systems suitable to monitor air-pollutants in urban streets and real scenario of smart cities with high spatial and time resolution. In ENEA, at Brindisi Research Center, a handheld gas sensor system called AIR-SENSOR BOX



based on solid state gas sensors was designed and implemented. The main goal of the system designed and built in our laboratory is the development of portable equipment in order to detect some air-pollutant gases such as CO, SO_2, NO_2, O_3 and PM in the urban areas at outdoor level. For that purpose, we have used electrochemical gas sensors by Alphasense, an Optical Particle Counter (OPC) by Shinyei, a humidity sensor by Honeywell, and a temperature sensor by Microchip. The results are encouraging for CO detection in terms of mean error and maximum error with respect to the reference equipment, but we found that interfering gases effects are still an open question (not shown) for NO_2 detection with O_3 as an interfering gas. We have planned additional systematic tests in order to better understand the effect of interfering gases, to improve sensor stability and lifetime in real scenarios, and moreover, the proper maintenance procedures (e.g. sensor re-calibration rates).



[1] M. Penza et al., Lecture Notes in Electrical Engineering 109 LNEE (2012) 87-92

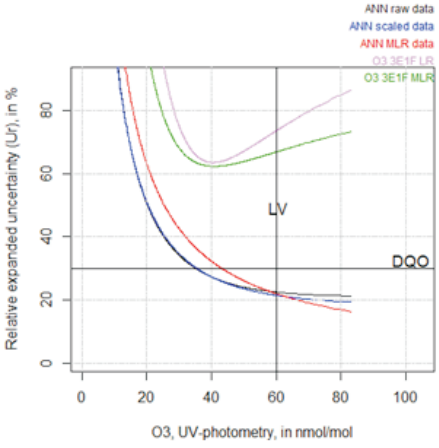
[2] M. Penza et al., Proceedings IMCS 2012, 20-23 May 2012, Nuremberg, Germany, doi: 10.5162/IMCS2012/P2.9.23

[3] M. Penza et al., A case-study of microsensors for landfill air-pollution monitoring applications, Urban Climate, 2014. In press. http://dx.doi.org/10.1016/j.uclim.2014.09.002

Note to EuNetAir Special Session at Eurosensors 2014

M. Gerboles, JRC-IES, Italy

The performances of several field calibration methods for low-cost sensors, including linear/multi linear regression and supervised learning techniques are compared. A cluster of ozone, nitrogen dioxide, nitrogen monoxide, carbon monoxide and carbon dioxide sensors was operated. The sensors were either of metal oxide or electrochemical type or base on miniaturized infra-red cell. For each method, a two-week calibration was carried out at a semi-rural site against reference measurements. Subsequently, the accuracy of predicted values was evaluated for about three months using a few indicators and techniques: orthogonal regression, target diagram, measurement uncertainty and drifts over time of sensor predictions. The study assessed if the sensors can reach the Data Quality Objective (DQOs) of the European Air Quality Directive for indicative methods (between 25 and 30 % of uncertainty for O_3 and NO_2). In this study, it appears that O_3 may be calibrated using simple regression techniques while for NO_2 better agreement between sensors and reference measurements was reached using supervised learning techniques. The hourly O_3 DQO was met while it is unlikely that NO_2 hourly one can be met. This was likely caused by the low NO_2 levels correlated with high O_3 levels that are typical of semi-rural site as where the measurements of this study took place.



The figure presents the relative expanded uncertainty, U_r of the different calibration models versus reference data of O_3.

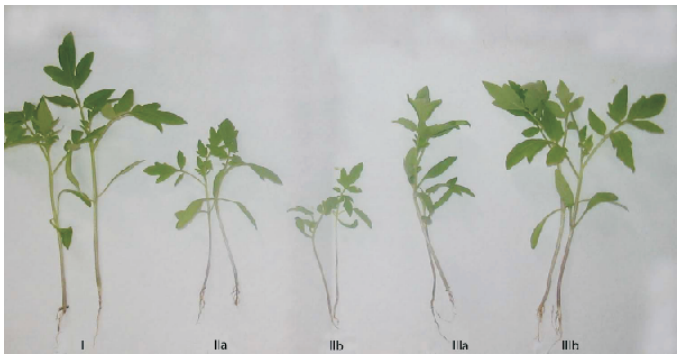
Overview on EuNetAir Events

NATO Advanced Workshop
Investigation of microorganisms' and plants' abilities to assimilate and metabolize organic ecotoxicants and heavy metals

G. Kvesitadze, Georgian National Academy of Sciences, Georgia

Co-Director of NATO Advanced Research Workshop on Nanotechnology to Aid Chemical and Biological Defense 2014

