COST Action TD1105 *EuNetAir*

BOOKLET

THIRD SCIENTIFIC MEETING

Working Groups and Management Committee

New Sensing Technologies

for Indoor Air Pollution Monitoring

GEBZE Institute of Technology and Bahcesehir University

Istanbul, Turkey, 3 - 5 December 2014

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST Office
Avenue Louise 149
1050 Brussels, Belgium
t: +32 (0)2 533 3800
f: +32 (0)2 533 3890
office@cost.eu

www.cost.eu

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

ESSEM Domain

COST Action TD1105

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

THIRD SCIENTIFIC MEETING

Working Groups and Management Committee
GEBZE Institute of Technology and Bahcesehir University
3 - 5 December 2014

hosted by Bahcesehir University
Ciragan Caddesi Osmanpasa School Sokak, No. 4 - 6, 34353 Besiktas Campus, Istanbul, Turkey

Meeting AGENDA		
3 Dec. 2014 - Wednesday		
08:30 - 18:00	***REGISTRATION***	
09:00 - 09:30	**WELCOME SESSION**	
09:30 - 11:00	**PLENARY SESSION 1: Indoor Environment Quality Applications**	
11:00 - 11:30	*Coffee-Break*	
11:30 - 13:00	**PLENARY SESSION 2: Indoor Environment Quality Applications**	
13:00 - 14:30	*Lunch*	
14:30 - 16:30	**WG1-WG2 Meeting**	**WG3-WG4 Meeting**
16:30 - 17:00	*Coffee-Break*	
17:00 - 18:30	**WG1-WG2 Meeting**	**WG3-WG4 Meeting**
18:30	*Gathering of Day*	
20:30 - 23:00	*Social Dinner*	
4 Dec. 2014 - Thursday		
09:00 - 18:00	***REGISTRATION***	
09.00 - 09.30	**Wrap-Up and Inputs from Action TD1105**	
09:30 - 10:30	**KEYNOTE SESSION**	
11:00 - 11:30	*Coffee-Break*	
10:30 - 13:00	**SIG SESSIONs: SIG1-SIG4 Meeting**	
13:00 - 14:30	*Lunch*	
14:30 - 15:30	**POSTER SESSION**	
15:30 - 16:30	**Indoor Environment Quality Cluster GENERAL ASSEMBLY**	
16:30 - 17:00	*Coffee-Break*	
17:00 - 18:30	**Action WGs/SIGs GENERAL ASSEMBLY**	
18:30	**CONCLUSIONS**	
20:30	*Free Dinner*	
5 Dec. 2014 - Friday		
09:30 - 13:00	**6th MANAGEMENT COMMITTEE MEETING**	
13:00 - 14:00	*Lunch*	
14:30	***Meeting Closing***	

COST is supported by the EU Framework Programme

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Background and goals

About COST Action TD1105 *EuNetAir*

COST Action TD 1105 EuNetAir, a Concerted Action on *New Sensing Technologies for Air-Pollution Control and Environmental Sustainability*, is a running Networking funded in the framework *European Cooperation in the field of Scientific and Technical Research* (COST) during 2012-2016.
The main objective of the Concerted Action 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 standardised methods for supporting environmental sustainability with a special focus on Small and Medium Enterprises.
This international Networking, coordinated by ENEA (Italy), includes over 80 big institutions from 28 COST Countries (EU-zone: *Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, The Former Yugoslav Republic of Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom*) and 7 International Partners Countries (extra-Europe: *Australia, Canada, China, Morocco, Russia, Ukraine, USA*) to create a S&T critical mass in the environmental issues.

About the *Third Scientific Meeting* at Bahcesehir University, Istanbul, 3-5 December 2014

The 6th MC Meeting jointly with WG1-4 Meeting will be held at Bahcesehir University, organized by GEBZE (Action MC partner) and Bahcesehir University, tentatively organized with a Plenary Session, parallel Inter-WGs Sessions including a General Assembly of the WGs and the four Special Interest Groups (SIGs), and finally, a MC Meeting. The Plenary Session will focus on ***New Sensing Technologies for Indoor Air-Pollution Monitoring*** in a multidisciplinary approach including International Experts and Coordinators of the running FP7 and H2020 research projects to consolidate an **EU Projects Cluster on Indoor Environment Quality and Applications**, with a possible patronage and sponsorship of the EC DG Research and Innovation.
Participation from research, academy, university, industry, environmental agencies, international stakeholders, policy-makers and institutional managers is widely planned with large outreach and dissemination activities, at high expected impact (28 Parties involved in the Action on July 2014).
Fruitful discussions between Action TD1105 participants, international experts, speakers and international institutional organizations delegates (e.g., WHO Europe, JRC, DG RTD) are strongly expected. At the open ***Third Scientific Meeting*** of the COST Action TD1105 *EuNetAir*, a strong impact on focusing of the critical indoor environmental issues would be mutual benefit.

More Information

Dr. Michele Penza
MC Chair/Proposer of COST Action TD1105 EuNetAir
ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development
Technical Unit for Materials Technologies - Brindisi Research Centre
PO BOX 51 Br-4, I-72100 Brindisi, ITALY. Email: michele.penza@enea.it. Action webpages: www.cost.eunetair.it

Prof. Dr. Zafer Ziya Ozturk	Prof. Ali Gungor
Local Organizing Team Chair	*Local Organizing Team Co-Chair*
Faculty of Science, Department of Physics	Bahcesehir University
GEBZE Institute of Technology, Kocaeli, Turkey	Ciragan Caddesi Osmanpasa School Sokak, No. 4 - 6
Çayırova Yerleşkesi, İstanbul Cad. 101, 41400 Gebze Kocaeli	34353 Besiktas Campus, Istanbul, Turkey
Email: zozturk@gyte.edu.tr	Email: ali.gungor@bahcesehir.edu.tr

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THIRD SCIENTIFIC MEETING

Working Groups and Management Committee

New Sensing Technologies for Indoor Air Pollution Monitoring

Istanbul (Turkey), 3 - 5 December 2014

Bahcesehir University - Ciragan Caddesi Osmanpasa School Sokak, No. 4 - 6, 34353 Besiktas Campus, Istanbul, Turkey






Action Meeting Programme Committee

Michele Penza, ENEA, Brindisi, Italy
Anita Lloyd Spetz, Linkoping University, Sweden
Andreas Schuetze, Saarland University, Germany
Zafer Ziya Ozturk, GEBZE Institute of Technology, Turkey
Ali Gungor, Bahcesehir University, Istanbul, Turkey
Carlos Borrego, IDAD, University of Aveiro, Portugal
Jurgen Frick, University of Stuttgart, Germany
Ole Hertel, Aarhus University, Denmark
Ingrid Bryntse, SenseAir AB, Sweden
Juan Ramon Morante, IREC, Spain
Marco Alvisi, ENEA, Italy
Corinna Hahn, Eurice GmbH, Saarbrucken, Germany
Juliane Rossbach, Eurice GmbH, Saarbrucken, Germany
Annamaria Demarinis Loiotile, University of Bari, Italy
Sadullah Ozturk, GEBZE Institute of Technology, Turkey
Lutfi Arda, Bahcesehir University, Istanbul, Turkey
Dogan Akcan, Bahcesehir University, Istanbul, Turkey

URL: www.cost.eunetair.it

COST Action TD1105 EuNetAir Steering Committee

Michele Penza, ENEA, Brindisi, Italy - *Action Chair*
Anita Lloyd Spetz, Linkoping University, Sweden - *Action Vice-Chair*
Juan Ramon Morante, IREC, Spain
Andreas Schuetze, Saarland University, Germany
Ole Hertel, Aarhus University, Denmark
Ingrid Bryntse, SenseAir AB, Sweden
Jan Theunis, VITO, Belgium
Marco Alvisi, ENEA, Brindisi, Italy
Gianluigi De Gennaro, University of Bari, Italy
Fabio Galatioto, Newscastle University, UK
Ralf Moos, University of Bayreuth, Germany
Mar Viana, CSIC-IDAEA, Barcelona, Spain
Iveta Steinberga, University of Latvia, Riga, Latvia
Corinna Hahn, Eurice GmbH, Saarbrucken, Germany - *Grant Holder*
Julian Gardner, University of Warwick, UK
Rod Jones, University of Cambridge, UK
Giorgio Sberveglieri, University of Brescia, Italy
Eduard Llobet, Universitat Roviri I Virgili, Tarragona, Spain
Thomas Kuhlbusch, IUTA eV, Duisburg, Germany
Albert Romano-Rodriguez, Universitat de Barcelona (UB), Spain
Carlos Borrego, IDAD, University of Aveiro, Portugal
Annamaria Demarinis Loiotile, University of Bari, Italy - *Secretary*

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EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Wednesday, 3 December 2014

COST Action TD1105 Working Groups and Special Interest Groups MEETING

Main Hall: *Fazil Say Room*

8:30 - 18:00	**Registration**
09:00 - 10:00	**Welcome Address Session** *Chairman: Zafer Ziya Ozturk, MC Member, GEBZE Institute of Technology, Istanbul, Turkey*
09:00 - 09:10	**Welcome Address from Host Institution and Local Co-Organizer** *Ali Gungor*, Vice-President of Bahcesehir University, Istanbul, Turkey
09:10 - 09:20	**Welcome Address from Local Organizer** *Zafer Ziya Ozturk*, MC Member, GEBZE Institute of Technology, Istanbul, Turkey
09:20 - 09:30	**Welcome Address from COST Action TD1105** *Michele Penza*, Action Chair, ENEA, Italy
09:30 - 11:00	**Plenary Session 1: Indoor Environment Quality Applications** *Chairman: Michele Penza, Action Chair - ENEA, Italy*
09:30 - 10:00	**COST Action TD1105: European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability** *Michele Penza*, Action Chair, ENEA, Italy
10:00 - 10:20	**FP7 SENSIndoor Project (NMP-2013-5) and VOC-IDS Project (Era-Net): Selective VOCs Detection in the ppb Range for Demand Controlled Ventilation** *Andreas Schuetze*, Saarland University, Saarbrucken, Germany
10:20 - 10:40	**FP7 Project MSP (ICT-2013-10): MSP for Air Quality in Building Technology Applications** *Oliver von Sicard*, Siemens AG, Munich, Germany
10:40 - 11:00	**Smart Calibration for Successful European Gas Sensor Production** *Ingrid Bryntse*, Action WG4 Leader & MC Member, SenseAir AB, Delsbo, Sweden
11:00 - 11:30	**Coffee Break**
11:30 - 13:00	**Plenary Session 2: Indoor Environment Quality Applications** *Chairman: Anita Lloyd Spetz, Action Vice-Chair - University of Linkoping, Sweden*
11:30 - 11:50	**FP7 Project CETIEB (EeB-2011): Active and Passive Measures to Assess and Improve Indoor Environment Quality** *Jurgen Frick*, Project Coordinator, University of Stuttgart, Germany
11:50 - 12:10	**IEQ Cluster: Technologies and Materials for a Healthier Indoor Environment** *Lorenzo Miccoli*, BAM Federal Institute for Materials Research and Testing, Berlin, Germany
12:10 - 12:30	**Highlights from EU and Belgian Projects on IAQ and Health and Future Needs for Sensor Technologies** *Jan Theunis*, STSMs Coordinator and MC Member, VITO, Mol, Belgium
12:30 - 12:50	**FP7 Project OFFICAIR: On the Reduction of Health Effects from Combined Exposure to Indoor Air Pollutants in Modern Office Buildings** *John Bartzis*, Project Coordinator, University of West Macedonia, Kozani, Greece
12:50 - 13:10	**FP7 Projects TeACH and NANOMATCH: Environmental Aspects in the Field of Cultural Heritage Conservation** *Adriana Bernardi*, Project Coordinator, CNR, Institute of Atmospheric Science and Climate, Padova, Italy
13:00 - 14:30	**Lunch offered by COST Action organization**

Wednesday, 3 December 2014

Action TD1105 Working Groups Meetings

Parallel Session of WG1-WG2. Location: Main Hall - *Fazil Say Room* (Theatre 300 seats)

14:30 - 16:30	**WG1: Sensor Materials and Nanotechnology** *Chairman: Jyrki Lappalainen, Action WG1 Vice-Chair - Oulu University, Oulu, Finland*
14:30 - 14:50	**Effect of Dopants and Humidity on NO_2-Sensing with Semiconducting Oxides** *Bilge Saruhan-Brings*, WG Member, German Aerospace Center, Institute of Materials Research, Cologne, Germany
14:50 - 15:10	**Pulsed Laser Deposition of Nanostructured Metal Oxides for Gas Sensors** *Jyrki Lappalainen*, Action WG1 Vice-Chair, Oulu University, Oulu, Finland
15:10 - 15:30	**Metal Functionalized ZnO Nanorods for Gas Sensing Applications** *Zafer Ziya Ozturk*, Gebze Institute of Technology, Kocaeli, Turkey
15:30 - 15:45	**Electrophoretic Au-NPs Deposition on Carbon Nanotube Networked Layers for Gas Sensors** *E. Dilonardo[1*], M. Penza[2], M. Alvisi[2], C. Di Franco[3], D. Suriano[2], R. Rossi[2], F. Palmisano[1], L. Torsi[1], and N. Cioffi[1]*; [1]Department of Chemistry, Università degli Studi di Bari Aldo Moro, Bari, Italy; [2]ENEA Brindisi, Italy; [3]CNR-IFN Bari, Bari, Italy
15:45 - 16:00	**Aerosol Deposited Thick Film $BaFe_{0.7}Ta_{0.3}O_{3-\delta}$ Ceramic for Nitrogen Monoxide Sensing** *Murat Bektas*, University of Bayreuth, Bayreuth, Germany
16:00 - 16:15	**Application of Chemiresistive Polymer Films in Air Quality Control** *G.Sakale, M.Knite, I.Klemenoks, S.Stepina, S.Sergejeva*, Riga Technical University, Latvia
16:15 - 16:30	**Nanostructured Metals and Metal Alloys for Hydrogen Sensors** *Necmettin Kilinc*, WG Member, Nigde University, Nigde, Turkey
16:30 - 17:00	**Coffee Break**

Parallel Session of WG1-WG2. Location: Main Hall - *Fazil Say Room* (Theatre 300 seats)

17:00 - 18:30	**WG2: Sensors, Devices and Systems for AQC** *Chairman: Andreas Schuetze, Action WG2 Chair - Saarland University, Saarbrücken, Germany*
17:00 - 17:15	**RFID Passive and Semi-Passive Tags for Environmental Monitoring: Current Results and Future Prospects** *Eduard Llobet*, Action MC Member, Universitat Roviri I Virgili, Tarragona, Spain
17:15 - 17:30	**Examples Modelling and Simulation Studies on Indoor Air Quality Monitoring** *Ahmet Özmen*, Sakarya University, Department of Computer Engineering, Sakarya, Turkey
17:30 - 17:45	**Particle Detection Using Acoustic Wave Technology for Air Quality Monitoring** *Farah H. Villa-López, S. Thomas, M. Cole and J.W. Gardner*, Warwick University, Coventry, UK
17:45 - 18:00	**New Principle of Gas Molecule Detection based on Nonlinear Electromagnetic Response of Graphene Nanoribbons** *M. Eriksson, L.Y. Gorelik, M.V. Voinova*, Chalmers University of Technology, Goteborg, Sweden
18:00 - 18:15	**Automated Computational Intelligence Model Selection for Sensor Data** *Roman Neruda, Petra Vidnerova, Vera Kurkova*, Institute of Computer Science, Academy of Sciences of Czech Republic, Prague, Czech Republic
18:15 - 18:30	**Gas Sensors for Environmental Monitoring** *Sadullah Ozturk*, Gebze Institute of Technology, Kocaeli, Turkey

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Parallel Session of WG3-WG4. Location: *A101 Room* (Boardroom 50 seats)

14:30 - 16:30	**WG3: Environmental Measurements and Air-Pollution Modelling** *Chairman: Ole Hertel, Action WG3 Chair - Aarhus University, Roskilde, Denmark*
14:30 - 14:50	**Particle Pollution in Danish Domestic Homes: Impact of Outdoor Sources for Indoor Exposure** *Ole Hertel, Action WG3 Chair - Aarhus University, Roskilde, Denmark*
14:50 - 15:10	**Air Quality in Subway Systems** *MariaCruz Minguillon*, Action WG Member, CSIC-IDAEA, Barcelona, Spain
15:10 - 15:30	**Spatial Data Fusion of Observations from Low-Cost Air Quality Sensors and Models for Urban-Scale Air Quality Mapping** *Philipp Schneider*, Action MC Member, NILU, Kjeller, Norway
15:30 - 15:45	**An Example of Low-Cost Devices for Indicative Indoor PM, CO_2 and Meteorological Parameters Monitoring** *Milena Jovasevic-Stojanovic*, Action WG3 Member, Institute Vinca, Belgrade, Serbia
15:45 - 16:00	**Influence of the Meteorological Conditions on Air Pollution in City of Skopje** *Igor Atanasov*, Ministry of Environment and Physical Planning, Skopje, Republic of Macedonia
16:00 - 16:15	**Impact of NO_x Emissions on Air Quality Simulations with the Bulgarian WFR-CMAQ Modelling System** *Emilia Georgieva*, Action WG Member, NIMH, Bulgarian Academy of Sciences, Sofia, Bulgaria
16:15 - 16:30	**Indoor Growing Plants of *Chlorophytum comosum* L Phytoremediate of Particulate Matter from Air** *H. Gawrońska, B. Bakera, <u>Stanislaw Gawronski</u>,* Warsaw University of Life Science, Warsaw, Poland
16:30 - 17:00	**Coffee Break**

Parallel Session of WG3-WG4. Location: *A101 Room* (Boardroom 50 seats)

17:00 - 18:30	**WG4: Protocols and Standardisation Methods** *Chairman: Ingrid Bryntse, Action WG4 Chair - SenseAir SA, Delsbo, Sweden*
17:00 - 17:15	**Gas and Particulate Monitors: Advances and Setbacks** *John Saffell*, Action Sub-WG4.3 Leader, Alphasense Ltd, Essex, UK
17:15 - 17:30	**Application of MEMS, CMOS Broadband Infrared Emitters and Detectors for Compact NDIR CO_2 Sensing** *Foysol Chowdhury*, Action WG Member, CCMOSS Ltd, Cambridge, UK
17:30 - 17:45	**Case-Study of the Spin-off RED: Devices for Indoor Environments Control** *Luc Pockelè*, Research and Environmental Devices, RED srl, Padova, Italy
17:45 - 18:00	**Citizen Science in Mapping Outdoor and Indoor Environments: Potentials and Challenges** *Jamal Jokar Arsanjani*, Action WG Member, Heidelberg University, Germany
18:00 - 18:15	**Green Smart Net: Environmental Data Acquisition, Handling and Transmission for Risk Assessment in Agriculture and Beyond** *Oriol Gonzales*, WG Member, Universitat Roviri I Virgili, Tarragona, Spain
18:15 - 18:30	**A Success Case of Synergy and Knowledge Transfer from Academia to Enterprise** *Annamaria Demarinis Loiotile*, University of Bari, Bari, Italy
18:30	**Gathering of Day**
20:30 - 23:00	**Social Dinner on a Boat Turning Bosphorus**

Thursday, 4 December 2014

Action TD1105 Special Interest Groups Meetings

Main Hall: *Fazil Say Room*

09:00 - 18:00	**Registration**
09:00 - 09:30	**Inputs from Action TD1105**
09:00 - 09:10	**Inputs from Action TD1105: Upcoming Action Events** *Michele Penza, Action Chair, ENEA, Brindisi, Italy*
09:10 - 09:20	**Inputs from Action TD1105: Online Travel Reimbursement Request & Strong Feature Authentication** *Juliane Rossbach, Grant Holder Manager, Eurice GmbH, Saarbrucken/Berlin, Germany*
09:20 - 09:30	**Inputs from Action TD1105: *EuNetAir* at COST Strategic Event *Cities of Tomorrow - The Challenges for Horizon 2020*, Turin (Italy), 17 - 19 September 2014** *Anita Lloyd Spetz, Action Vice-Chair, Linkoping University, Linkoping, Sweden*
09:30 - 10:30	**KEYNOTE SESSION: Sensors for Sustainable Cities** *Chairman: Michele Penza, Action Chair* *Italian National Agency for New Technologies, Energy and Sustainable Economic Development - ENEA, Brindisi, Italy*
09:30 - 10:00	**The SENSEable Cities** *Marguerite Nyhan*, SENSEable City Lab, Massachusetts Institute of Technology, Cambridge, USA
10:00 - 10:30	**Environmental Measurements Using Low-Cost Sensors: Latest Results and Future Directions** *Rod Jones*, Action SIG2 Leader and MC Member, University of Cambridge, Cambridge, UK
10:30 - 11:00	**SIG1: Network of spin-offs** *Chairman: Marco Alvisi, Action SIG1 Leader* *Italian National Agency for New Technologies, Energy and Sustainable Economic Development - ENEA, Brindisi, Italy*
	Specific Presentations from SIG1
10:30 - 10:45	**Overview of Support Structures and Funding Opportunities for Small and Medium Sized Enterprises in Europe** *Corinna Hahn*, Action GH Manager and EEN Germany National Contact Point, Saarbrucken, Germany
10:45 - 11:00	**Applications and Trends in Gas Sensing for Home and Health** *Oliver von Sicard*, Siemens AG, Munich, Germany
11:00 - 11:30	**Coffee Break**

11:30 - 12:00	**SIG2: Smart Sensors for Urban Air Monitoring in Cities** *Chairman: Rod Jones, Action SIG2 Leader* *University of Cambridge, Centre for Atmospheric Science, Cambridge, UK*
	Specific Presentations from SIG2
11:30 - 11:45	**Comparison of Low Cost Sensors and Reference Equipment in Laboratory and in Real-World. First Experiences in Oslo, Norway** *Nuria Castell-Balaguer*, Action Sub-WG3.1 Leader, NILU - Norwegian Institute for Air Research, Kjeller, Norway
11:45 - 12:00	**Indoor Air Quality Monitoring: Guidelines for Sensor Network Design** *Joao Ginja*, WG Member, IDAD, Aveiro, Portugal
12:00 - 12:30	**SIG3:Guidelines for Best Coupling Air Pollutants and Transducer** *Chairman: Eduard Llobet, Action SIG3 Vice-Chair, Universitat Roviri I Virgili, Tarragona, Spain*
	Specific Presentations from SIG3
12:00 - 12:15	**Detection of Odorant Molecules Using Proteins** *Marcel Bouvet*, Action Sub-WG1.3 Leader, Universitè de Bourgogne, Dijon, France
12:15 - 12:30	**Mastering VOC Detection for Better Indoor Air Quality** *Donatella Puglisi*[1], *C. Bur*[1,2], *M. Bastuck*[2], *A. Schuetze*[2], *M. Andersson*[1,3], *R. Yakimova*[1], *A. Lloyd Spetz*[1], *J. Eriksson*[1], WG Member, [1]Linkoping University, Linkoping, Sweden; [2]Saarland University, Saarbrücken, Germany; [3]SenSiC AB, Kista/Stockholm, Sweden
12:30 - 13:00	**SIG4:Expert Comments for the Revision of the Air Quality Directive (AQD)** *Chairman: Nuria Castell-Balaguer*, Action MC Member, NILU, Kjeller, Norway
	Specific Presentations from SIG4
12:30 - 12:45	**Outline of Chemical Sensors Applications for IAQ Evaluation** *Anne-Claude Romain*, Action Sub-WG4.2 Leader, Universitè de Liège, Arlon, Belgium
12:45 - 13:00	**Eye Symptoms from Reactive Indoor Air Chemistry ?** *Peder Wolkoff*, National Research Centre for the Working Environment, Copenhagen, Denmark
13:00 - 14:30	**Lunch offered by COST Action organization**

Main Hall: *Fazil Say Room - 4 December 2014*

15:20
(Local time)

Live Video Chat - *nanoFIS* Conference 2014 in Graz

***nanoFIS* Conference,** Graz (Austria time: 14:20)
***COST Action TD1105* Meeting,** Istanbul (Turkey time: 15:20)

***nanoFIS* Conference 2014**
1st International Conference on Functional Integrated nano Systems
Dr. Anton Kock, MSP FP7-project Coordinator, Materials Center Leoben Forschung GmbH (Austria)

Email: Anton.Koeck@mcl.at **URL**: www.nanofis.net

Thursday, 4 December 2014

Gallery of Main Hall Fazil Say Room

14:30 - 15:30	***Poster Session:*** ***New Technologies and Methods for Environmental Monitoring*** *Chairperson: Andreas Schuetze, Action WG2 Leader, Saarland University, Saarbrucken, Germany*

Posters (max sizes: 90 cm width x 120 height) will be exhibited on Panels. The Poster Presenter, preferably Early Stage Researcher, is required to stay near poster for discussion with interested people.

P01 **Acetylene Detection by Fiber Loop Ring-Down Technique**
M. Fatih Danışman[1], Okan Esentürk[1], Md. Abu Sayed[1], Alim Yolalmaz[2];
[1]Department of Chemistry, Middle East Technical University, Ankara;
[2] Micro and Nano-Technology Program, Middle East Technical University, Ankara

P02 **Simulation of Air Pollution in the Cross-Border Region Bulgaria-Turkey**
E. Georgieva, K. Slavov, D. Syrakov, Action WG3 Member, NIMH, Bulgarian Academy of Sciences, Sofia, Bulgaria

P03 **Distributed Online Gas Sensor Simulator For Indoor Air Quality Monitoring**
Deniz Balta and Ahmet Özmen; Department of Computer Engineering, University of Sakarya, Esentepe Campus, Sakarya, Turkey

P04 **Indoor Modelling and Sımulator Development for Measurement Systems and Gas Sensors**
N. Yalçın[1], A. Özmen[2]; [1]Department of Computer Engineering, University of Bilecik Şeyh Edebali, Gülümbe Campus, Bilecik, Turkey; [2]Department of Computer Engineering, University of Sakarya, Esentepe Campus, Sakarya, Turkey

P05 **Graphene Sheets and Silicon Cantilevers Employed in Laser Photoacoustic Spectroscopy for Gas Sensing**
M. Dostál[1,2], J. Suchánek[1,2], P. Janda[1], Z. Zelinger[1];
[1]J.Heyrovský Institute of Physical Chemistry, v.v.i., Academy of Sciences of the Czech Republic, Dolejškova 3, 182 23 Praha 8, Czech Republic;
[2] Technical University of Ostrava, Faculty of Safety Engineering, Lumírova 13, Ostrava-Vyškovice, 700 30 Ostrava, Czech Republic

P06 **Magnetic and Optical Properties of Nanostructured Iron Biogenic Materials for Sensoric Applications**
I. Nedkov, Action MC Member, Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria

P07 **Preparation, Growth, and Gas Sensing Properties of Nonvacuum Er-doped ZnO Thin Films**
L. Arda[1], D. Akcan[1], S. Ozturk[2], O. Sisman[2], A. Gungor[1], Z. Z. Ozturk[2]
[1]Departmen of Mathematics Engineering, Bahcesehir *University, Besiktas, 34100, Istanbul*
[2]Departmen of Physics, Gebze Institute of Technology, Gebze, 41400, Kocaeli

P08 **Structural, Electrical and Gas Sensing Properties of Mg-doped ZnO Films**
D. Akcan[1], L. Arda[1], S. Ozturk[2], O. Sisman[2], A. Gungor[1], Z. Z. Ozturk[2]
[1]Departmen of Mathematics Engineering, Bahcesehir *University, Besiktas, 34100, Istanbul*
[2]Departmen of Physics, Gebze Institute of Technology, Gebze, 41400, Kocaeli

P09 **Palladium Modified TiO_2 Nanorods to Methanol Sensing Device**
Onur Alev[1], Erdem Sennik[1], Z.Z. Ozturk[1,2];
[1]Gebze Institute of Technology, Department of Physics, Kocaeli, Turkey
[2]TÜBITAK-Marmara Research Center, Materials Institute, Kocaeli, Turkey

P10	**Sımple Fabrıcation of Network-like CuO Nanowires with Thermal Oxidatıon on Glass Substrate and Theır Ethanol Sensıng Propertıes** *O. Sisman[1], E. Sennik[1], S. Ozturk[2], N. Kilinc[3], Z.Z. Ozturk[1]*; [1]Department of Physics, Gebze Institute of Technology, KOCAELI; [2]Department of Physics, Fatih Sultan Mehmet University, ISTANBUL; [3]Department of Mechatronics Engineering, Nigde University, NIGDE
P11	***In Situ* Monitoring of Oxidation Process of Tin Oxide Nanolayers by the Novel Deposition Technique Based on Rheotaxial Growth and Vacuum Oxidation** *Monika Kwoka*, Institute of Electronics, Silesian University of Technology, Gliwice, Poland
P12	**Characterization of Dust and Ash Particles with a Micro-heater and Gas Sensitive SiC Field Effect Transistors** *Christian Bur[1,2], Manuel Bastuck[1], Andreas Schütze[1], Mike Andersson[2], Anita Lloyd Spetz[2];* [1]Linkoping University, Linkoping, Sweden; [2]Saarland University, Saarbrücken, Germany
P13	**Gas Sensor Self-Test Using Fourier-based Impedance Spectroscopy** *Marco Schüler, Tilman Sauerwald, Andreas Schütze* Saarland University, Saarbrücken, Germany
P14	**Illumination Comfort in a Retrofitted Shopping Center in Sopron Hungary** *L. Pockelé[1], A. Whang[2]*; [1]R.E.D. Srl, Padova, Italy; [2]National Taiwan University of Science and Technology, Taipei City 106, Taiwan (R.O.C.)
P15	**Indoor Comfort Determination in Apartments Designed according to Passive Haus Standards in ECO-SILVER House, a High Rise Building in Ljubljana** *Luc Pockelé[1], A. Bernardi[2], P. Bison[3], G. Cadelano[3], A. Bortolin[3], G. Ferrarini[3], M.C. Di Tuccio[2,4]*; [1]R.E.D. Srl, Padova, Italy; [2]CNR-ISAC, Padova, Italy; [3]CNR-ITC, Padova, Italy; [4]Physics Department, University of Milan (Italy).
P16	**Environmental Impact of PCMs Incorporated in Gypsum Panel for Cultural Heritage Application** *A. Bernardi[1], F. Becherini[1], A. Vivarelli[1], M. Favaro[2], M.C. Di Tuccio[1,3]*; National Research Council (CNR), [1]ISAC- [2]IENI, Corso Stati Uniti 4, Padova (Italy); [3] Physic Department, University of Milan (Italy), Via Giovanni Celoria 16, Milano (Italy)
P17	**Towards Air Quality Indices (AQIs) in Smart Cities by Calibrated Low-Cost Sensors Applied to Networks** *Domenico Suriano, Mario Prato, Gennaro Cassano, Michele Penza* ENEA, Technical Unit for Materials Technologies - Brindisi Research Centre, Brindisi, Italy
P18	**Electrochemical Modification of Nanostructured Metal-Oxides by Gold Nanoparticles for Gas Sensing Application** *E. Dilonardo[1*], M. Penza[2], M. Alvisi[2], C. Di Franco[3], F. Palmisano[1], L. Torsi[1], and N. Cioffi[1]*; [1]Department of Chemistry, Università degli Studi di Bari Aldo Moro, Bari, Italy; [2]ENEA Brindisi, Italy; [3]CNR-IFN Bari, Bari, Italy
P19	**Vascular and Lung Function Related to Ultrafine and Fine Particles Exposure Assessed by Personal and Indoor Monitoring** *Yulia Olsen[1], Dorina Gabriela Karottki[1], Ditte Marie Jensen[1], Gabriel Beko[2], Birthe Uldahl Kjeldsen[2], Geo Clausen[2], Lars-Georg Hersoug[1], Aneta Wierzbicka[3], Gitte Juel Holst[4], Torben Sigsgaard[4], Peter Møller[1], Steffen Loft[1];* [1]University of Copenhagen, Copenhagen, Denmark; [2]Technical University of Denmark, Lyngby, Denmark; [3]Lund University, Lund, Sweden; [4]Aarhus University, Roskilde, Denmark

Thursday, 4 December 2014

COST Action TD1105 for EU Clusters

Main Hall: *Fazil Say Room*

15:30 - 16:30	**Action TD1105 ROUND-TABLE DISCUSSION** *Chairman(s): Michele Penza, Action Chair, ENEA, Brindisi, Italy* *Chairman(s): Jurgen Frick, IEQ Cluster Coordinator, University of Stuttgart, Stuttgart, Germany*
	EU Clusters: The Indoor Environment Quality (IEQ) Cluster
15:30 - 15:50	**RTD Environment: *Nature Based Solutions and Renaturing Cities* H2020 Initiative** *Maria Yeroyanni*, Policy Officer, EC DG Research & Innovation, Unit I.3 - Sustainable Management of Natural Resources, Brussels, Belgium - ***tbc***
15:50 - 16:00	**Presentation of the IEQ Cluster Paper given to EC Policy-Makers** *Jurgen Frick*, IEQ Cluster Coordinator, University of Stuttgart, Germany
16:00 - 16:10	**Presentation of the NANOMECH Cluster: Environment and Health Impact of Nanomaterials for Cultural Heritage** *Adriana Bernardi*, NANOMECH Cluster Coordinator, CNR, Institute of Atmospheric Science and Climate, Padova, Italy
16:10 - 16:15	**A New EC DG R&I Clusters Initiative: The Characterization Cluster** *Michele Penza*, COST Action TD1105 Chair, ENEA, Brindisi, Italy
16:15 - 16:30	**Discussion of Action/Cluster Participants:** **Comments and Inputs on Priorities, R&I Needs, Strategies, Roadmap for future joint-activities of IEQ Cluster and COST Action TD1105 *EuNetAir*** **Speeches and Comments from Action WGs/SIGs Leaders and Participants** **Free Comments from Action and IEQ Cluster Stakeholders**
16:30 - 17:00	**Coffee-Break**

COST
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Thursday, 4 December 2014

Action TD1105 Working Groups and Special Interest Groups Meetings

Main Hall: *Fazil Say Room*

17:00 - 18:30	**Action WGs GENERAL ASSEMBLY** *Chairman: Michele Penza, Action Chair* *Italian National Agency for New Technologies, Energy and Sustainable Economic Development - ENEA, Brindisi, Italy*
	Specific Presentations from Vice-Chair and WGs Leaders
17:00 - 17:10	**New Methods for Control of Nanoparticles in Indoor Environment** *Anita Lloyd Spetz*, Action Vice-Chair, Linkoping University (Sweden) and University of Oulu (Finland)
17:10 - 17:20	**Research and Innovation Needs of WG1: Sensor Materials and Nanotechnology** *Jyrki Lappalainen*, Action WG1 Vice-Chair, Oulu University, Oulu, Finland
17:20 - 17:30	**Research and Innovation Needs of WG2: Sensors, Devices and Systems for AQC** *Andreas Schuetze*, Action WG2 Chair, Saarland University, Saarbrucken, Germany
17:30 - 17:40	**Research and Innovation Needs of WG3: Environmental Measurements and Air-Pollution Modelling** *Ole Hertel*, Action WG3 Chair, Aarhus University, Roskilde, Denmark
17:40 - 17:50	**Research and Innovation Needs of WG4: Protocols and Standardisation Methods** *Ingrid Bryntse*, Action WG4 Chair, SenseAir SA, Delsbo, Sweden

17:00 - 18:30	**Action SIGs GENERAL ASSEMBLY** *Chairman: Anita Lloyd Spetz, Action Vice-Chair* *Linkoping University (Sweden) and Oulu University (Finland)*
	Specific Presentations from SIGs Leaders
17:50 - 18:00	**Research and Innovation Needs of SIG1: Network of Spin-offs** *Marco Alvisi*, Action SIG1 Leader, ENEA, Brindisi, Italy
18:00 - 18:10	**Research and Innovation Needs of SIG2: Smart Sensors for Urban Air Monitoring in Cities** *Rod Jones*, Action SIG2 Leader, University of Cambridge, UK
18:10 - 18:20	**Research and Innovation Needs of SIG3: Guidelines for Best Coupling Air Pollutants and Transducer** *Eduard Llobet,* Action SIG3 Vice-Chair, Universitat Roviri I Virgili, Tarragona, Spain
18:20 - 18:30	**Research and Innovation Needs of SIG4: Expert Comments for the Revision of the Air Quality Directive (AQD)** *Nuria Castell-Balaguer*, Action MC Member, NILU, Kjeller, Norway

18:30	**CLOSING of WGs and SIGs MEETING**
20:30	**Free Dinner**

COST is supported by the EU Framework Programme

European Science Foundation — ESF provides the COST Office through a European Commission contract

Friday, 5 December 2014

Action TD1105 MANAGEMENT COMMITTEE Meeting

Main Hall: *Fazil Say Room*

09:30 - 13:00	**Action TD1105 6th MANAGEMENT COMMITTEE MEETING** *Chairman: Michele Penza, Action Chair* *Italian National Agency for New Technologies, Energy and Sustainable Economic Development - ENEA, Brindisi, Italy*
09:30 - 10:00	**Integrated Nanosensors for Indoor Air Quality Applications** *Juan Ramon Morante*, WG1 Leader and MC Member, IREC, Barcelona, Spain
10:00 : 13:00	**6th Management Committee Meeting** *Michele Penza*, Action Chair, ENEA, Brindisi, Italy
	• **DISCUSSION** (see MCM AGENDA)
	• **Coffee-Break** (timely scheduled)
13:00 - 14:30	• **Lunch offered by the Conference Organization**
14:30	• **Meeting Closing**

Draft Agenda
6th Management Committee Meeting
COST Action TD1105

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

THIRD SCIENTIFIC MEETING
Working Groups and Management Committee

New Sensing Technologies for Indoor Air Pollution Monitoring

Istanbul (Turkey), 3 - 5 December 2014

hosted by Bahcesehir University
Ciragan Caddesi Osmanpasa School Sokak, No. 4 - 6,
34353 Besiktas Campus, Istanbul, Turkey

Management Committee Meeting, 5 December 2014, 9:30 - 14:30 (local time)

To be completed by the meeting secretary and circulated to the MC, the DC Rapporteur(s) and the COST Office (Science and Administrative Officer)

1. Welcome to participants
2. Adoption of agenda
3. Approval of minutes and matters arising of last meeting
4. Update from the Action Chair
   a. Status of Action, including participating countries
   b. Action budget status
   c. STSM status and new applications
5. Promotion of gender balance and of Early Stage Researchers (ESR)
6. Update from the Grant Holder
7. Update from the COST Office
8. Update from the DC Rapporteur
9. Annual Progress Conference (preparation and/or feedback from DC)
10. Follow-up of MoU objectives
    a. Progress report of working groups
11. Scientific planning
    a. Scientific strategy
    b. Action Budget Planning
    c. Long-term planning (including anticipated locations and dates of future activities)
    d. Dissemination planning (Publications and outreach activities)
12. Requests for new members
13. Non-COST applications to the Actions
14. AOB
15. Location and date of next meeting
16. Summary of MC decisions
17. Closing

6th MC Meeting Venue/Location of COST Action TD1105 EuNetAir

THIRD SCIENTIFIC MEETING

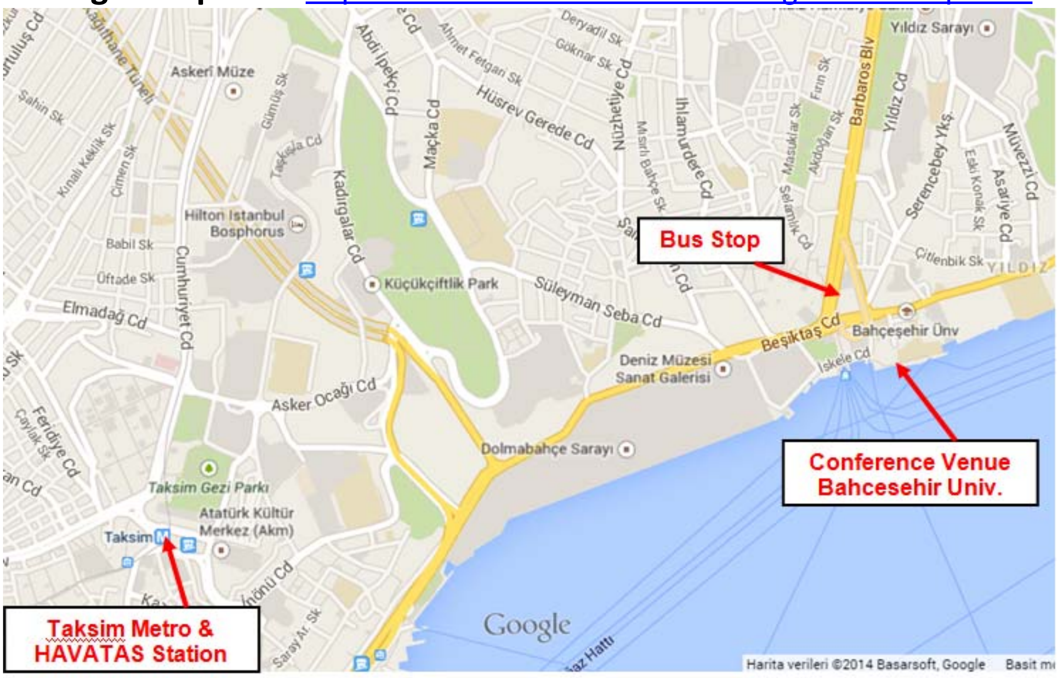
Working Groups and Management Committee

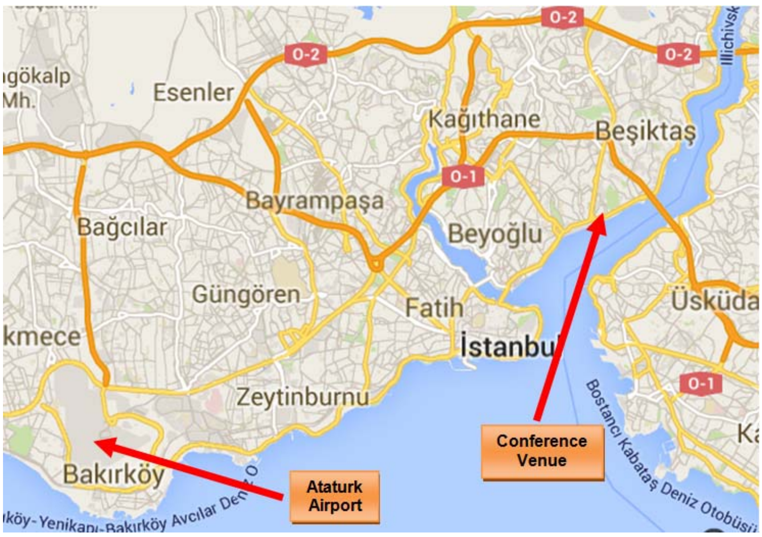
New Sensing Technologies for Indoor Air Pollution Monitoring

Istanbul (Turkey), 3 - 5 December 2014

Bahcesehir University - Ciragan Caddesi Osmanpasa School Sokak, No. 4 - 6, 34353 Besiktas Campus, Istanbul, Turkey

Google Map Link: http://content.bahcesehir.edu.tr/diger/bau-map.html





COST is supported by the EU Framework Programme

European Science Foundation — ESF provides the COST Office through a European Commission contract

WELCOME ADDRESS

This is a great honor and my pleasure to chair and welcome to ALL PARTICIPANTS of the **THIRD SCIENTIFIC MEETING**, including **Working Groups Meeting** and **Management Committee Meeting**, of our COST Action TD1105 *European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability - EuNetAir.*

This COST Meeting - held on 3-5 December 2014 - on ***New Sensing Technologies for Indoor Air-Pollution Monitoring*** is organized by **GEBZE Institute of Technology** and **Bahcesehir University** in Istanbul, supported by **TUBITAK** and hosted at **Auditorium of Bahcesehir University**, Besiktas Campus in Istanbul, with the Local Organizing Support from **GEBZE**, Kocaeli, Turkey.