The effect of prolonged and over usage of chemicals in crops production has resulted in human health hazards and pollution of environment and ground water. Identification of new sources for biological control of plant diseases is important for sustainable agriculture, ensuring food security, improving human health and rehabilitating the environment. The use of bacterial viruses or bacteriophages for bacterial diseases control is a fast expanding area of plant protection. Study of phages diversity, specificity, stability and efficacy are important for their application as biological means against the pathogens. The paper summarizes data on properties of bacteriophages specific to Xanthomonas vesicatoria strains spread in Georgia and efficacy to prevent tomato bacterial spot in laboratory conditions under artificial infection.



The figure shows the effect of phage treatment on development of tomato seedlings from artificially infected seeds

I - Intact seedlings; IIa-Seedlings raised from infected by X. vesicatoria strain 7 seeds; IIb - Seedlings raised from infected by X. vesicatoria strain 1258; IIIa - Seedlings raised from infected by X.vesicatoria strain7 and treated with phage; IIIb - Seedlings raised from infected by X. vesicatoria strain 1258 and treated with phage.

IEEE SENSORS 2014; Special Session Smart Cities Sensors

M. Penza, Action Chair, ENEA, Italy

The Special Session - Smart Cities Sensors - chaired by Action TD1105 Chair, has been organized as parallel Open Event inside to IEEE SENSORS 2014 Conference (http://ieee-sensors2014.org/), chaired by the General Chair as Prof. Candid Reig, University of Valencia, Spain, and Prof. Lina Sarro, TU Delft, The Netherlands, with the Technical Program Chair as Prof. Ignacio R. Matias, Public University of Navarra, Pamplona, Spain.

The Special Session was composed by the Invited Talk of the Action Chair on New Sensing Technologies for Environmental Sustainability in Smart Cities and other 4 contributed speakers from Italy, Spain, Japan and EC JRC-Ispra. The Special Session COST Action TD1105 was planned on first day just after the first visionary Keynote Lecture (Prof. Carlo Ratti, MIT, USA) on The Senseable City, and was well-attended by at least 150 international experts in room.

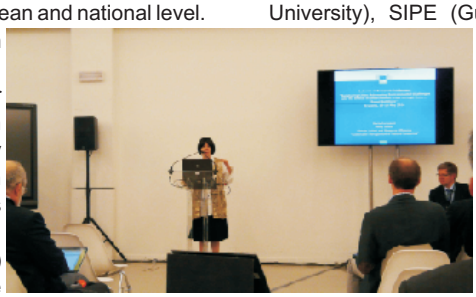
This Special Session - one of the 10 special sessions in the conference - will be beneficial for COST Action TD1105 by the presence of many international experts at world-class level and several involved Action MC Members to participate at the Special Session. Very good visibility for the COST Action TD1105 EuNetAir was provided by the IEEE Sensors 2014 Conference as show-case to disseminate the achieved Action results. The IEEE Sensors 2014 Conference was attended by about 750 delegates. The extended manuscript (978-1-4799-0162-3/14/ ©2014 IEEE) of the Lecture on COST Action TD1105 given by Action Chair at the Special Session Smart Cities Sensors has been already published in the Proceedings IEEE Sensors 2014 by the e-papers system via peer-review process.

Overview on EuNetAir Events

ECTP Conference 2014 – Indoor Environment Quality Cluster

J. Frick, University of Stuttgart, Germany

A session on Indoor Environment Quality (IEQ) took place at 9th June 2014 during the ECTP/E2BA conference 2014 in Brussels. The session included information about actions, clusters and best practice examples on European and national level. Additionally, an overview on planned research fields and cluster activities for indoor environment quality within Horizon 2020 were given by Monique Levy (European Commission). It was followed by Anita Lloyd Spetz (Linkoping University) with information about the European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability – EuNetAir – Cost action TD1105. Séverine Kirchner (CSTB) gave an insight in French activities on Indoor Air Quality: a Health challenge for Occupants. Lorenzo Miccoli (BAM) followed with information about the Indoor Environment group within the Advanced Material & Nanotechnology Cluster (AMANAC) of EeB. Than followed a series of best practice examples of projects: OFFICAIR (John Bartzis, University of Western Macedonia), IAQSense (Claude Iroulart, EFFICIENCE Marketing), SensIndoor (Anita Lloyd Spetz, Linkoping University), SIPE (Guido Vaes, Hydroscan). For 3 projects the presentations were attached in the session information: INTASENSE (Gemma García Mandayo, CEIT), CETIEB (Jürgen Frick, MPA University Stuttgart), clear-up (Udo Weimar, University Tübingen). The participants agreed to establish a cluster on Indoor Environment Quality and accepted the invitation of the Cost action EuNetAir to the workshop in Istanbul 3rd to 5th December 2014. A first action was the generation of a first version of research ideas for IEQ contributing to the new HORIZON 2020 flagship: Renaturing cities trough nature-based solutions. The paper was given to the EC in July 2014. One of the tasks at the Istanbul meeting will be the updating of this research agenda. The session presentations and the research agenda could be downloaded from the CETIEB website: www.cetieb.eu under downloads.