This **Third Scientific Meeting** follows the previous *EuNetAir Meeting in Cambridge* (18-20 December 2013), and it is attended from at least 64 Participants and includes 11 Sessions with 2 Keynote Speakers, 20 Invited Speakers, 23 Contributed Speakers and 19 Poster Presenters from at least 21 COST Countries and 1 International Partner Country (USA). 2 **Plenary Sessions** devoted to ***Indoor Environment Quality Applications*** were participated by 9 Invited Speakers from 6 COST Countries. A Round-Table on **EU Clusters: The Indoor Environment Quality Cluster** has been organized with the attendance of *DG Officers* and *Cluster Coordinators*. An international Advisory Board (*Steering Committee*) composed by 22 Members served with S&T inputs to define Workshop Programme. *Female participants* are as 31% and *Male participants* are as 69% with a quota of *Early Stage Researchers* as 34%.

The concerted COST Action TD1105 *EuNetAir* - related to R&D issues of the air quality monitoring including environmental technologies, nanomaterials, functional materials, gas sensors, smart systems, air-pollution modelling, measurements, methods, standards and protocols - is very pleased to connect international specialists and excellent scientists to create a networking of Pan-European R&D platform from 29 COST Countries and 7 Non-COST Countries. Most part of COST Countries are represented in this Meeting.

Special thanks to **COST Officers**: Dr. Deniz Karaca, *ESSEM Science Officer* and Dr. Andrea Tortajada, *Administrative Officer*, involved to manage policy & administration in our Action.

On behalf of the Action Management Committee, I would like to thank **ALL Participants**, **Grant Holder**, **Action Scientific Secretary**, **Local Organizing Committee** by **GEBZE** and **Bahcesehir University**, represented by *Vice-Rector*, in order to give us the opportunity to disseminate the results of the COST Action TD1105 *EuNetAir* towards a wide international targeted audience involved in the Air Quality Control, with special focus on *Indoor Environment Quality Applications*. With their valuable scientific work and management, kind availability and great enthusiasm will make our Action Meeting very successful !

Enjoy your *EuNetAir* Meeting at *Bahcesehir University* in Istanbul !

Brindisi, 28 November 2014

Michele Penza, ENEA, Brindisi, Italy
COST Action TD1105 Chair
michele.penza@enea.it

EuNetAir COST Action TD1105 Logo

LIST OF PRESENTERS

THIRD SCIENTIFIC MEETING
Working Groups and Management Committee

New Sensing Technologies for Indoor Air Pollution Monitoring

Welcome Address Session

Welcome Address from Host Institution and Local Co-Organizer
Ali Gungor, Vice-President of Bahcesehir University, Istanbul, Turkey

Welcome Address from Local Organizer
Zafer Ziya Ozturk, MC Member, GEBZE Institute of Technology, Istanbul, Turkey

Welcome Address from COST Action TD1105
Michele Penza, Action Chair, ENEA, Italy

Plenary Session 1: Indoor Environment Quality Applications

COST Action TD1105: European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability
Michele Penza, Action Chair, ENEA, Italy

FP7 SENSIndoor Project (NMP-2013-5) and VOC-IDS Project (Era-Net): Selective VOCs Detection in the ppb Range for Demand Controlled Ventilation
Andreas Schuetze, Saarland University, Saarbrucken, Germany

FP7 Project MSP (ICT-2013-10): MSP for Air Quality in Building Technology Applications
Oliver von Sicard, Siemens AG, Munich, Germany

Smart Calibration for Successful European Gas Sensor Production
Ingrid Bryntse, Action WG4 Leader & MC Member, SenseAir AB, Delsbo, Sweden

Plenary Session 2: Indoor Environment Quality Applications

FP7 Project CETIEB (EeB-2011): Active and Passive Measures to Assess and Improve Indoor Environment Quality
Jurgen Frick, Project Coordinator, University of Stuttgart, Germany

IEQ Cluster: Technologies and Materials for a Healthier Indoor Environment
Lorenzo Miccoli, BAM Federal Institute for Materials Research and Testing, Berlin, Germany

Highlights from EU and Belgian Projects on IAQ and Health and Future Needs for Sensor Technologies
Jan Theunis, STSMs Coordinator and MC Member, VITO, Mol, Belgium

FP7 Project OFFICAIR: On the Reduction of Health Effects from Combined Exposure to Indoor Air Pollutants in Modern Office Buildings
John Bartzis, Project Coordinator, University of West Macedonia, Kozani, Greece

FP7 Projects TeACH and NANOMATCH: Environmental Aspects in the Field of Cultural Heritage Conservation
Adriana Bernardi, Project Coordinator, CNR, Institute of Atmospheric Science and Climate, Padova, Italy

Parallel Session of WG1-WG2

WG1: Sensor Materials and Nanotechnology

Effect of Dopants and Humidity on NO2-Sensing with Semiconducting Oxides
Bilge Saruhan-Brings, WG Member, German Aerospace Center, Institute of Materials Research, Cologne, Germany

Pulsed Laser Deposition of Nanostructured Metal Oxides for Gas Sensors
Jyrki Lappalainen, Action WG1 Vice-Chair, Oulu University, Oulu, Finland

Metal Functionalized ZnO Nanorods for Gas Sensing Applications
Zafer Ziya Ozturk, Gebze Institute of Technology, Kocaeli, Turkey

Electrophoretic Au-NPs Deposition on Carbon Nanotube Networked Layers for Gas Sensors
E. Dilonardo, M. Penza, M. Alvisi, C. Di Franco, D. Suriano, R. Rossi, F. Palmisano, L. Torsi, and N. Cioffi; Department of Chemistry, Università degli Studi di Bari Aldo Moro, Bari, Italy; ENEA Brindisi, Italy; CNR-IFN Bari, Bari, Italy

Aerosol Deposited Thick Film $BaFe_{0.7}Ta_{0.3}O_3$-□ Ceramic for Nitrogen Monoxide Sensing
Murat Bektas, University of Bayreuth, Bayreuth, Germany

Application of Chemiresistive Polymer Films in Air Quality Control
G.Sakale, M.Knite, I.Klemenoks, S.Stepina, S.Sergejeva, Riga Technical University, Latvia

Nanostructured Metals and Metal Alloys for Hydrogen Sensors
Necmettin Kilinc, WG Member, Nigde University, Nigde, Turkey

WG2: Sensors, Devices and Systems for AQC

RFID Passive and Semi-Passive Tags for Environmental Monitoring: Current Results and Future Prospects
Eduard Llobet, Action MC Member, Universitat Roviri I Virgili, Tarragona, Spain

Examples Modelling and Simulation Studies on Indoor Air Quality Monitoring
Ahmet Özmen, Sakarya University, Department of Computer Engineering, Sakarya, Turkey

Particle Detection Using Acoustic Wave Technology for Air Quality Monitoring
Farah H. Villa-López, S. Thomas, M. Cole and J.W. Gardner, Warwick University, Coventry, UK

New Principle of Gas Molecule Detection based on Nonlinear Electromagnetic Response of Graphene Nanoribbons
M. Eriksson, L.Y. Gorelik, M.V. Voinova, Chalmers University of Technology, Goteborg, Sweden

Automated Computational Intelligence Model Selection for Sensor Data
Roman Neruda, Petra Vidnerova, Vera Kurkova, Institute of Computer Science, Academy of Sciences of Czech Republic, Prague, Czech Republic

Gas Sensors for Environmental Monitoring
Sadullah Ozturk, Gebze Institute of Technology, Kocaeli, Turkey

Parallel Session of WG3-WG4

WG3: Environmental Measurements and Air-Pollution Modelling

Particle Pollution in Danish Domestic Homes: Impact of Outdoor Sources for Indoor Exposure
Ole Hertel, Action WG3 Chair - Aarhus University, Roskilde, Denmark

Air Quality in Subway Systems
MariaCruz Minguillon, Action WG Member, CSIC-IDAEA, Barcelona, Spain

Spatial Data Fusion of Observations from Low-Cost Air Quality Sensors and Models for Urban-Scale Air Quality Mapping
Philipp Schneider, Action MC Member, NILU, Kjeller, Norway

An Example of Low-Cost Devices for Indicative Indoor PM, CO2 and Meteorological Parameters Monitoring
Milena Jovasevic-Stojanovic, Action WG3 Member, Institute Vinca, Belgrade, Serbia

Influence of the Meteorological Conditions on Air Pollution in City of Skopje
Igor Atanasov, Ministry of Environment and Physical Planning, Skopje, Republic of Macedonia

Impact of NOx Emissions on Air Quality Simulations with the Bulgarian WFR-CMAQ Modelling System
Emilia Georgieva, Action WG Member, NIMH, Bulgarian Academy of Sciences, Sofia, Bulgaria

Indoor Growing Plants of Chlorophytum comosum L Phytoremediate of Particulate Matter from Air
H. Gawrońska, B. Bakera, Stanislaw Gawronski, Warsaw University of Life Science, Warsaw, Poland

WG4: Protocols and Standardisation Methods

Gas and Particulate Monitors: Advances and Setbacks
John Saffell, Action Sub-WG4.3 Leader, Alphasense Ltd, Essex, UK

Application of MEMS, CMOS Broadband Infrared Emitters and Detectors for Compact NDIR CO2 Sensing
Foysol Chowdhury, Action WG Member, CCMOSS Ltd, Cambridge, UK

Case-Study of the Spin-off RED: Devices for Indoor Environments Control
Luc Pockelè, Research and Environmental Devices, RED srl, Padova, Italy

Citizen Science in Mapping Outdoor and Indoor Environments: Potentials and Challenges
Jamal Jokar Arsanjani, Action WG Member, Heidelberg University, Germany

Green Smart Net: Environmental Data Acquisition, Handling and Transmission for Risk Assessment in Agriculture and Beyond
Oriol Gonzales, WG Member, Universitat Roviri I Virgili, Tarragona,Spain

A Success Case of Synergy and Knowledge Transfer from Academia to Enterprise
Annamaria Demarinis Loiotile, University of Bari, Bari, Italy

Inputs from Action TD1105

Inputs from Action TD1105: Upcoming Action Events
Michele Penza, Action Chair, ENEA, Brindisi, Italy

Inputs from Action TD1105: Online Travel Reimbursement Request & Strong Feature Authentication
Juliane Rossbach, Grant Holder Manager, Eurice GmbH, Saarbrucken/Berlin, Germany

Inputs from Action TD1105: EuNetAir at COST Strategic Event Cities of Tomorrow - The Challenges for Horizon 2020, Turin (Italy), 17 - 19 September 2014
Anita Lloyd Spetz, Action Vice-Chair, Linkoping University, Linkoping, Sweden

KEYNOTE SESSION: Sensors for Sustainable Cities

The SENSEable Cities
Marguerite Nyhan, SENSEable City Lab, Massachusetts Institute of Technology, Cambridge, USA

Environmental Measurements Using Low-Cost Sensors: Latest Results and Future Directions
Rod Jones, Action SIG2 Leader and MC Member, University of Cambridge, Cambridge, UK

SIG1: Network of spin-offs

Specific Presentations from SIG1

Overview of Support Structures and Funding Opportunities for Small and Medium Sized Enterprises in Europe
Corinna Hahn, Action GH Manager and EEN Germany National Contact Point, Saarbrucken, Germany

Applications and Trends in Gas Sensing for Home and Health
Oliver von Sicard, Siemens AG, Munich, Germany

SIG2: Smart Sensors for Urban Air Monitoring in Cities

Specific Presentations from SIG2

Comparison of Low Cost Sensors and Reference Equipment in Laboratory and in Real-World. First Experiences in Oslo, Norway
Nuria Castell-Balaguer, Action Sub-WG3.1 Leader, NILU - Norwegian Institute for Air Research, Kjeller, Norway

Indoor Air Quality Monitoring: Guidelines for Design of a Sensor Network in a Shopping Mall
Joao Ginja, WG Member, IDAD, Aveiro, Portugal

SIG3:Guidelines for Best Coupling Air Pollutants and Transducer

Specific Presentations from SIG3

Detection of Odorant Molecules Using Proteins
Marcel Bouvet, Action Sub-WG1.3 Leader, Universitè de Bourgogne, Dijon, France

Mastering VOC Detection for Better Indoor Air Quality
Donatella Puglisi, C. Bur, M. Bastuck, A. Schuetze, M. Andersson, R. Yakimova, A. Lloyd Spetz, J. Eriksson, WG Member, Linkoping University, Linkoping, Sweden; Saarland University, Saarbrücken, Germany; SenSiC AB, Kista/Stockholm, Sweden

SIG4:Expert Comments for the Revision of the Air Quality Directive (AQD)

Specific Presentations from SIG4

Outline of Chemical Sensors Applications for IAQ Evaluation
Anne-Claude Romain, Action Sub-WG4.2 Leader, Universitè de Liège, Arlon, Belgium

Eye Symptoms from Reactive Indoor Air Chemistry?
Peder Wolkoff, National Research Centre for the Working Environment, Copenhagen, Denmark

Live Video Chat - nanoFIS Conference 2014 in Graz

nanoFIS Conference, Graz
COST Action TD1105 Meeting, Istanbul

nanoFIS Conference 2014
1st International Conference on Functional Integrated nano Systems
Dr. Anton Kock, MSP FP7-project Coordinator, Materials Center Leoben Forschung GmbH (Austria)

Poster Session: New Technologies and Methods for Environmental Monitoring

P01: Acetylene Detection by Fiber Loop Ring-Down Technique
M. Fatih Danışman, Okan Esentürk, Md. Abu Sayed, Alim Yolalmaz; Department of Chemistry, Middle East Technical University, Ankara; Micro and Nano-Technology Program, Middle East Technical University, Ankara

P02: Simulation of Air Pollution in the Cross-Border Region Bulgaria-Turkey
E. Georgieva, K. Slavov, D. Syrakov, Action WG3 Member, NIMH, Bulgarian Academy of Sciences, Sofia, Bulgaria

P03: Distributed Online Gas Sensor Simulator For Indoor Air Quality Monitoring
Deniz Balta and Ahmet Özmen; Department of Computer Engineering, University of Sakarya, Esentepe Campus, Sakarya, Turkey

P04: Indoor Modelling and Sımulator Development for Measurement Systems and Gas Sensors
N. Yalçın, A. Özmen; Department of Computer Engineering, University of Bilecik Şeyh Edebali, Gülümbe Campus, Bilecik, Turkey; Department of Computer Engineering, University of Sakarya, Esentepe Campus, Sakarya, Turkey

P05: Graphene Sheets and Silicon Cantilevers Employed in Laser Photoacoustic Spectroscopy for Gas Sensing
M. Dostál, J. Suchánek, P. Janda, Z. Zelinger; J.Heyrovský Institute of Physical Chemistry, v.v.i., Academy of Sciences of the Czech Republic, Dolejškova 3, 182 23 Praha 8, Czech Republic; Technical University of Ostrava, Faculty of Safety Engineering, Lumírova 13, Ostrava-Vyškovice, 700 30 Ostrava, Czech Republic

P06: Magnetic and Optical Properties of Nanostructured Iron Biogenic Materials for Sensoric Applications
I. Nedkov, Action MC Member, Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria

P07: Preparation, Growth, and Gas Sensing Properties of Nonvacuum Er-doped ZnO Thin Films

L. Arda, D. Akcan, S. Ozturk, O. Sisman, A. Gungor, Z. Z. Ozturk; Departmen of Mathematics Engineering, Bahcesehir University, Besiktas, 34100, Istanbul; Departmen of Physics, Gebze Institute of Technology, Gebze, 41400, Kocaeli

P08:Structural, Electrical and Gas Sensing Properties of Mg-doped ZnO Films

D. Akcan, L. Arda, S. Ozturk, O. Sisman, A. Gungor, Z. Z. Ozturk; Departmen of Mathematics Engineering, Bahcesehir University, Besiktas, 34100, Istanbul; Departmen of Physics, Gebze Institute of Technology, Gebze, 41400, Kocaeli

P09: Palladium Modified TiO2 Nanorods to Methanol Sensing Device

Onur Alev, Erdem Sennik, Z.Z. Ozturk; Gebze Institute of Technology, Department of Physics, Kocaeli, Turkey; TÜBITAK-Marmara Research Center, Materials Institute, Kocaeli, Turkey

P10:Sımple Fabrıcation of Network-like CuO Nanowires with Thermal Oxidatıon on Glass Substrate and Theır Ethanol Sensıng Propertıes

O. Sisman, E. Sennik, S. Ozturk, N. Kilinc, Z.Z. Ozturk; Department of Physics, Gebze Institute of Technology, KOCAELI; Department of Physics, Fatih Sultan Mehmet University, ISTANBUL; Department of Mechatronics Engineering, Nigde University, NIGDE

P11:In Situ Monitoring of Oxidation Process of Tin Oxide Nanolayers by the Novel Deposition Technique Based on Rheotaxial Growth and Vacuum Oxidation

Monika Kwoka, Institute of Electronics, Silesian University of Technology, Gliwice, Poland

P12: Characterization of Dust and Ash Particles with a Micro-heater and Gas Sensitive SiC Field Effect Transistors

Christian Bur, Manuel Bastuck, Andreas Schütze, Mike Andersson, Anita Lloyd Spetz; Linkoping University, Linkoping, Sweden; Saarland University, Saarbrücken, Germany

P13:Gas Sensor Self-Test Using Fourier-based Impedance Spectroscopy

Marco Schüler, Tilman Sauerwald, Andreas Schütze; Saarland University, Saarbrücken, Germany

P14: Illumination Comfort in a Retrofitted Shopping Center in Sopron Hungary

L. Pockelé, A. Whang; R.E.D. Srl, Padova, Italy; National Taiwan University of Science and Technology, Taipei City 106, Taiwan (R.O.C.)

P15: Indoor Comfort Determination in Apartments Designed according to Passive Haus Standards in ECO-SILVER House, a High Rise Building in Ljubljana

Luc Pockelé, A. Bernardi, P. Bison, G. Cadelano, A. Bortolin, G. Ferrarini, M.C. Di Tuccio; R.E.D. Srl, Padova, Italy; CNR-ISAC, Padova, Italy; CNR-ITC, Padova, Italy; Physics Department, University of Milan (Italy).

P16: Environmental Impact of PCMs Incorporated in Gypsum Panel for Cultural Heritage Application

A. Bernardi, F. Becherini, A. Vivarelli, M. Favaro, M.C. Di Tuccio; National Research Council (CNR), ISAC- IENI, Corso Stati Uniti 4, Padova (Italy); Physic Department, University of Milan (Italy), Via Giovanni Celoria 16, Milano (Italy)

P17:Towards Air Quality Indices (AQIs) in Smart Cities by Calibrated Low-Cost Sensors Applied to Networks

Domenico Suriano, Mario Prato, Gennaro Cassano, Michele Penza; ENEA, Technical Unit for Materials Technologies - Brindisi Research Centre, Brindisi, Italy

P18: Electrochemical Modification of Nanostructured Metal-Oxides by Gold Nanoparticles for Gas Sensing Application

E. Dilonardo, M. Penza, M. Alvisi, C. Di Franco, F. Palmisano, L. Torsi, and N. Cioffi; Department of Chemistry, Università degli Studi di Bari Aldo Moro, Bari, Italy; ENEA Brindisi, Italy; CNR-IFN Bari, Bari, Italy

P19: Vascular and Lung Function Related to Ultrafine and Fine Particles Exposure Assessed by Personal and Indoor Monitoring

Yulia Olsen, Dorina Gabriela Karottki, Ditte Marie Jensen, Gabriel Beko, Birthe Uldahl Kjeldsen, Geo Clausen, Lars-Georg Hersoug, Aneta Wierzbicka, Gitte Juel Holst, Torben Sigsgaard, Peter Møller, Steffen Loft; University of Copenhagen, Copenhagen, Denmark; Technical University of Denmark, Lyngby, Denmark; Lund University, Lund, Sweden; Aarhus University, Roskilde, Denmark

Action TD1105 ROUND-TABLE DISCUSSION

EU Clusters: The Indoor Environment Quality (IEQ) Cluster

RTD Environment: Nature Based Solutions and Renaturing Cities H2020 Initiative

Maria Yeroyanni, Policy Officer, EC DG Research & Innovation, Unit I.3 - Sustainable Management of Natural Resources, Brussels, Belgium

Presentation of the IEQ Cluster Paper given to EC Policy-Makers

Jurgen Frick, IEQ Cluster Coordinator, University of Stuttgart, Germany

Presentation of the NANOMECH Cluster: Environment and Health Impact of Nanomaterials for Cultural Heritage

Adriana Bernardi, NANOMECH Cluster Coordinator, CNR, Institute of Atmospheric Science and Climate, Padova, Italy

A New EC DG R&I Clusters Initiative: The Characterization Cluster

Michele Penza, COST Action TD1105 Chair, ENEA, Brindisi, Italy

Discussion of Action/Cluster Participants:
Comments and Inputs on Priorities, R&I Needs, Strategies, Roadmap for future joint-activities of IEQ Cluster and COST Action TD1105 EuNetAir

Speeches and Comments from Action WGs/SIGs Leaders and Participants
Free Comments from Action and IEQ Cluster Stakeholders

Action WGs GENERAL ASSEMBLY

Specific Presentations from Vice-Chair and WGs Leaders

New Methods for Control of Nanoparticles in Indoor Environment

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

Research and Innovation Needs of WG1: Sensor Materials and Nanotechnology

Jyrki Lappalainen, Action WG1 Vice-Chair, Oulu University, Oulu, Finland

Research and Innovation Needs of WG2: Sensors, Devices and Systems for AQC

Andreas Schuetze, Action WG2 Chair, Saarland University, Saarbrucken, Germany

Research and Innovation Needs of WG3: Environmental Measurements and Air-Pollution Modelling
Ole Hertel, Action WG3 Chair, Aarhus University, Roskilde, Denmark

Research and Innovation Needs of WG4: Protocols and Standardisation Methods
Ingrid Bryntse, Action WG4 Chair, SenseAir SA, Delsbo, Sweden

Action SIGs GENERAL ASSEMBLY

Specific Presentations from SIGs Leaders

Research and Innovation Needs of SIG1: Network of Spin-offs
Marco Alvisi, Action SIG1 Leader, ENEA, Brindisi, Italy

Research and Innovation Needs of SIG2: Smart Sensors for Urban Air Monitoring in Cities
Rod Jones, Action SIG2 Leader, University of Cambridge, UK

Research and Innovation Needs of SIG3: Guidelines for Best Coupling Air Pollutants and Transducer
Eduard Llobet, Action SIG3 Vice-Chair, Universitat Roviri I Virgili, Tarragona, Spain

Research and Innovation Needs of SIG4: Expert Comments for the Revision of the Air Quality Directive (AQD)
Nuria Castell-Balaguer, Action MC Member, NILU, Kjeller, Norway

ABSTRACTS OF INVITED TALKS

Invited Talk

COST ACTION TD1105 ON NEW SENSING TECHNOLOGIES FOR AIR-POLLUTION CONTROL AND ENVIRONMENTAL SUSTAINABILITY: OVERVIEW AND PLANS OF ACTION

M. Penza and Consortium *EuNetAir*
ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Technical Unit for Materials Technologies-Brindisi Research Center, PO Box 51 Br-4, I-72100 Brindisi, Italy. Email: michele.penza@enea.it

Abstract
This is a short overview of the COST Action TD1105 *EuNetAir - European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability* - funded in the framework *European Cooperation in the field of Scientific and Technical Research* (COST) during the period 2012-2016.

The main objective of the Concerted Action 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 standardised methods for supporting environmental sustainability with a special focus on Small and Medium Enterprises.

This international Networking, coordinated by ENEA (Italy), includes over 80 big institutions and over 180 international experts from 28 COST Countries (EU-zone: *Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, The Former Yugoslav Republic of Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom*) and 7 Non-COST Countries (extra-Europe: *Australia, Canada, China, Morocco, Russia, Ukraine, USA*) to create a S&T critical mass in the environmental issues.

This COST Action [1, 2] (see logo in Fig. 1) will focus on a new detection paradigm based on sensing technologies at low cost for Air Quality Control (AQC) and set up an interdisciplinary top-level coordinated network to define innovative approaches in sensor nanomaterials, gas sensors, devices, wireless sensor-systems, distributed computing, methods, models, standards and protocols for environmental sustainability within the European Research Area (ERA).

The state-of-the-art showed that research on innovative sensing technologies for AQC based on advanced chemical sensors and sensor-systems at low-cost, including functional materials and nanotechnologies for eco-sustainability applications, the outdoor/indoor environment control, olfactometry, air-quality modelling, chemical weather forecasting, and related standardisation methods is performed already at the international level, but still needs serious efforts for coordination to boost new sensing paradigms for research and innovation. Only a close multidisciplinary cooperation will ensure cleaner air in Europe and reduced negative effects on human health for future generations in smart cities, efficient management of green buildings at low CO_2 emissions, and sustainable economic development.

Figure 1. COST Office, ESSEM Domain and Action TD1105 EuNetAir Logo.

The aim of the Action is to create a cooperative network to explore new sensing technologies for low-cost air-pollution control through field studies and laboratory experiments to transfer the results into preventive real-time control practices and global sustainability for monitoring climate changes and outdoor/indoor energy efficiency. Establishment of such a European network, involving Non-COST key-experts, will enable EU to develop world capabilities in urban sensor technology based on cost-effective nanomaterials and contribute to form a critical mass of researchers suitable for cooperation in science and technology, including training and education, to coordinate outstanding R&D and promote innovation towards industry, and support policy-makers. Main objectives of Action are listed, but not limited to:

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

The Workplan is organized in four complementary Working Groups (WGs), each devoted to a progressive development of synthesis, characterization, fabrication, integration, prototyping, proof-of-concepts, modeling, measurements, methods, standards, tests and application aspects. The four WGs with the specific objectives are:

- **WG1**: *Sensor materials and nanotechnology*
- **WG2**: *Sensors, devices and sensor-systems for AQC*
- **WG3**: *Environmental measurements and air-pollution modeling*
- **WG4**: *Protocols and standardisation methods*

This Action will focus on the study of sensor nanomaterials and nanotechnologies exhibiting unique properties in terms of chemical and thermal stability, high sensitivity, selectivity. Nanosize effects of functional materials will be explored for integration in the gas sensors at low power-consumption. Furthermore, specific nanostructures with tailored sensing properties will be developed for gas sensors and sensor-systems with advanced functionalities.

Selected high-quality research products and innovative technologies developed by the partnership of COST Action TD1105 are shown in the Figure 2.

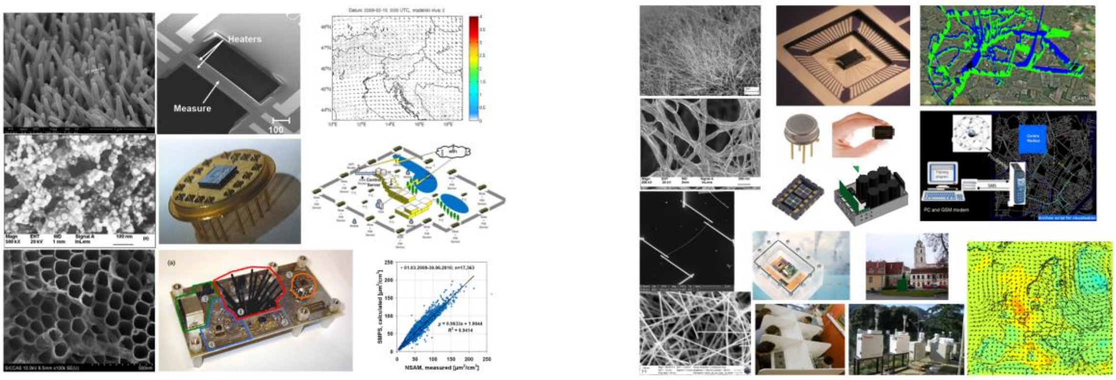


Figure 2. Selected R&D technological products developed by some partners (academia, research institutes, agencies, industry) involved in the COST Action TD1105 *EuNetAir*. Courtesy from *EuNetAir* partnership.

References

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Invited Talk

SELECTIVE VOC DETECTION IN THE PPB RANGE FOR DEMAND CONTROLLED VENTILATION – PROJECT SENSINDOOR

A. Schütze[1], A. Lloyd Spetz[2], J. Lappalainen[3], J. Hürttlen[4], M. Andersson[5], C. Alépée[6], T. Conrad[7], O. Martimort[8], J. Liimatainen[9], J. Petry[10]

[1]Lab for Measurement Technology, Saarland Univ., Saarbrücken, Germany; schuetze@LMT.uni-saarland.de
[2]Linköping University, [3]University of Oulu, [4]Fraunhofer ICT, [5]SenSiC AB, [6]SGX Sensortech SA, [7]3S GmbH, [8]NanoSense, [9]Picodeon Ltd Oy, [10]Eurice GmbH

Abstract

The EU FP7-project SENSIndoor [1] aims at the development of novel nanotechnology based intelligent sensor systems for selective monitoring of Volatile Organic Compounds (VOC) for demand controlled ventilation in indoor environments. Greatly reduced energy consumption without adverse health effects caused by the Sick Building Syndrome requires optimized ventilation schemes adapted to specific application scenarios like offices, hospitals, schools, nurseries or private homes. These must be based on selective detection and reliable quantification of relevant VOCs such as formaldehyde or benzene at ppb or even sub-ppb levels in complex environments [2, 3]. Priority scenarios and corresponding target gases and concentrations will be defined together with an advisory board representing health standard experts and major industrial stakeholders. The project addresses two sensor technologies with MEMS-based metal oxide semiconductor gas sensors [2] and SiC-based gas sensitive field effect transistors [3]. Gas sensitive layers for both sensor technologies are realized by Pulsed Laser Deposition (PLD) for well-defined, stable and highly sensitive nanostructured layers. These are combined with gas pre-concentration to boost the sensitivity of the overall system. Dynamic operation of the gas sensor elements by temperature cycling combined with pattern recognition techniques is employed to further boost sensitivity and selectivity [2, 3] and expanded to optimally use the gas pre-concentration. The project thus combines physical and chemical nanotechnologies for extremely sensitive and selective gas sensing, MEMS technologies for low-power operation as well as low-cost manufacture and finally dynamic operating modes together with advanced signal processing for unrivalled system performance. Sensor elements and systems are evaluated under controlled lab conditions derived from priority application scenarios. The final demonstration of the SENSIndoor technology will include field tests with sensor systems integrated into building control systems.

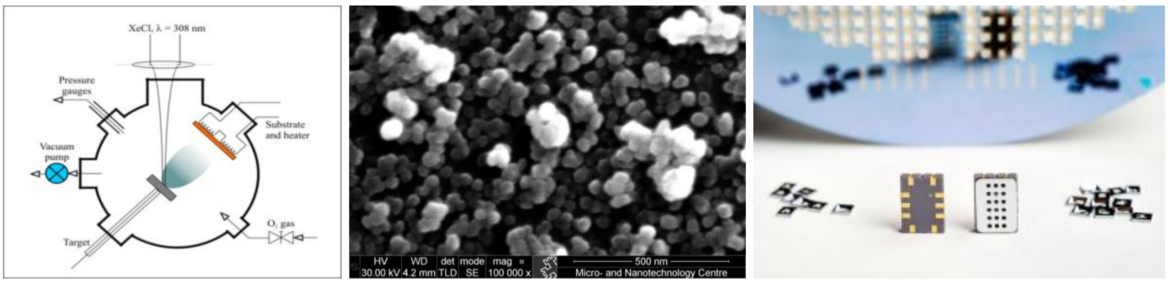

Fig. 1. Schematic of the PLD process (left) for deposition of gas sensitive layers (centre) on microsensors (right)

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Invited Talk

MSP FOR AIR QUALITY IN BUILDING TECHNOLOGY APPLICATIONS

O. von Sicard[1], Anton Köck[2]
[1]*Siemens AG, CT RTC SET CPS-DE, Otto-Hahn-Ring 6, 81730 Munich, Germany*
(oliver.v.sicard@siemens.com)
[2]*Department of Microelectronics, Materials Center Leoben Forschung GmbH, Roseggerstrasse 12, 8700 Leoben, Austria(anton.koeck@mcl.at)*

Abstract

For the industries involved in providing building infrastructure and building management systems the use of gas sensors becomes increasingly important. The applications range from indoor air quality monitoring and personal safety systems for CO detection to outdoor environmental monitoring for advanced HVAC control strategies.
All these applications require reliable, compact and efficient gas sensor systems which are capable of multi-gas sensing. However, up to now, there are no low cost gas sensor devices on the market which are capable of multi-gas sensing and which could fulfil the requirements for smart gas sensor applications in consumer electronics or HVAC applications.
This presentation will give a short insight into the requirements and show how projects like MSP are right on track to provide a solution for them.

A most powerful strategy to improve gas sensor performance is the implementation of nanostructured materials, such as nanowires, graphene, carbon nanotubes or nanoparticles, which have a high surface to volume ratio and thus a strong interaction between the surrounding gas and the material. A gas sensor array implemented with CMOS technology might be the approach of choice to solve multi-parameter sensing requirements for daily life applications as well as cost issues.
The MSP project “Multi-Sensor Platform for Smart Building management” is focused on the development of essential components and sensors that are required for the realization of miniaturized smart systems capable for indoor and outdoor environmental monitoring:

- Gas sensors for detection of potentially harmful or toxic gases
- Sensors for particulate matter and ultrafine particles
- Development of IR sensors for presence and fire detection
- Development of optimized IR detectors based on SOI thermopiles
- Development of highly efficient photovoltaics and piezoelectrics for energy harvesting
- Development of light sensor and UV-A/B sensors.

The concept of the MSP-project is based on rigorous employment of Through-Silicon-Via (TSV) technology to enable flexible 3D-integration of components and sensors on CMOS electronic platform chips in order to develop highly innovative miniaturized smart systems with significantly advanced functionalities. The MSP concept shall enable the early take up of Key Enabling Technologies for highly innovative product development.

This work was done within the project “MSP - Multi Sensor Platform for Smart Building Management” (FP7-ICT-2013-10 Collaborative Project, No. 611887).

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Invited Talk

SMART CALIBRATION FOR SUCCESSFUL EUROPEAN GAS SENSOR PRODUCTION

I. Bryntse and H. Martin
SenseAir AB, Stationsgatan 12, SE-820 60 DELSBO, Sweden; ingrid.bryntse@senseair.com

Abstract
Parallel to development of novel gas sensors with sub-ppm resolution it is crucial to optimize the corresponding calibration system, aiming at efficient high-volume production. SenseAir has together with Autoliv from the Automotive industry, developed a mouthpiece-free alcolock device with as high performance as police / evidence instruments - for a tenth of the price and with a considerably reduced size. This rigid NDIR based platform with ppb-resolution is also suitable for measuring various greenhouse gases absorbing in the region 6 – 10 μm [1].
In a joint project, partly supported by Vinnova (Sweden´s Innovation Agency), we built a research park for refining and testing calibration models. We have focused on the following areas: Rapid, stable and accurate temperature- and gas control, new methods of yielding & mixing vapours / gases, reference sensor improvement, certification of incoming reference gas (from different suppliers), reduction of the time for a full calibration process including verification, and smart communication and programming of sensor parameters.
Since the exhale of a drunk person contains ethanol vapour as well as carbon dioxide, both species are simultaneously measured to determine the sample dilution level, which in turn will yield the “soberness” [2]. Figure 1 displays a recent calibration experiment, indicating that each step could be finished in less than 0.25 h. In future, we believe that a complete process including initializing, zero-point and communication will only take about 2 h.

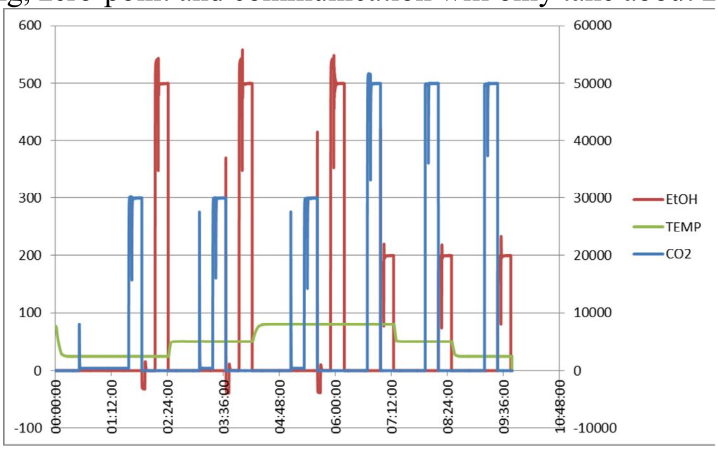

Figure 1. Calibration process parameters *versus* time, where ethanol vapour concentration and temperature (in ppm and °C, respectively) is shown to the left and carbon dioxide concentration (in ppm) to the right.

A similar calibration process can for instance be used for producing methane sensors for US fracking industry, or for terrestrial evaporation studies. The main expectation of any calibration system should be that it should perform at least 3 times better than the requirements of the produced sensor.

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Invited Talk

ACTIVE AND PASSIVE MEASURES TO ASSESS AND IMPROVE INDOOR ENVIRONMENT QUALITY - THE EU-PROJECT CETIEB

J. Frick[1], on behalf of the CETIEB consortium
[1]*Materials testing institute, University of Stuttgart, Pfaffenwaldring 32, D-70569 Stuttgart; juergen.frick@mpa.uni-stuttgart.de*

Abstract
The Energy Performance of Buildings Directive (EPBD) leads to energy-efficient buildings. However, refurbishment of existing buildings to an energy-efficient standard leads to tight buildings and affects the indoor climate and users are not adapted to this new situation. There is clearly a need for developing new methods for continuous detection of indoor pollution considering all key factors and for studying and identifying the best systems that allow an efficient control of the indoor environment.
Coordinated by the Materials Testing Institute (MPA) of the University of Stuttgart the EU-FP7 project "CETIEB - Cost-Effective Tools for Better Indoor Environment in Retrofitted Energy Efficient Buildings" (www.cetieb.eu) was performed from 1st October 2011 to 30th September 2014. 15 industrial and research oriented partners from 6 European countries and Taiwan were involved. CETIEB developed cost-effective, innovative solutions for better monitoring indoor environment quality and investigates active and passive systems to improve. The focus was to develop cost-effective solutions to ensure a wide application of the resulting systems.