The figure shows Monique Levy (EC) presenting the views of EC at the IEQ session.

Announcements

Upcoming Events

ICEPPHI 2015 - International Conference on Environmental Pollution, Public Health and Impacts
January 26-27, 2015, Istanbul, Turkey
http://www.waset.org/conference/2015/01/Istanbul/ICEPPHI/call-for-papers

ICAPC 2015 - International Conference on Air Pollution and Control
February 23-24,2015, Paris, France
https://www.waset.org/conference/2015/02/Paris/ICAPC

3rd International Workshop of the COST Action TD1105 on New Trends and Challenges on Air Quality Control
March 26-27, 2015, University of Latvia, Riga, Latvia

3rd International Training School on Atmospheric Aerosol Physics, Measurements and Sampling
May 2-8, 2015, Hyytiala Station of the University of Helsinki, Helsinki, Finland

10th Annual International Symposium on Environment
May 11-14, 2015, Athens, Greece
http://www.atiner.gr/environment.htm

ECCA 2015 - European Climate Change Adaption Conference
May 12-15, 2015, Copenhagen, Denmark
http://www.burchardt-apps.dk/ecca2015.eu/

Sensor 2015 - 16th International Conference on Sensors and Measurement Science
May 19-21, 2015, Nuremberg, Germany
http://www.sensor-test.de

Air Pollution 2015 - 23rd International Conference on Modelling, Monitoring and Management of Air Pollution
June 1-3, 2015, Valencia, Spain
http://www.wessex.ac.uk/15-conferences/air-pollution-2015.html

4th SCIENTIFIC MEETING: WGs Meeting and 7th MC Meeting
June 3-5, 2015, Linkoping University, Linkoping, Sweden

EAC 2015 - European Aerosol Conference
September 6-11, 2015, Milan, Italy
http://www.aec2015.it/

Publications of EuNetAir participants

List of publications related to EuNetAir

Metal oxide semiconductor gas sensor self-test using Fourier-based impedance spectroscopy
M. Schüler, T. Sauerwald, and A. Schütze
J. Sens. Sens. Syst., 3, 213-221, 2014

Aerosol-deposited BaFe0.7Ta0.3O3-δ for nitrogen monoxide and temperature-independent oxygen sensing
M. Bektas, D. Hanft, D. Schönauer-Kamin, T. Stöcker, G. Hagen, and R. Moos
J. Sens. Sens. Syst., 3, 223-229, 2014

Devices based on series-connected Schottky junctions and β-Ga2O3/SiC heterojunctions characterized as hydrogen sensors
S. Nakagomi, K. Yokoyama, and Y. Kokubun
J. Sens. Sens. Syst., 3, 231-239, 2014

A simple method to recover the graphene-based chemi-resistor signal
F. Fedi, F. Ricciardella, M. L. Miglietta, T. Polichetti, E. Massera, and G. Di Francia
J. Sens. Sens. Syst., 3, 241-244, 2014

Electrophoretic deposition of Au NPs on CNT networks for sensitive NO2 detection
E. Dilonardo, M. Penza, M. Alvisi, C. Di Franco, D. Suriano, R. Rossi, F. Palmisano, L. Torsi, and N. Cioffi
J. Sens. Sens. Syst., 3, 245-252, 2014

Selective detection of hazardous VOCs for indoor air quality applications using a virtual gas sensor array
M. Leidinger, T. Sauerwald, W. Reimringer, G. Ventura, and A. Schütze
J. Sens. Sens. Syst., 3, 253-263, 2014

Catalytic and thermal characterisations of nanosized PdPt / Al2O3 for hydrogen detection
T. Mazingue, M. Lomello-Tafin, M. Passard, C. Hernandez-Rodriguez, L. Goujon, J.-L. Rousset, F. Morfin, and J.-F. Laithier
J. Sens. Sens. Syst., 3, 273-280, 2014

EuNetAir

Newsletter COST Action TD1105 EuNetAir

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