CETIEB addressed three main objectives:
- Development of monitoring systems (wireless and/or partly wired) to detect insufficient comfort and health factor. One focus was the detection of VOC.
- Development of control systems for indoor environments which could be based on passive elements like cost-effective photo catalytic or phase change materials and active systems which control the air flow rates based on the monitored data. In addition, plant based systems were tested.
- Modelling of indoor environments to assess and validate monitored data and to optimise the control parameters and systems for energy-efficiency.

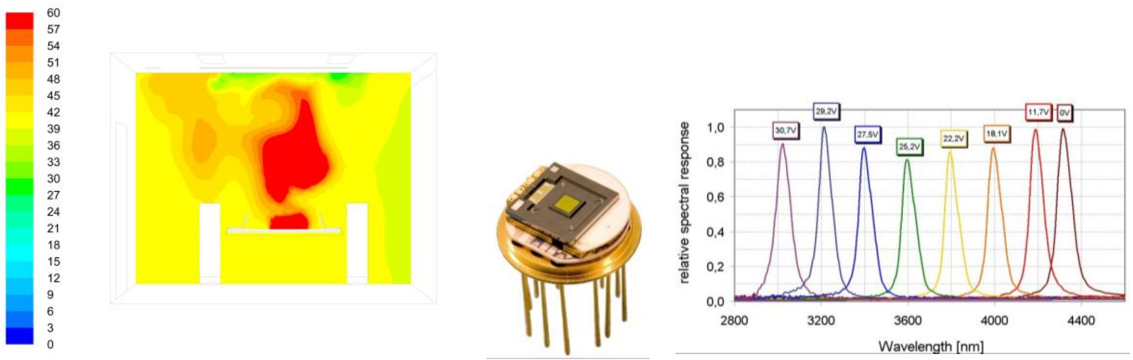

Figure 1. Left: Modelling of noxious gas distribution in ppm (partner USTUTT-IGE). Middle and right: MEMS based micro spectrometer module for VOC detection and spectral response (partner InfraTec).

Invited Talk

IEQ CLUSTER. TECHNOLOGIES AND MATERIALS FOR A HEALTHIER INDOOR ENVIRONMENT

L. Miccoli[1], R. Bell[2], A.M. Ferrari[3], J. Frick[4], M. Garcia Gonzalez[5], K. Malaga[6], P. Walker[7]
[1]*Division 7.1 Building Materials, BAM Federal Institute for Materials Research and Testing, Unter den Eichen 87, 12205 Berlin, Germany; lorenzo.miccoli@bam.de*
[2]*C-Tech Innovation Ltd, Capenhurst Technology Park, Chester CH1 6EH, United Kingdom; rob.bell@ctechinnovation.com*
[3]*D'Appolonia S.p.A., Via San Nazaro 19, 16145 Genoa, Italy; andrea.ferrari@dappolonia.it*
[4]*Materials Testing Institute (MPA), University of Stuttgart, Pfaffenwaldring 2b, 70569 Stuttgart, Germany; juergen.frick@mpa.uni-stuttgart.de*
[5]*Tecnalia, Bizkaia Technology Park, C/ Geldo Building 700, 48160 Derio - Bizkaia, Spain; miriam.garcia@tecnalia.com*
[6]*CBI Swedish Cement and Concrete Research Institute, Drottning Kristinas väg 26, 114 28 Stockholm, Sweden; katarina.malaga@cbi.se*
[7]*BRE Centre for Innovative Construction Materials, Department of Architecture and Civil Engineering, University of Bath, Bath BA2 7AY, United Kingdom; p.walker@bath.ac.uk*

Abstract

The goal of this cluster is to help increasing the impact/exploitation of the results of six research projects related to Indoor Environment Quality (IEQ). All six projects have received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration. Two of six projects, CETIEB (Cost-effective tools for better indoor environment in retrofitted energy efficient buildings) and INTASENSE (Integrated air quality sensor for energy efficient environment control) were completed in 2014. They started in 2011 and are related to the Call EeB.ENV.2011.3.1.5-1. The goal of the thematic area is the development of technologies for ensuring, monitoring and/or controlling a high quality indoor environment (including comfort, health, safety, accessibility and positive stimulation). The other four projects, BRIMEE (Cost-effective and sustainable bio-renewable indoor materials with high potential for customisation and creative design in energy efficient buildings), ECO-SEE (Eco-innovative, safe and energy efficient wall panels and materials for a healthier indoor environment), H-HOUSE (Healthier life with eco-innovative components for housing constructions) and OSIRYS (Forest based composites for facades and interior partitions to improve indoor air quality in new builds and restoration) will be completed by 2017. They started in 2013 and are related to Call EeB.NMP.2013-2. The goal of the thematic area is the development of new eco-innovative materials for the building envelope and/or internal walls/partitions leading to healthier indoor environment.

The cluster strategies to increase the impact of the projects are related to Life Cycle Assessment (LCA), fire protection, standardisation aspects and sharing data about renovation of buildings and case studies. Workshops of LCA experts and fire issues were planned. The share of info about regulations in different countries and discussion on the standardisation of common products is on-going. Other strategies to increase the impact are related to non-technical priorities. Share info about associations and public authorities playing in the field will be carried out. The use organisations of which the partners are members for dissemination activities (i.e. Netcomposites in Network Group for Composites in Construction) is on-going. A website for the IEQ cluster will be created. Website news between projects will be shared. At the current status the use common demo activities for modelling work and mobility action for PhD exchange are under consideration.

Invited Talk

Highlights from Belgian and EU Projects on IAQ and Health: Future Needs for Sensor Technologies

E. Goelen[1], M. Stranger[1], J.Theunis[1]
[1]*VITO,Unit Environmental Risk& Health, Boeretang 200, B-2400 Mol; Eddy.Goelen@vito.be*

Abstract
The contribution of non-ideal IAQ to the loss of healthy life expectancy, expressed as disability adjusted life years (DALY), has been calculated in the EU ENVIE study for 7 diseases: asthma, cardiovascular diseases, COPD (Chronic Obstructive Pulmonary Disease), lung cancer, SBS (sick building syndrome), respiratory infectious diseases and acute CO intoxication. At EU level overall it involves 2 million DALY's/year within a population of 480 million. These figures are the driving force for further national and European projects mapping the air quality indoors. Emissions of consumer products were quantified, based on new test protocols, in Ephect (www. Ephect.eu); modern office material emissions in the EU project Officair. An inventory of school IAQ at the Belgian level was collected in the Biba study and in a large surveillance in 450 complaint free dwellings. Data sets were also collected in dwellings where occupants had indoor related health complaints.
Typically one notices, as a global picture, that pollution levels differ substantially depending on the fact whether occupants report indoor related health complaints or not.
This observation is illustrated and confirmed when comparing the TVOC level between various studies (Figure 1). A general IAQ sensor providing continuous TVOC measurements, may therefore be a valuable tool as a first alert for predicting (avoiding) possible IAQ complaints from occupants.

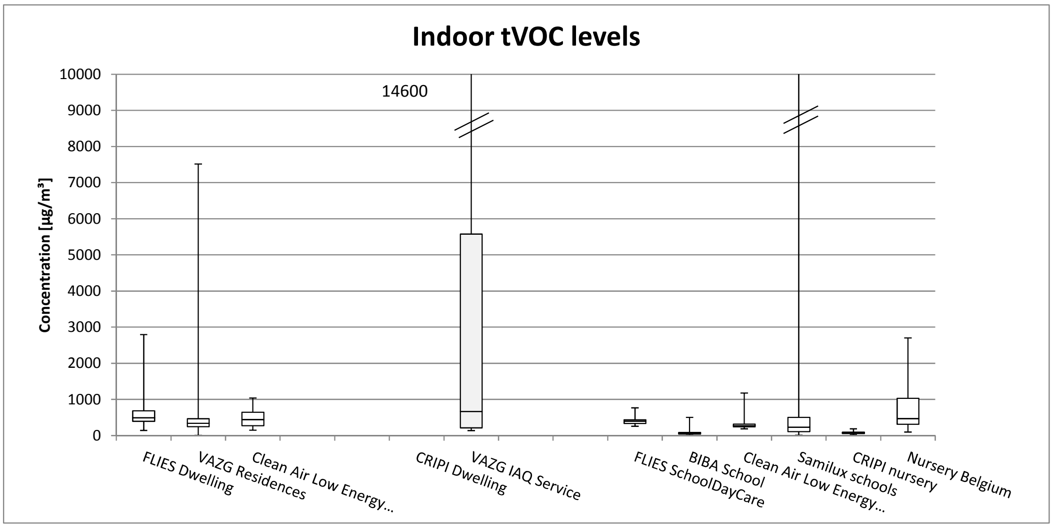

Figure 1 : Box and whiskers plot of indoor TVOC levels in Belgian residences and schools/nurseries with and without health complaints.

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Invited Talk

SAFETY RISK OF NANO-METAL ALKOXIDES FOR THE CONSERVATION OF CULTURAL HERITAGE: RESULTS FROM NANOMATCH PROJECT

A. Bernardi[1], M.Favaro[2], M. Chiurato[2], F. Becherini[1], A. Vivarelli[1], G. Schottner[3], B. Mueller[4]

CNR [1]ISAC and [2]IENI, Corso Stati Uniti 4, Padova (IT); a.bernardi@isac.cnr.it,
[3] Fraunhofer-Institute for Silicate Research (ISC) Bronnbach Branch 28, Wertheim-Bronnbach (DE) [4] T_O_P Oberflächen GmbH, Friedrichstr. 10a, Würzburg (DE)

Abstract

Historical Buildings and works of art are threatened by a great variety of deterioration agents (climate and pollutants) which can affect very seriously the materials, irreversibly altering their preservation and enjoyment. The same factors acting on the historic substrates are effective also on the products used for conservation, reducing their efficacy and removability.
The FP7 NANOMATCH PROJECT - ***Nano-systems for the conservation of immoveable and moveable polymaterial Cultural Heritage in a changing environment*** addressed this issue through the development of innovative nano-materials specifically designed to meet the requirements of the historic substrates, ensuring at the same time better performance and long durability compared to the products actually available in the restoration market. In particular, two calcium alkoxides ($Ca(OTHF)_2$, $Ca(OEt)_2$) for the consolidation of stone and the deacidification of wood and one aluminium alkoxide (A18) for the consolidation of micro-fractured glass have been synthetized and produced. Due to the extremely small size and peculiar chemical-physical proprieties of nanoparticles, sometimes it is possible to have an interaction with human organism. Therefore, it is necessary a complete evaluation of the risks connected with species that belong to this class. For this reason, as well as to ensure the achievement of the targets of eco-compatibility and respect of the environment and human health, the hazard impact of the NANOMATCH alkoxides on environment and human health has been monitored in all the phases of their life cycle, i.e. from the synthesis over the production of the solutions and sols, to their application in laboratory and in field. For glass frits the released Ca concentration ranges from 25 to 31 µg/mL; conversely, for marble specimens, the contribution from the treatments to the released Ca concentration is negligible due to the high Ca background in the matrix. The characterization of leached solutions from nanoparticles released in outdoor scenario tests, mimicking the outdoor ageing due to rainwater and seasonal temperature turnover, has confirmed the full missing of such nanoparticles due to their dissolution in the water. In conclusion, the main risks are only related to the dermal and eye contact in handling the solvents, which can be avoided adopting adequate personal protections (gloves, glasses, mask). Concerning the risk assessment of the glass consolidant, nanoparticles as such are not present neither in the solution nor in the microcavities of the glass. Possible risks may arise from the hydrolysation of methoxysilane, an additive used to stabilize the product under high humidity levels, which causes the formation of methanol. Anyway, so far, the required quantities keep the methanol content below 3% and therefore below the amount relevant for declaration. All the results have led to the production of Material Safety Data Sheet (MSDS) and operational guidelines [1] on production and safe handling.

References

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Invited Talk

TECHNOLOGIES FOR THE DIAGNOSIS OF THE POLLUTION IMPACT ON HISTORIC BUILDINGS SURFACES: THE TEACH PROJECT

A. Bernardi[1], F. Becherini[1], A. Vivarelli[1], Luc Pockelé[2]
[1]*Institute of Atmospheric Sciences and Climate (ISAC), National Research Council (CNR), Corso Stati Uniti 4, 35127 Padova (Italy);* *a.bernardi@isac.cnr.it*
[2] *R.E.D. srl, Viale dell'industria 58b, Padova (Italy);* *luc.pockele@red-srl.com*

Abstract

Gaseous and aerosol pollutants are known to be the main cause of surface blackening in urban sites. Moreover, the available scenarios in Europe indicate that the impact of atmospheric air pollution on building materials due to industrial, domestic and transport emissions is changing over time. In particular, the "future" soiling on architectural surface is most likely going to contain primarily organic carbon, due to the increase of the mobile combustion sources. This situation will presumably lead to a yellowing-browning of surfaces, besides the "traditional" blackening. Hence, improved methods for a more accurate diagnosis, monitoring and assessment of the damage on movable and immovable Cultural Heritage are required.

In this framework, the European TeACH PROJECT – ***Technologies and tools to prioritize Assessment and diagnosis of air pollution impact on immovable and movable Cultural Heritage*** (2008-2012, funded by the 7th FP) aimed:

1. to identify the main pollutants that will constitute a serious threat to Cultural Heritage in the future and to forecast the upcoming damages of artworks;
2. to develop a simple, economic, compact kit consisting of existing and new monitoring devices, including the continuous measurement of surface color changes;
3. to produce a new tool that can correlate the changing outdoor damage patterns with the likely damage to cultural materials indoors.

The new kit for the monitoring of the deterioration of stone surfaces includes a colorimeter and an electronic interface, mounted on a mechanical arm to automate the functions normally performed manually by spectrophotometers or colorimeters, as well as microclimatic sensors. After laboratory calibration and testing, the prototype has been tested at 3 historic sites in urban areas in Europe representative of different environmental and climatic conditions: the Opera del Duomo Museum in Florence (Italy), the Arriaga Theatre in Bilbao (Spain) and the Cologne Cathedral (Germany). At each target site, samples of surface deposits and damage layers were also collected and analysed from a mineralogical and chemical point of view.

In conclusion, a methodology has been established to assess the changing impact of the pollutants responsible for the damage of Cultural Heritage in synergy with the environmental factors. The results highlight how the development and optimization of appropriate technologies and tools to monitor and control the effect of these changes on architectural surfaces constitutes a potential tool in preventive conservation strategies [1, 2].

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Invited Talk

EFFECT OF DOPANTS AND HUMIDITY ON NO_2-SENSING WITH SEMICONDUCTING OXIDES

B. Saruhan-Brings, A. A. Haidry
[1]*Department of High-Temperature and Functional Coatings, Institute of Materials Research, German Aerospace Center, Linder Hoehe, 51147 Cologne/Germany*
Email: bilge.saruhan@dlr.de

Abstract

Sensors based on semiconductor oxides are generally of low cost and high stability even in corrosive environments [1-4]. The disadvantages are lack of sensitivity to monitor dilute NO_x, deprivation long-term stability under fluctuating environments and yield of signals from interfering gases [2]. SnO_2 is the most studied semiconducting metal-oxide, but its use is limited to lower operation temperatures (typically up to 300°C). In the presence of reducing gases, SnO_2 begins to reduce at temperatures about 350°C to 450°C, due to the consumption of surface oxygen. The sensitivity and selectivity of semiconductor oxides can be adjusted by doping with Nb, Sn, Pt, Zn, La, Y, Cr, Al, etc. or by forming heterojunctions using other oxides (e.g. CuO and WO_3) [3,4]. Al-doping of TiO_2 inhibits the grain growth and also retards phase transformation from anatase to rutile by stabilizing the surface state, resulting in better sensing properties [5]. Al-doping of SnO_2 has not been investigated thoroughly as a gas sensor material.

This work employed reactive magnetron sputtering technique for deposition of sensing layers on Al_2O_3 sensor platforms of containing inter-digital platinum electrodes (IDEs) which were previously patterned by screen printing method. Sputtering technique allows flexibility in adjusting composition and layer thickness yielding fine columnar structured morphology. The SEM micrograph of undoped and 800°C calcined SnO_2 layer exhibits dense morphology (Figure 1-a) with fine pores in cross sections, while Al-doped SnO_2 shows finer grain sizes with relatively wide cracks and fine columns at cross-section (Figure 1b).

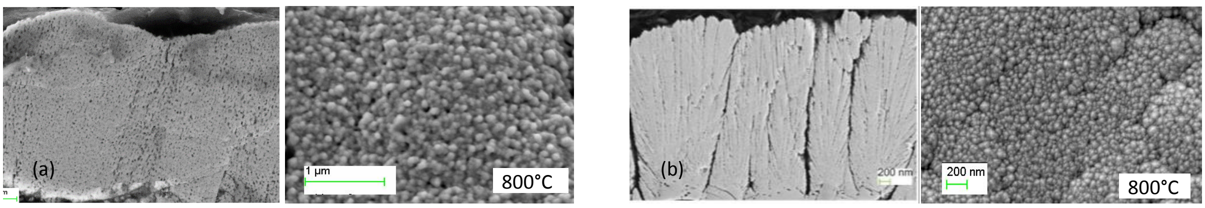

Figure 1. SEM micrographs of (a) undoped SnO_2 layers and (b) Al-doped SnO_2 layers after heat-treatment at 800°C, at cross-section and from top view.

Our studies show that sensors having Al-doped SnO_2 (3 at % Al) sensing layers exhibit excellent chemical stability under humid environment and display high selectivity to NO_2 at a temperature range of 300–600°C. Figure 2 displays the sensor response of undoped and Al-doped SnO_2 towards NO_2 at 300°C under dry conditions and 50% humidity. NO_2-sensing with undoped SnO_2 sensors is possible only in a smaller temperature range at lower temperatures. The response improvement with Al-doped SnO_2 can be related to the reduced grain size and to the corresponding increased surface area.

Invited Talk

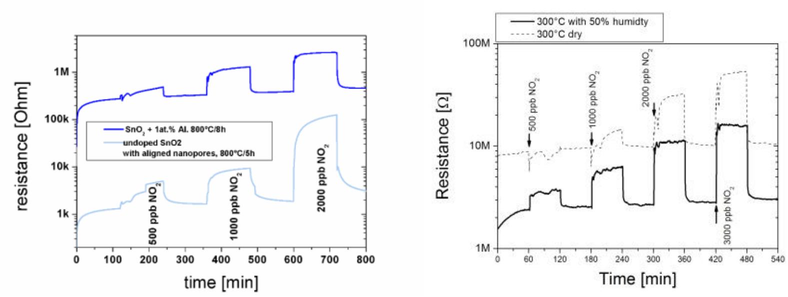

Figure 2. : (a) Sensor response of undoped and 1 at. % Al-doped SnO_2 at 300°C (b) Sensor response of 2.6 at. % Al-doped SnO_2 layers towards NO_2 at 300°C with and without 50 % humidity (dry).

Response and recovery times of undoped and Al-doped SnO_2 sensing layers were at high temperatures too long (several minutes). In fact, at some cases, the determination of recovery was not possible, due to not reaching back to baseline resistance related to failing of desorption. On the other hand, in the presence of humidity (10% RH), the response and recovery times under NO_2 of Al-doped SnO_2 sensors were shortened drastically indicating a change in adsorption kinetics probably due to change in sensing mechanism. Moreover, the Al-doped SnO_2 sensor becomes more selective towards NO_2 in CO+NO_2 gas mixtures. While an enhanced sensitivity was observed with this sensor towards various concentrations of NO_2 in humid background environment (1-10 %RH), its sensitivity reduces in oxygen rich environment, indicating a low cross-sensitivity to oxygen. Hence, it can be concluded that Al-doped SnO_2 sensors are promising candidates to monitor NO_2 at higher temperatures under oxidizing and humid environments with fast response rates and low oxygen cross-sensitivity.

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Oral Presentation

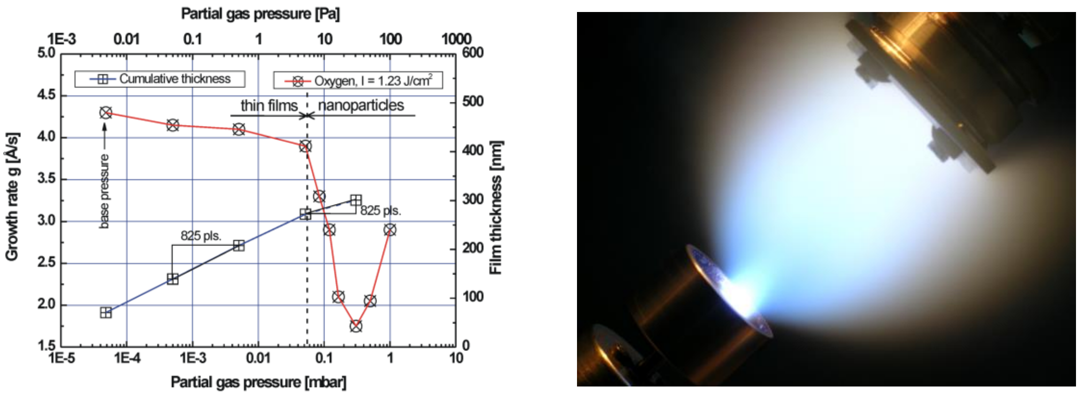
PULSED LASER DEPOSITION OF NANOSTRUCTURED METAL OXIDES FOR GAS SENSORS

J. Huotari[1], R. Bjorklund[2], T. Baur[3], J. Lappalainen[1], A. Lloyd Spetz[1,2], and A. Schütze[3]
[1]*Microelectronics and Material Physics Laboratories, University of Oulu, FIN-90570, Oulu, Finland; jyla@ee.oulu.fi*
[2]*Department of Physics, Chemistry and Biology, Linköping University, SE-581 83, Linköping, Sweden; spetz@ifm.liu.se*
[3]*Laboaratory for Measurement technology, Saarland University, 66123 Saarbrücken, Germany; schuetze@lmt.uni-saarland.de*

Abstract

In the case of pulsed laser deposition (PLD), one utilizes intense laser pulses guided in to a vacuum chamber to ablate and evaporate the target material surface. Generated plasma is adiabatically expanding in the low-pressure atmosphere, and can be collected onto a substrate some distance away from the target to form a thin film of atomic scale species. However, by carefully adjusting the laser beam properties and increasing the partial oxygen pressure $p(O_2)$ of PLD process, nucleation and clustering of nanoparticles can already be initiated in the plasma, as is shown in Fig. 1(a). At higher values of $p(O_2)$, the plasma emits a brite bluehish glow, as in Fig. 1(b).

PLD of various metal oxides were made at room temperature and in relatively high partial oxygen pressures. The deposited materials were tungsten trioxide (WO_3), vanadium pentoxide (V_2O_5), and tin dioxide (SnO_2), the latter also with platinum (Pt) nanoparticle decoration. Both conventional MEMS microheaters and silicon carbide (SiC) GasFET structures were used as substrates and sensor platforms. The layers have shown to be consisted of small metal oxide nanoparticles below 50 nm in diameter, and the nanoparticle agglomerates, which sizes are clearly dependent on values of $p(O_2)$ used during depositions. On the other hand, crystal structure of the nanoparticles was strongly dependent also on post-annealing procedures. The first gas sensing measurements have shown very promising results, e.g. good selectivity and response to ppb-levels for naphthalene and ammonia, for example, detected with WO_3 and V_2O_5 nanoparticle layer sensors, respectively.



(a) **(b)**

Figure 1. (a) Quartz crystal microbalance (QCM) measurements of PLD process of WO_3 revealed two modes of growth: (i) thin-film growth in the pressures $p(O_2) \leq 0.05$ mbar, and (ii) nanoparticle formation in the higher oxygen pressures. **(b)** With higher $p(O_2)$ values ablation plasma starts to glow bright blue.

Invited Talk

METAL FUNCTIONALIZED ZnO NANORODS FOR GAS SENSING APPLICATIONS

S.Öztürk[1], N.Kılınç[2], Z. Z. Ozturk[3,4]

[1] *Faculty of EngineeringFatih Sultan Mehmet Vakif University Istanbul*, Turkey, sadullahozturk@gyte.edu.tr

[2] *Faculty of Engineering Nigde University, Nigde, Turkey, nkilinc@gyte.edu.tr*

[3]*TUBITAK Marmara Research Center, P.O. Box 21, 41470 Gebze Kocaeli, Turkey,* zozturk@gyte.edu.tr

[4]*Department of Physics, Gebze Institute of Technology, KOCAELI*

Abstract

This work is based on functionalization of zinc oxide (ZnO) nanostructures with by using simple and low-cost fabrication techniques for gas sensing applications. ZnO nanostructures were produced in the shape of nanorods with hydrothermal process on glass susbtrate. To enhance sensing properties of ZnO nanorods, surfaces of the nanords were modified with metal nanoparticle by sol-gel techniques and tested against to different gas species as hydrogen (H_2), and volatile organic compounds (VOCs) in dry air and humid air ambient at different operation temperature.

ZnO is a n-type semiconducting materials with direct and wide energy band gap. Due to the electrical, optical and non-toxic properties, ZnO have been used in transistors, light emitting diodes, solar cells, gas sensors and medicine [1]. ZnO nanorods were fabricated vertically aligned on glass substrate and the details were given in our previous work [2]. ZnO nanorods were functionalized by Ni (Nickel), Chromium (Cr), Cobalt (Co), Cupper (Cu) by sol-gel deposition techniques. In sol-gel process ZnO nanorods were coated with acetate solution (0.001M) prepared in ethanol by using spin coating and then dired at 130ºC for 5 min. Coating and drying process were repeated for five times and then samples were annealed in air ambient at 300°C. The diameters and lengths of ZnO nanorods were approximately 100 nm and 1.62 µm, respectively. Functionalized and undecorated ZnO nanorods were characterized by scanning electron microscopy (SEM). SEM images of samples were given in Figure 1.

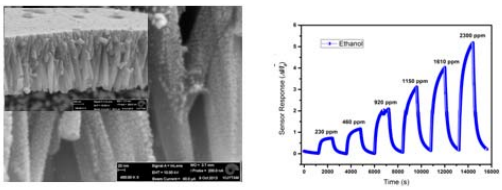


Figure 1. a) SEM images of Co functionalized of ZnO nanorods and b) Sensor responses of undecorated of ZnO nanorods for ethanol vapour at 300°C.

Gas Sensing properties of the metal nanoparticle funtionalized ZnO nanorods were investigated in dry air and humid air ambient at different operation temperature zone from 200°C to 350°C.

Acknowledgements

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Oral Presentation

ELECTROPHORETIC Au-NPs DEPOSITION on CARBON NANOTUBE NETWORKED LAYERS for GAS SENSORS

Elena Dilonardo[1*], Michele Penza[2], Marco Alvisi[2], Cinzia Di Franco[3], Domenico Suriano[2], Riccardo Rossi[2], Francesco Palmisano[1], Luisa Torsi[1], and Nicola Cioffi[1]

[1]*Department of Chemistry, Università degli Studi di Bari Aldo Moro, Bari, Italy*
[2]*ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Technical Unit for Materials Technologies - Brindisi Research Center, Italy.*
[3]*CNR-IFN Bari, Bari, Italy.*

*elena.dilonardo@uniba.it

Abstract

Carbon nanotubes (CNTs) have attracted considerable attention as gas sensing materials because of their potential for the selective and rapid detection of various gaseous species by novel nanostructures integrated in small and low-power consuming electronics. CNTs have the ability to detect the adsorbed/desorbed gas molecules, changing their resistance [1]. However, CNT-based gas sensors have some limitations, such as low sensitivity, lack of selectivity, irreversibility, and long recovery time; to overcome these drawbacks, the functionalization of CNTs with different materials to alter their chemical nature and enhance their sensing performance have been proposed [2,3].

In this contribution, a controlled amount of Au-surfactant core-shell colloidal nanoparticles (NPs), previous electrochemically synthesized, were electrophoretically deposited on CNT-based sensor device. The Au NPs/CNTs hybrid material was morphologically and chemically characterized, by revealing the successful functionalization of CNTs with elemental gold nanophases. Au NP/CNTs networked films were tested as active layers in a two-pole resistive gas sensor for detection of pollutant gases, exhibiting a *p-type* response with a decrease in the electrical resistance upon exposure to oxidizing gas and an increase in resistance upon exposure to reducing gas [4]. The Au-modified CNT-based sensor response towards common pollutant gases was investigated, showing a very good short-term repeatability and faster recovery. Specifically, a high sensitivity to NO_2 was found using CNTs modified with the lowest Au-loading; while, on the contrary, a high sensitivity to H_2S was found using CNTs modified with the highest Au content. The impact of the Au loading on gas sensing performance was investigated as a function of the working temperature, gas concentration and interfering gases. Finally, the sensing properties of the Au-decorated CNTs sensor are promising in environmental and automotive gas sensing applications, based on low-power consumption and moderate sensor temperature.

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Oral Presentation

AEROSOL DEPOSITED THICK FILM $BaFe_{0.7}Ta_{0.3}O_{3-\delta}$ CERAMIC FOR NITROGEN MONOXIDE SENSING

M. Bektas, D. Hanft, D. Schönauer-Kamin, T. Stöcker, G. Hagen, R. Moos
Department of Functional Materials, University of Bayreuth, 95447, Bayreuth;
functional.materials@uni-bayreuth.de

Abstract
The gas sensing properties of the conductometric gas sensor material $BaFe_{0.7}Ta_{0.3}O_{3-\delta}$ (BFT30), which has recently found to be a temperature independent oxygen sensor [1] between 800 and 900°C were studied. BFT30 fine powder was produced by mixed-oxide route. The novel aerosol deposition method (ADM) was used to produce BFT30 thick films on alumina substrates with Pt electrodes in four-wire configuration. With ADM, thick and dense ceramic films can be deposited at room temperature directly from the powder.

The sensitivity of BFT30 samples was investigated in environments with various gases (C_3H_8, NO, NO_2, CO, CO_2, and H_2O) at a constant oxygen partial pressure between 350 and 800 °C. BFT30 sensor exhibits excellent sensing properties to NO at 350 and 400 °C with a high selectivity towards all other examined gas species. Figure 1a shows the normalized resistance, $S_{NO} = R/R_0$, of a BFT30 ADM-coated sensor under the presence of NO in concentrations between 250 and 2000 ppm in flowing synthetic air. The sensor responds fast, stably and reversibly to NO. Especially low NO concentrations seem to affect the sensor response strongly. Figure 1b shows the NO dependence of the ADM BFT30 sensor at lower NO concentrations from 1.5 to 100 ppm. BFT30 sensor material is a good candidate as NO sensor for air quality control applications at 400 °C, when the oxygen concentration remains constant.

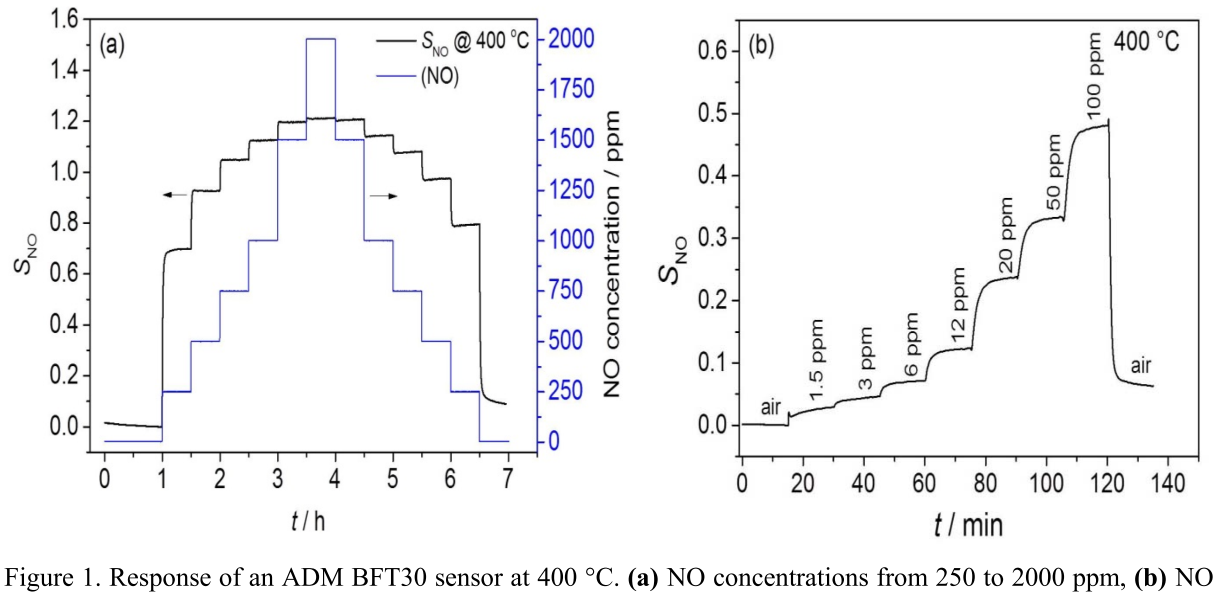

Figure 1. Response of an ADM BFT30 sensor at 400 °C. **(a)** NO concentrations from 250 to 2000 ppm, **(b)** NO concentrations between 1.5 and 100 ppm

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Oral Presentation

APPLICATION OF CHEMIRESISTIVE POLYMER FILMS IN AIR QUALITY CONTROL

G.Sakale[1], M.Knite, I.Klemenoks, S.Stepina, S.Sergejeva
[1]*Institute of Technical Physics, Riga Technical University, Paula Valdena 3, Riga, Latvia;*
Gita.Sakale@rtu.lv

Abstract
It is already a well known fact that indoor air quality (AQ) directly affects human productivity, possibility to concentrate and to perform physical activities in short term, but in long-term it can be a reason for serious illnesses like asthma. AQ control is essential at public places like office buildings and educational institutions, where main air pollutants can be CO_2, VOC, particulate matter etc. Looking at the public media resources this year in Latvia two cases have been reported related to indoor AQ. The first case, Latvian State Revenue Service was moved to new office building, where employees complained about AQ, skin and eye irritation, headaches and tiredness. It was thought that the main reason is formaldehyde coming from building materials like floor covering or furniture. Air quality measurements were made, formaldehyde emissions were well below threshold level, but the real cause was not found. The second case is related to AQ at educational institutions. In last few years grate number of educational institution buildings have been renovated to increase building energy efficiency. However in most cases it does not include ventilation system renovation. It leads to problems with AQ at schools and kinder gardens. AQ is of concern at production sites (use and storage of harmful chemicals) and at public transport like underground subways as well. As shown in research paper [1] main air pollutants present in underground subways are PM, VOC, formaldehyde, CO_2 and CO. Tools, which could ensure proactive action - monitoring air quality in real time and effectively interact with ventilation system, are in demand.
Chemiresistive polymer films can be promising AQ control tool for sensing VOC [2]. These type of sensors have several advantages: easy production, sensitive and selective, low power consumption and in-situ monitoring of AQ can be ensured. Current research is related to exploring different kind of conductive fillers (carbon black, MWCNT, SWCNT) to obtain conductive polymer films with high VOC sensitivity. One can conclude that high filler loadings are not favourable because it restricts swelling of polymer film and aggregates of the filler can act as obstacles for diffusion of VOC molecules inside the polymer matrix material. The compromise has to be found in order to obtain conductive polymer film with low filler loading and good diffusion characteristics.

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Oral Presentation

NANOSTRUCTURED METALS AND METAL ALLOYS FOR HYDROGEN SENSORS

Necmettin Kilinc[1,2]

[1]*Department of Mechatronics Engineering, Nigde University, 51245 Nigde, Turkey;* *nkilinc@nigde.edu.tr*

[2]*Nanotechnology Application and Research Center, Nigde University, 51245 Nigde, Turkey*

Abstract

Hydrogen (H_2), as a renewable energy source, has numerous applications such as chemical production, fuel cell technology, rocket engines, fuel for cars etc [1, 2]. The detection of H_2 is so important in safety issue due to the flammable and explosive properties of H_2 gas, in a H_2 source for leak detection and in H_2 production process because of real-time quantitative analysis of production. There are many various types of H_2 sensor commercially available or in development. The research is ongoing on the design and development of H_2 gas sensor that is reliable, smaller size, chemically selective, reversible, real-time detection, has low working temperature, low-power consumption, and simple to operate, cheap, and sensitive to low concentration of H_2 with fast response time. The H_2 sensors could be specified into seven categories, depending on evident physico-chemical principles of detection mechanism: Catalytic, electrochemical, resistor based (semiconducting metal-oxide and metallic resistor), work function based, mechanical, optical, acoustic [3,4].

This presentation is a review for resistive type H_2 sensor based on palladium (Pd), platinum (Pt) and their alloy nanostructures in the forms of thin films, nanoporous films, nanowires, nanoparticles, nanotubes, etc [5]. The sensing mechanism of the nanostructured Pd and Pt resistive sensor will be discussed in details. Nanostructured Pd sensors show a decrease or an increase in their resistance towards H_2 gas depending on continuity of the nanostructure and will be examined in two parts: discontinuous (nano-gap based) and continuous Pd and Pd alloy nanostructure sensors [5-7]. On the contrary to Pd nanostructure sensor, nanostructured Pt sensors require oxygen (O_2) to operate. There are limited numbers of publications about nanostructured Pt and Pt alloy sensors, so further investigation are needed to well understand sensing mechanism of the Pt sensors.

Acknowledgement: This study was supported by The Scientific and Technological Research Council of Turkey (TUBITAK) with project number of 114M853 and COST Action TD1105.

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Invited Talk

RFID PASSIVE AND SEMI-PASSIVE TAGS FOR ENVIRONMENTAL MONITORING: CURRENT RESULTS AND FUTURE PROSPECTS

Pierrick Clément[1], Angel Ramos[3], David Girbau[2], Eduard Llobet[1]
[1]*MINOS-EMaS, Universitat Rovira i Virgili, Avda. Països Catalans, 26, 43007 Tarragona, Spain; eduard.llobet@urv.cat*
[2]*NEPHOS-EMaS, Universitat Rovira i Virgili*

Abstract

In recent years, hand-held devices for gas detection are getting more and more popular. This entails increasing research activities to develop gas sensors featuring small size, low power consumption and low costs. There is a need for developing grids of wireless, intelligent, autonomous and very low power multisensory systems requiring no human intervention after their implementation, since this would allow setting smart global systems of networked sensors for many different applications, including indoor or outdoor air pollution monitoring [1,2]. Radiofrequency identification (RFID) is a widely extended technology where it is needed to remotely identify an object [3]. It is based on a reader that interrogates one or more tags. The reader acquires their identification (ID) remotely via a radiofrequency (RF) link. Since RFID systems first appeared, a lot of research has been done to improve their capabilities: the aim is to obtain not only the ID, but also parameters of the tag's surrounding physicochemical environment. These parameters are sensed by the tag itself, which becomes a wireless sensor [4]. However, there are still important technological barriers that limit the implementation of smart and autonomous systems with sensing capabilities. These obstacles are related to (i) sensor performance, (ii) power consumption and (iii) size of the system as a whole. Here we will review the last developments in this field and give an outlook.

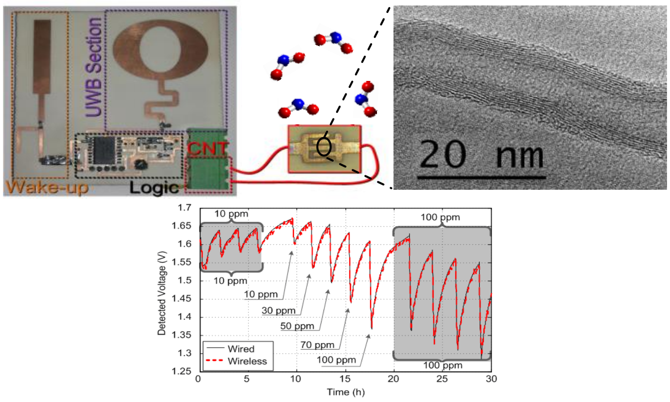

Figure 1. Semi-passive TAG employing functionalised carbon nanotubes for the wireless detection of NO_2. [5]

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Invited Talk

MODELLING AND SIMULATION STUDIES ON INDOOR AIR QUALITY MONITORING

Ahmet ÖZMEN
Department of Computer Engineering, University of Sakarya, Esentepe Campus, Sakarya
ozmen@sakarya.edu.tr

Abstract

The goal of this study is to develop a software simulation system for indoor air quality monitoring. Indoor air quality monitoring requires multiple gas sensors along with temperature and humidity sensors to be installed to the rooms of a building. Managing the data that comes from such number of sensors becomes a very complex problem. Modelling and simulation studies speed up gas sensor researches because they alleviate troubles that occur especially during the testing part of the distributed gas sensor systems.

Many models have been developed to determine indoor air quality and to analyse the dispersion of the pollutants [1, 2, 3]. These studies create a strong background to the topic; however, advances in electronic sensor technologies require revisiting the problem. Similarly, rapid developments in computer technologies make distributed on-line measurement systems possible.

In the first phase of this study, mathematical models for indoor environments and gas sensors are developed [4, 5, 6]. By this way, it has been aimed to predict the indoor gasses (such as CO, CO_2, SO_2) pollutants' concentrations as a function of temperature, humidity, pressure and pollutant sources in a room. On the other hand, modelling gas sensors are accomplished based on characterization studies. Once these models are verified, they are coded as software components. Interaction of simulated environment and sensors results in real-like synthetic data which can be controlled by us. Using the simulator, any virtual environment can be created, and sensor data on multiple sensor cells are collected in a laboratory.

This simulation platform will help us to create and test various scenarios virtually. For example, what happens at a crowded classroom during a winter day, and what can be done to make the air cleaner in the classroom? This simulator will guide us how to develop a distributed gas sensor system for air quality monitoring, and it can also help us to make smart decisions about air conditioning with respect to comfort and energy consumption.

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Oral Presentation

PARTICLE DETECTION USING ACOUSTIC WAVE TECHNOLOGY FOR AIR QUALITY MONITORING

F.H. Villa-López, S. Thomas, M. Cole and J.W. Gardner
Microsensors and Bioelectronics Laboratory, University of Warwick, Coventry, UK
F.H.Villa-Lopez@warwick.ac.uk

Abstract

Human exposure to airborne particulate matter, namely PM2.5 and PM10 is considered especially hazardous for health. For this reason, there is a special need of monitoring particulate matter concentrations in both indoor and outdoor environments. Commonly employed devices for particle detection are based on optical techniques but these are complex and costly [1]. As an alternative approach, acoustic wave technology has been proposed for the development of low-cost particle detectors. Previous work has demonstrated the use of Surface Acoustic Wave Resonators (SAWRs) as particle detectors [2]. Seeking the miniaturization of particle sensors, this paper presents the development of a lower cost, highly sensitive and portable particle sensing unit based on Solidly Mounted Resonators (SMRs).

In this work, SMR devices are used because they can operate at high frequencies (in the range of GHz) while maintaining a much smaller size than SAWR sensors. Furthermore, higher mass sensitivities can be achieved so nanoparticles can be detected and they are CMOS compatible.

The SMR-based particle sensing system has been designed to operate in a dual configuration in order to eliminate common mode variations. The bulk acoustic wave based devices operate at a resonant frequency of 970 MHz driven by a Colpitts type oscillator circuit. The mass loading on the sensing device due to the total number of particles deposited causes a change in its resonant frequency. The differential frequency output is interfaced to a microcontroller and data are logged through a USB communication channel to a PC with National Instruments LabVIEW software.

The assembled particle sensing unit is shown in Figure 1. The system has been found to be capable of detecting fine particles with masses in the picogram range demonstrating its potential to be miniaturised in CMOS technology as a smart low-cost particle air quality sensor.

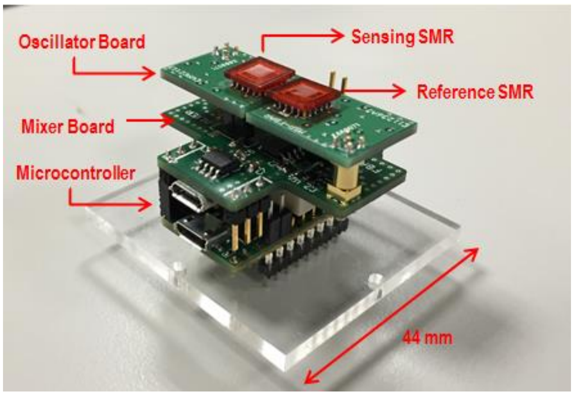

Figure 1. Particle sensing unit.

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Oral Presentation

NEW PRINCIPLE OF GAS MOLECULE DETECTION BASED ON NONLINEAR ELECTROMAGNETIC RESPONSE OF GRAPHENE NANORIBBONS

M. Eriksson, L.Y. Gorelik, M.V. Voinova

Department of Applied Physics, Chalmers University of Technology, Fysik Grand 1, 41296, Goteborg; marina.voinova@chalmers.se

Abstract

Graphene nanoribbons (GNRs) are considered now as new promising materials for mass measurements with the accuracy up to a single molecule level [1]. Typically, the NEMS-based mass sensors employed the near-resonance measurements of NEMS response to the mass adsorption. It was found that the adsorption of some gases (for example, NH_3) [2] may affect also the graphene conductance. In our work [3] we have investigated a new nonlinear electromechanical phenomenon in the system of a graphene ribbon suspended over the trench and subjected to the electromagnetic field induced by the AC gate voltage (Fig. 1). It was shown that the amplitude of GNR oscillations demonstrates a large growth (via the electromechanical instability) when the amplitude of the applied AC voltage exceeds a certain critical value. The threshold voltage is proportional to the effective mass density and depends on the GNR conductance. Therefore, the studying of the variations may bring the information about the effective density of the adsorbed material. The latter suggested a new non-resonant mechanism of the adsorbed material detection via electromagnetic instability monitoring.

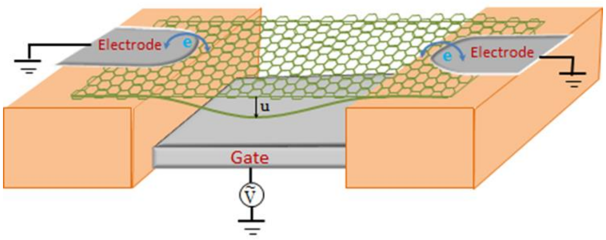

Figure 1. A sketch of the proposed electromechanical sensor system based on GNR.

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Oral Presentation

AUTOMATED COMPUTATIONAL INTELLIGENCE MODEL SELECTION FOR SENSOR DATA

R. Neruda, P. Vidnerová., V. Kůrková[1]
[1]*Institute of Computer Science, Academy of Sciences of the Czech Republic, Pod Vodárenskou věží 2, 18207 Prague, Czech Republic; roman@cs.cas.cz*

Abstract

Numerous data-mining methods have been proposed during the recent decades and most of them can be used to build model of various datasets. Naturally, the performance of different methods is different for each dataset. Moreover, due to the no-free lunch theorem, there is not any method which would perform the best on all possible datasets. This leads to the need to select the best-performing method for the problem at hand. This is the goal of meta-learning.

The research area of meta-learning is trying to augment, or even replace, human expertise in solving the problem of selection of a suitable model for a given data [1]. In this work we will demonstrate two important steps of meta-learning: the method recommendation [2], and the parameter selection [3] for the application area of sensor data [4]. These procedures utilize extensive analysis of dataset properties together with sophisticated search algorithms in the parameter space of the models. Together, they should provide a recommendation of a good model including its parameters for unseen data, based on previous experience. Focusing on classification problems from sensor data shows several specific implications for meta-learning. The good news is that the data are typically homogenous in terms of meta-data indicators, thus the parameter search and recommendation works rather reliably. On the other hand, the quality of method recommendation would improve with more experiments utilizing at least dozens of data sets, as well as more methods.

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Oral Presentation

GAS SENSORS FOR ENVIROMENTAL MONITORING

S.Öztürk[1], A. Kosemen[2], N.Kılınç[3], Z. Z. Ozturk[4]

[1] *Faculty of EngineeringFatih Sultan Mehmet Vakif University Istanbul*, Turkey, sadullahozturk@gyte.edu.tr

[3] *Faculty of Engineering Nigde University, Nigde, Turkey*

[4]*TUBITAK Marmara Research Center, P.O. Box 21, 41470 Gebze Kocaeli, Turkey*

Abstract

Intresting on enviromental monitoring have been increased in recent years due to the public safety, industrial process. Generally enviromental monitoring system trace gas molecule can be found in any atmosphere as road, airport, offices or houses. In some cases, the air quailty of atmospehere can be decreased down to uninhitable levels. So air quality must be trace by systematical and reliable systems.

Applications about environmental monitoring have been found in many areas as (air contamination of atmosphere or waste water), such as those of the energy, defence, chemical, paper, food, agriculture and waste processing industries. The diversity of sectors represented is the source of many opportunities for the environmental industry, but also in many cases, of costly method development in order to suit application-specific requirements [1].

Gas sensors are good the volunteers of environmental monitoring of air quality surrounded our life. A gas sensor consists of three different parts as sensitive layer, transducer parts. Metal, metal oxides, polymers and catalytic materials can be used as sensitive layer. On the other hand transducer parts can be based on some physical or chemical principle as electrical conductance, optical absorbance, optical or mass spectroscopy, etc. The diversity of gas sensors can be high depends on its parts or environmental conditional, and this situation make harder to choose best suitable sensor element. So before the using them, environmental conditions must be realized by users and there some parameters about them [1].

Semiconducting metal oxide materials have been used in gas sensors application more than fifty years and started to use for environmental monitoring system in recent years [2]. The main advantages of metal oxide is high sensitivity used in sensing areas create their big disadvantages is selectivity. This antimony can be eliminated by different approaches as doping of them, heterostructures or sensor arrays. By these ways electronic configurations or structural properties can be specified to one gas molecule or gas molecules can be classified by one by [3].

Acknowledgement

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Invited Talk

PARTICLE POLLUTION IN DANISH DOMESTIC HOMES: IMPACT OF OUTDOOR SOURCES FOR INDOOR EXPOSURE

O. Hertel[1], A. Massling[1], Y. Olsen[1], H.R. Olesen[1], and T. Ellermann[1]
[1]*Department of Environmental Science, Aarhus University, P.O. 358, Frederiksborgvej 399, 4000 Roskilde, Denmark City; Email: oh@envs.au.dk*

Abstract

Epidemiological studies of air pollution (AP) and health effects are usually using the AP level in urban background (but sometimes also at front door) at the address as a proxy for the exposure of the individuals. In DK and many other Western countries, the local contribution to AP exposure in urban areas is mainly related to road traffic. The questions is to what extent the outdoor AP level is representative for the actual personal exposure, given that people spend about 90% of their time indoors. Since epidemiological studies are used to statistically relate outdoor levels to various negative health outcomes, one may argue that this is less important. However, it may affect how results should be interpreted as e.g. different particle sizes will penetrate a building to different degrees, and the relationship thus vary from one particle size to another. The relationship between indoor and outdoor AP may thus vary pending on pollutant (including particle size), sources, meteorology and other factors. At the same time, different particle size deposit in different places within the respiratory system and have different impacts on health. In 2000-2004, a project was carried out in central Copenhagen (Schneider et al., 2004). An apartment in an old building complex was equipped with particle measurement devices. The study showed that the indoor particle levels were affected by neighbouring apartments during periods where it was likely that the latter were occupied. The signal from traffic in the street was modest and the results pointed to the need for studying factors such as particle chemical composition, within building movement patterns, and the impact of occupant behaviour on other apartments. In 2002-2004, measurements were carried out in a Danish village with intensive use of woodstoves (Glasius et al., 2006). This project showed that particle pollution levels could be of comparable magnitude to levels in trafficked streets in Copenhagen. In 2006-2007 another woodstove project was carried out in DK. The latter project was a follow-up study in another village with less intense use of woodstoves. In this study, measurements were performed also inside houses in the village, showing that indoor levels were affected by AP from one's own stove during startup of the woodstove. In 2013, a study was carried out using personal monitoring of fine fraction particle mass and particle number concentrations (PNC) in combination with measurements of microvascular function (MVF) (Olsen et al., 2014). An inverse relationship between PNC and MVF was shown, indicating their importancet in relation to cardiovascular illness and that more studies should investigate indoor/outdoor AP relationships and how these relate to health outcomes.

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Oral presentation

AIR QUALITY IN SUBWAY SYSTEMS

M.C. Minguillón[1], V. Martins[1], T. Moreno[1], M. Nieuwenhuijsen[2], X. Querol[1]
[1]*Institute of Environmental Assessment and Water Research (IDAEA), CSIC, Jordi Girona 18-26, 08034 Barcelona, Spain, mariacruz.minguillon@idaea.csic.es*
[2]*Centre for Research in Environmental Epidemiology (CREAL), Barcelona, Spain*

Abstract
Citizens usually spend a considerable amount of their daily time commuting in large urban agglomerations. The subway is energetically efficient and contributes to reduce the road traffic, hence it is considered one of the cleanest public transport systems. However, studies in numerous subway systems found that particulate matter (PM) concentrations are generally higher in these environments than in outdoor ambient air [1] (and references therein).
The exposure to ambient PM is usually studied in outdoor stations, which only represent what the people breathe during part of the day. The personal exposure to ambient PM was studied based on personal samples, and it was found that personal PM exposure is influenced by the subway source for persons travelling regularly by subway [2]. Moreover, the contribution of the subway source did not depend directly on the time spent travelling, indicating that the highest exposure to specific subway pollutants takes place on the platforms and not inside the trains [2].
To reduce such exposure, it is necessary to determine the factors influencing PM concentrations in underground railway systems. Some of these factors are the length and design of the stations and tunnels, the system age, the wheel, rail-track and brakes materials (which generate particles by abrasion), the train speed and frequency, the passenger densities, the ventilation and air conditioning systems, and the cleaning frequencies [3,4] (and references therein).
The Barcelona subway system comprises eight subway lines, at different depths, with different tunnel and station designs and train frequencies. An extensive measurement campaign was performed in this subway system [5]. PM concentrations varied widely between underground stations, attributed to different ventilation systems, characteristics of each station and variations in the train frequency. $PM_{2.5}$ concentrations on the platforms were higher during the colder than the warmer period due to differences in ventilation. $PM_{2.5}$ concentrations in the platforms of the new subway lines equipped with platform screen doors were lower than those in conventional platforms, which indicates that the main PM sources in the subway environment are the abrasion and wear of rail tracks, wheels and braking pads caused during the motion of the trains. PM concentrations inside the trains were lower than those on the platforms, attributable to the air conditioning systems inside the trains [5]. Additional studies in Athens, Prague and Oporto subway systems revealed similar conclusions.

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Oral Presentation

DATA FUSION OF OBSERVATIONS FROM LOW-COST AIR QUALITY SENSORS AND MODELS FOR URBAN-SCALE AIR QUALITY MAPPING

P. Schneider[1], N. Castell[1], W. A. Lahoz[1]
[1]*NILU - Norwegian Institute for Air Research, PO Box 100, Kjeller, Norway; ps@nilu.no*

Abstract
Low-cost air quality sensors have significant potential for improving the spatial mapping of urban-scale air pollution. The reason for this is that due to their small size and comparatively low price they can be deployed in a much larger number and thus higher density of sampling sites throughout a certain area than was previously possible with traditional, costly equipment. This allows capturing much more of the fine spatial patterns that are prevalent in city-scale air pollution.
However, two main issues prohibit the use of low-cost sensor as the sole source of information for mapping urban air quality: Firstly, at this point low-cost sensors for air quality do not reach the accuracy of traditional methods and as such have considerable systematic biases, which sometimes even vary over time, as well as significant species-dependent random errors. Secondly, even a dense deployment with several hundred nodes is still prone to substantial spatio-temporal gaps in the data.
Data fusion techniques (as a subset of data assimilation) allow for combining observations with model data and therefore provide a means of adding value to both the observations by filling spatio-temporal gaps in the data and the model by constraining it with the observations (Lahoz & Schneider, 2014). As such data fusion of observations from high-density low-cost sensor networks together with air quality models can contribute to improving urban-scale air quality mapping.
The data fusion approach described here uses the output from a local air dispersion model as basemaps and subsequently fuses them using geostatistical techniques with real-time observations from a low-cost sensor network deployed throughout a city. In order to generate static maps, which are essentially used as a proxy to guide the interpolation of the observations, we use the EPISODE air pollution dispersion model (Slørdal, Walker, & Solberg, 2003). This is a combined 3D Eulerian/Lagrangian air pollution dispersion model for urban and local-to-regional scale applications. The model includes schemes for advection, turbulence, deposition, and chemistry. EPISODE is generally run at a spatial resolution of 1 km. The resulting concentrations fields are subsequently post-processed and downscaled to a spatial resolution of 100 m using a high-density network of receptor points. This is also the spatial resolution of the basemaps used for the data fusion.
The underlying methodology for the data fusion approach is based on residual kriging and includes a fully automated system for establishing a relationship between the downscaled model output and the observations, estimating the spatial autocorrelation function from the observations, performing kriging of residuals, and producing the final map as a combination of a regressed map and kriged residuals. Initial testing of the methodology has been performed in the city of Oslo, Norway, using annual average concentration of NO_2 as computed by the EPISODE model with a synthetic dataset of observations at 50 stations located throughout Oslo. First results indicate that the system is very well capable of adequately adjusting the static basemaps with new information from the observations. The impact of the stations is limited to the station's spatial sphere of influence as specified by the

theoretical semivariogram. Outside of the area where the observations were taken the basemap remains largely unmodified. Evaluation of the methodology is being carried out using the leave-one-out cross validation technique.
The system further includes an automated component for filling short data gaps at individual nodes on the order of several hours using fully automated time series analysis based on autoregressive integrated moving average (ARIMA) modelling.
The results presented here are part of the ongoing FP7-funded project CITI-SENSE.

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Oral Presentation

AN EXAMPLE OF TESTING LOW-COST DEVICES FOR INDICATIVE INDOOR PM, $C0_2$ AND METEOROLOGICAL PARAMETERS MONITORING

Milena Jovašević-Stojanović(1), Dušan Topalović(1), Boris Pokrić(2), Tihomir Popović(3), Marija Živković(1), Ivan Lazović(1), Zoran Ristovki(4)

[1]Vinča Institute of Nuclear Sciences, University of Belgrade, P.O.Box 522, 11001, Belgrade, Serbia; Email mjovst@vinca.rs

[2]DunavNet d.o.o., Antona Čehova 1, 21000 Novi Sad, Serbia

[3]Serbian Environmental Protection Agency-SEPA, Ruže Jovanovića 27a, 11160 Belgrade, Serbia

[4]Queensland University of Technology, Science and Engineering Faculty, GPO Box 2434, Brisbane QLD 4001, Australia

Abstract

In European countries citizens spend most of the time in different indoor microenvironments such as homes, offices, transport, public buildings, etc. Due to such a life style, Indoor air quality (IAQ) has a significant impact on comfort and productivity at work and schools, human health and general well-being. It is well documented that pollutant levels may be two to five times higher indoor than outdoor. Emerging of new sensing technologies such as devices with low-cost sensors that monitor pollutants and other parameters and transfer the data via wireless networks to the back-end cloud infrastructure. This enables monitoring IAQ data in real-time as well as collection and analysis of historical data. Schools are the microenvironments where adolescents spend significant period of time. The typical classroom has on average four times as many occupants per m^2 as a typical office building. The CO_2 level within the classroom is affected by air exchange rate; number, age and physical activity of children in relation to room area and volume. In addition, the particulate matter (PM) concentration within clasrooms is determined from infiltrated outdoor PM as well as from indoor sources, i.e. cleaning practices. We have tested new low-cost device which have been designed and developed by DunavNET (Serbia). Low-cost sensors for meteorological data and gases have been supplied by Alphasense, while $PM_{0.5\text{-}2.5}$ and $PM_{2.5\text{-}10}$ have been measured with a Dylos 1700 monitor. Platforms were co-located at the Automatic Monitoring Station (AMS) in Belgrade that belong to the National Network for Monitoring Air Quality. In this study we present results of correlation of measured data between the platforms as well as their correlation with reference equipment for PM fractions ($0.6<r<0.9$) and meteorological data (>0.9) supplied by AMS. CO_2 concentrations were compared with a Testo CO_2 monitor ($0.6<r<0.9$). Before the calibration procedure a linear interpolation of reference signals for each platform was performed. Filtering of the signals was also performed by using a smooth function, generalized cross-validation method. Fitting of data from platforms with reference monitors was done using a polynomial of the first degree. Examples of a pilot IAQ campaign with DunavNET platforms in an elementary school in Belgrade show promising results and can be considered as indicative measurements. Levels of CO_2 was affected by the outdoor air when there were no occupants in the school, while it was strongly influenced by the presence of children in the classroom and rose from about 500 to more than 1000 ppm. Fine particulate fraction level in the classroom where under strong influence from outdoor $PM_{2.5,}$ while PM_{10} was more in correlation with children activities as well as and cleaning practise.

Presented results have been obtained within the activities that are carried out as part of the ongoing FP7 European project CITI-SENSE (Grant agreement nº: 308524).

Oral Presentation

INFLUENCE OF THE METEOROLOGICAL CONDITIONS ON AIR POLLUTION IN CITY OF SKOPJE

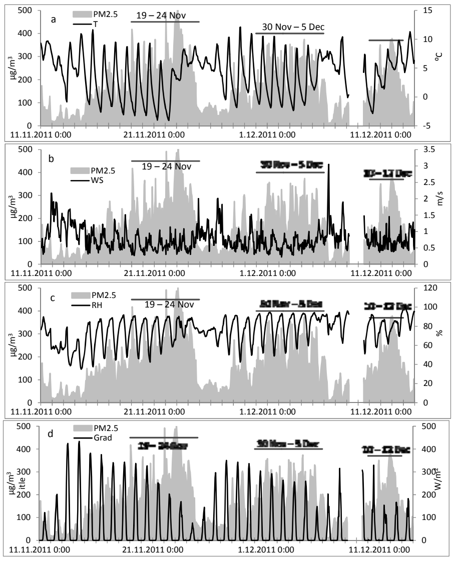
I.Atanasov[1], P.Antila[2]
[1]*Ministry of environment and physical planning; I.Atanasov@moepp.gov.mk*
[2]*Finnish meteorological institute; pia.anttila@fmi.fi*

Abstract

The hourly concentrations of PM10, PM2.5 were monitored at two urban monitoring sites, Centar and Karpos, in the city Skopje in the Republic of Macedonia for one year period from 1 October 2011 to 31 September 2012. The aim of the study was to investigate relations between meteorological conditions and PM pollution on one urban background and one urban traffic station in city of Skopje.

Extremely high pollutant concentrations were recorded. During the one year study period The annual means of PM10 and PM2.5 and the daily limit value of PM10 all exceeded their limit values at both study sites. PM10 and PM2.5 concentration levels in particular were very high; at Centar the annual means were around 85 µg/m^3 and 56 µg/m^3, respectively.

The most serious pollution episodes occurred during winter months November and December 2011. During the studied 15 most severe episode days at Centar the 24-h mean of $PM_{2.5}$ was 230 µg/m^3. The highest hourly PM_{10} and $PM_{2.5}$ concentrations were 800 and 500 µg/m^3. During these episodes clear sky conditions, light winds and low nocturnal temperatures were recorded. Also an extremely homogenous pollution field (both spatially and by components) in the Skopje valley was formed together with night-time maximum concentrations. Based on the available meteorological data, during the episode days a high atmospheric stability prevailed over large areas and at the daytime the mixing layer typically was only 700-900 meters high. In these circumstances the mountains surrounding the Skopje city extremely effectively trapped the pollution inside the valley.



This study shows that the extremely high pollutant concentrations recorded in this one year study period were mostly originated from local emissions and were enhanced by the local topography together with poor atmospheric mixing conditions. Meteorological conditions or the topography cannot be controlled by man, so only way to improve the air quality is to implement stricter emission controls. The most urgent task will be the reduction of local PM emissions. No local plan for city of Skopje was prepared until now. Preparation of this type of plan with clearly defined actions and their implementation will be way forward towards better air quality in city of Skopje [1].

Acknowledgement

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Oral Presentation

IMPACT OF NOX EMISSIONS ON AIR QUALITY SIMULATIONS WITH THE BULGARIAN WFR - CMAQ MODELING SYSTEM

D. Syrakov[1], M. Prodanova[1], E. Georgieva[1], I. Etropolska[1], K. Slavov[1]
[1]*National Institute of Meteorology and Hydrology - Bulgarian Academy of Sciences, 66, Tzarigradsko chausse, 1784 Sofia, Bulgaria*
emilia.georgieva@meteo.bg

Abstract

The WRF-CMAQ modeling system is the backbone of the Bulgarian chemical weather forecast [1]. This system was applied also for air quality simulation over Europe in the frame of the Air Quality Model Evaluation International Initiative AQMEII-2[2]. The main goal of the present work was to study the effect of different NOx emissions on ground level ozone and nitrogen dioxide concentrations.

The model system was run for the year 2010 for a domain of 5000 x 5000 km^2 with a horizontal grid resolution of 25 km. The emissions were provided by AQMEII-2 based on TNO anthropogenic emissions [3] and FMI wild fire emissions database. These emissions have been further processed to feed the CMAQ chemistry transport model. Two runs, with two different NOx emissions were performed (BG1 and BG2). The second set of emissions is characterized by about 30% increase in NOx emissions.

Model performance was investigated by means of the AQMEII-2 web based evaluation platform ENSEMBLE [4], using various statistical indexes and diagrams -Taylor, box-and-whisker plots, time-series. Model evaluation for O_3, NO_2 and PM10 was conducted based on comparison between simulated and observed concentrations at about 1300 air quality stations of different type- background urban, rural, suburban in the EU wide domain. The analysis of BG1 results revealed overestimation for ozone and underestimation for the other pollutants. Trying to understand ozone overestimation at surface level, another set of NOx emissions, more complete one, was prepared and the simulations were repeated for the entire year (BG2). The preliminary results show that BG2 still overestimates mean O_3 at all type of stations, with about 20-30% during summer, particularly evident during night time. Slight improvement in statistical indexes for winter time is evident. BG2 produces higher values for NO_2 surface concentrations than BG1. At urban stations, however, these higher BG2 mean values are still below the observations. The model systems performs better at rural than at urban stations, as expected in view of the coarse model grid resolution and lack of particular urban parameterizations in the code.

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Oral Presentation

Indoor growing plants of *Chlorophytum comosum* L phytoremediate of particulate matter from air

H.Gawrońska[1]., B. Bakera[2]., S.W. Gawroński[1]
[1]*Laboratory of Basic Research in Horticulture*
[2]*at present a PhD student at the Department of Plant Genetics, Breeding, and Biotechnology*
Faculty of Horticulture, Biotechnology and Landscape Architecture
Warsaw University of Life Sciences – SGGW
Nowoursynowska 159, 02 - 776 Warsaw, Poland; email helena_gawronska@sggw.pl

Abstract

Higher plants, including spider plants, are able to take up and degrade detoxify various pollutants from the air. Although literature on uptake of particulate matter (PM) from air in open space, on their fate is very extensive and nearly 120 plant species have been tested for indoor air phytoremediation, but to the best of the authors' knowledge, data on PM phytoremediation from indoor air are not yet available in literature.

In this work we attempted at: 1/to determine the ability of spider plants to accumulate on foliage PM, one of the most harmful pollutants to man, in the indoor air of five rooms differing in activities: (i) dental clinic, (ii) perfume-bottling room, (iii) suburban house, (iv) apartment and (v) office, 2/ to determine the amount of wax deposited on foliage, and 3to check whether on PM accumulation on foliage participate also other than gravity forces.

Amount of PM was determined gravimetrically in two categories (washable with water and chloroform called surface; sPM and stabilized in waxes; wPM respectively) and in three size fractions (10-100, 2,5- 10 and 0,2-2,5 μm). More details on methodology are described in other our work: Dzierżanowski *et al* 2011 and Popek *et al* 2013.

In order to answer a question whether other than gravity forces are involved in PM accumulation on plants' foliage, under the same conditions, aluminum foil plates were also exposed to PM deposition from air.

Results of study showed that indoor growing spider plants accumulate both sPM and wPM and in all three size fractions determined. The amount of accumulated total PM on foliage differed depending on the type of activity taking place in the particular rooms ranging from 13.62 to 19.79 $\mu g/cm^2$. Out of all size fractions the large PM constitutes the greatest proportion of PM accumulated on plants' leaves. The amount of wax deposited on the leaves of plants grown in these rooms also differed (34.46 -72.97 $\mu g/cm^2$).

The results of this study also clearly demonstrated that the amount of PM accumulated on aluminum plates was always significantly lower than that accumulated on the plants' leaves, showing that more than simply gravity forces are involved in PM accumulation on leaf blades.

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Oral Presentation

GAS AND PARTICULATE MONITORS: ADVANCES AND SETBACKS

J. Saffell[1], R. Baron[1], M. Giles[1], R. Jones[2], P. Kaye[3]
[1]*Alphasense Limited, 300 Avenue West, Great Notley, Essex UK CM77 7AA*
[2]*Department of Chemistry, University of Cambridge, Cambridge, UK CB2 1EW*
[3]*STRI, University of Hertfordshire. Hatfield, Hertfordshire UK AL10 9AB*
jrs@alphasense.com

Abstract

Wireless air quality networks are now collecting real time data on several continents. Data quality remains a problem as users realise that imperfect correction for humidity, temperature and interfering gases increases the errors for the gas or particulate measurements.

Although many gases are measured reliable at low ppb levels (CO, NO, H_2S, SO_2), the problem with NO_2 and O_3 remains: how to speciate and quantify these very reactive oxidants at low ppb concentrations. We will show results from recent developments to isolate the two gases using amperometric electrochemical gas sensors. Alternative technologies, specifically n-type metal oxides are also considered.

$PM_{2.5}$ is a critical measurement for air quality, but suffers from either high cost or poor performance. We review recent advances using OPCs and quickly look at MEMS TEOM technology. Optical, electronic and air flow improvements have led to low cost OPCs operating from 0.38 to 17 µm, providing particle size histograms in real time. Errors due to particle count to particle mass conversion to respirable PM are considered.

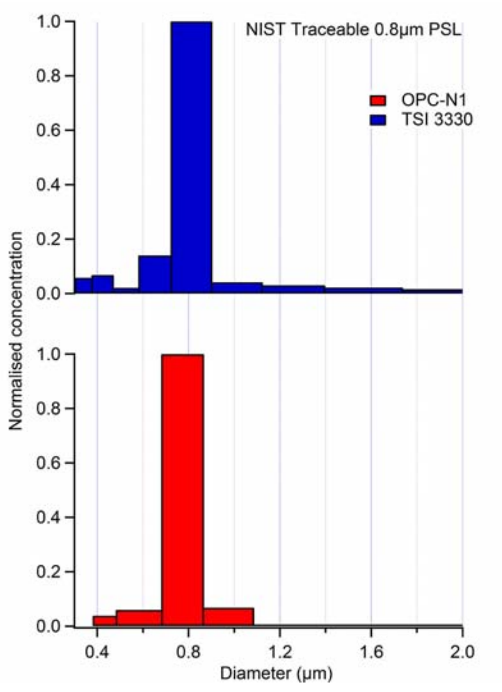

Figure 1. Histogram of OPC-N1, compared with TSI 3330.

Oral Presentation

APPLICATION OF MEMS CMOS BROADBAND INFRARED EMITTERS AND DETECTORS FOR COMPACT NDIR CO_2 SENSING

M.F. Chowdhury[1], S. Boual[1], J.W. Gardner[1,2] and F. Udrea[1,3]
[1]Cambridge CMOS Sensors, Deanland House, Cowley Road, Cambridge CB4 0DL, UK; mohamed.chowdhury@ccmoss.com; [2]University of Warwick, Coventry CV4 7AL, UK; j.w.gardner@warwick.ac.uk; [3]University of Cambridge, Cambridge CB2 1TN, UK; fu10000@cam.ac.uk

Abstract

Reliable, low cost method of detecting carbon dioxide (CO_2) for environmental monitoring has been a challenge for sensor manufacturers, especially when developing solutions for compact, high volume and low power applications. Recently, metal oxide [1] or thermal conductivity [2] methods of detecting CO_2 has been reported, but they suffer from selectivity, stability as well as long term reliability issues [3]. These methods, also do not measure the CO_2 gases, directly, for example, using MOX sensor, CO_2 concentration level is inferred from relative variation of VOC gases. Such methods can offer a low cost, compact solution, but they require more development efforts and at present are not suitable for deployment in general AQM applications, where environmental behaviour cannot be controlled in a predictable way.

Most common and direct method used for measuring CO_2 is a technique based on the absorption of gas molecules to infrared radiation source at specific wavelengths [4]. In this case it is found that CO_2 molecules have peak absorptions at ~2.75µm and 4.26µm wavelengths. To ensure good selectivity, typically a narrowband band-pass filter with window of 90-180nm is used. This technique is known as non-dispersive infrared (NDIR) method. Here, the theoretical principle is based on Beer-Lambert law [5].

An NDIR gas sensing system typically comprise of five main components: IR emitter; IR detector; IR filter; optical path; and electronic control with signal processing unit as shown in Fig 1. The radiated IR emission generated from the emitter is measured by IR detector with a narrow band filter placed in front of the detector. The performance of NDIR sensor depends on number of factors such as: stability of the IR emitter; incident angle of radiated rays passing through the filter to the detector; as well as ambient parameters variations such as temperature, humidity and pressure. Most NDIR CO_2 sensors uses micro-bulbs as an IR source, though it offers cheap solution as far as the emitter is concerned, but this imposes limitation in terms of developing highly compact NDIR sensors. This is because there is a limit to which a micro-bulb can be miniaturised, and furthermore as the filament has manufacturing tolerance in 3D space, design of optics and alignments to achieve optimal performance can be challenging in high volume automated product line. In order to make highly compact NDIR system, MEMS, CMOS IR emitter offers significant advantages over a micro-bulb where the silicon die can either be directly placed on the PCB or suitably mounted on 2mm x 2mm x 1mm SMD package. Using MEMS solution also offered the added benefit of providing a point IR emitting source, thereby simplifying the design of optics and enabling high volume manufacturing process by reducing tests and calibration overheads.

In this presentation, we will highlight the benefits of MEMS CMOS devices in term of: low power; point source no optical alignment or calibration requirements; small form factor; high

stability; high reproducibility; minimal or no calibration due to hear resistance drift; high modulation depth and switching frequency (> 25Hz or five-fold improvement over micro-bulb) that can be beneficial for reducing 1/f noise (hence improved SNR); fast response, real time gas sensing application, for example, breath analysis capnometry, where the signal can be electronically chopped thereby eliminating expensive mechanical chopper used with micro-bulbs-based system; broadband emission (micro-bulb cuts-off at 5um, due to glass) that leads to other longer wavelength NDIR gas sensing application (ethanol; methane; acetone; etc.).

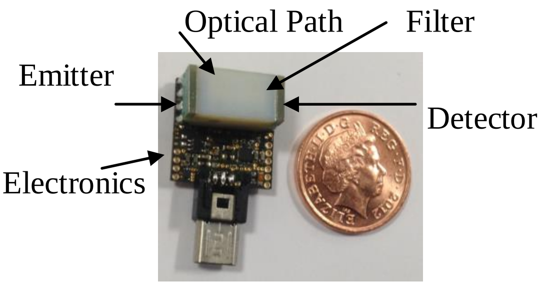

Fig 1: Compact NDIR Sensor

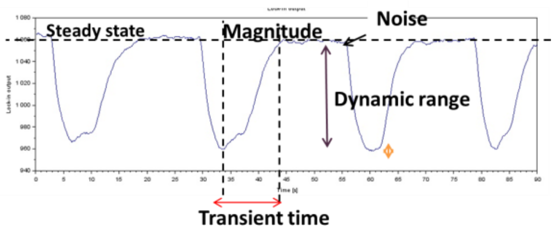

Fig 2: Response to breath CO_2

We will conclude our presentation with discussion on application solutions and provide experimental results to highlight some added benefits of using MEMS CMOS IR emitters [6] and detectors components with integrated simple drive circuit and ambient temperature sensing diode incorporated on the thermopile IR detector [7] for developing low cost, low power compact NDIR sensor for high concentration breath analysis leading low concentration environmental CO_2 gas sensing applications.

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Oral Presentation

CASE STUDY OF THE SPIN-OFF RED SRL: DEVICES FOR INDOOR ENVIRONMENTS CONTROL

L. Pockelé[1], A. Bernardi[2], S. De Grandi[1]
[1]*R.E.D. S.r.l., Viale dell' Industria 58 B, Padova, Italy; luc.pockele@red-srl.com*,
[2]*CNR -ISAC Corso Stati Uniti 4, Padova (Italy); a.bernardi@isac.cnr.it*

Abstract

R.E.D. stands for Research and Environmental Devices [1]. The Company was created on January 26, 2006 as a spin-off of the Italian **C**onsiglio **N**azionale delle **R**icherche (CNR) on a research project funded in part by the Italian Ministry of Education and Research (MIUR).
The research addressed the "Development of new meteorological and microclimatic instruments to measure physical parameters in extreme environments". Within this project, highly accurate air and surface temperature sensors (+ 0.02°C) and relative humidity sensors (0.2–0.3%) for extremely high humidity conditions of over 96% were developed. In addition, a dew sensor which measures directly the condensation on surfaces was miniaturized. This sensor was developed in the FP5 project VIDRIO [2], subsequently patented by the CNR [3] and is able to detect surface condensation at the very early stages [4]. Condensation is taking place usually 1–3°C earlier than the theoretical dew point due to impurities in the environment. All these sensors were deployed in a multidisciplinary research project on the microbiological activity in the Lascaux caves in France. Within the FP7 collaborative research project TeACH [5] the colour change of surfaces of historic monuments as a consequence of pollution had to be monitored. For this purpose a surface colour sensing device was developed [6]. The colour sensing is realized by measuring the Red, Green and Blue components reflected from a white light source illuminating the surface under examination. This device is costing much less than a spectrophotometer and gives good results if properly calibrated. The device was mounted on a mechanical arm to leave the surface free when measurements are not taken. Within the FP7 collaborative project CETIEB [7] the same sensing principle was used to develop a sensor capable to measure the correlated colour temperature (CCT) of white light together with the illumination level (in Lux). After calibration with a reference spectrophotometer, this device is able to drive an illumination system and regulate the colour temperature of the light following the changes of daylight colour throughout the day. A control algorithm based on the input from this sensor had to be developed to command the dimmers of the Red, Green and Blue light sources of the illumination system. In summary, R.E.D. Srl has built capabilities and expertise in the design and development of highly accurate sensors and devices, realizable ad hoc and based on economic principles.

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Oral Presentation

GREEN SMART NET: ENVIRONMENTAL DATA ACQUISITION, HANDLING AND TRANSMISSION FOR RISK ASSESSMENT IN AGRICULTURE AND BEYOND

Oriol Gonzalez[1], Raul Calavia[1], Xavier Vilanova[1], Eduard Llobet[1]
[1]*MINOS-EMaS, Universitat Rovira i Virgili, Avda. Països Catalans, 26, 43007 Tarragona, Spain; oriol.gonzalez@urv.cat*

Abstract
Green Smart Net is an URV spin-off that emerges from the MINOS research group. The aim of this spin-off is to find solutions for agriculture using sensors. In other words, Green Smart Net wants to apply the knowledge and improvements from smart cities to countryside, so it could be called "Smart Rural". For the moment, the efforts have been focused on plague prediction: it is widely regognised that climate parameters affect the development of different vegetable pathogens (bacteria, fungus, insects…). The life cycle of any pathogen correlates with temperature, relative humidity and leaf moisture [1]. The difficulty is to detect when and where these conditions appear, inside micro climates. To address this, a remote and autonomous system is developed to collect data employing sensors deployed at cultivars, able to communicate to a central server through a GPRS mobile network. Then, this server analyses the data and makes use of meteorological predictions using specific algorithms in order to assess risk and to generate alarms and reports. Although our work has been focused on the prediction of the propagation of *xantomonas arborea* in different walnuts crops [2], the system can be easily adapted to predict other plagues. Furthermore, by incorporating other types of sensors this system could be used in environmental monitoring. In this case, the developed system could be a useful tool to create models for the prediction of pollution episodes.

Figure 1. Remote Dataloger image.

Figure2. Visible effects of "Xantomonas bacteria" in nuts.

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Oral Presentation

A SUCCESS CASE OF SYNERGY AND KNOWLEDGE TRANSFER FROM ACADEMIA TO ENTERPRISE

A. Demarinis Loiotile[1], G. de Gennaro[1], L. de Gennaro[2], M. Amodio[2]
[1]*Department of Chemistry, University of Bari, Via Orabona 4, 70126 Bari, ITALY;*
annamaria.demarinis@uniba.it
[2]*LEnviroS srl, Via Piazza, 15, Molfetta (BA), ITALY*

Abstract

Knowledge Transfer (KT) has been identified by academics and policy makers as an essential ingredient for innovation and enterprise development, which in turn are important drivers for a competitive and thriving knowledge economy [1]. KT is defined as, '*the iterative cycle of sharing ideas, research results, expertise or skills between interested parties that enables the creation, transfer, adoption and exploitation of new knowledge in order to develop new products, processes or services and influence public policy*' [2]. KT has an impact on innovation and growth in the individual and in firms, at regional and national levels, resulting in economic growth and national competitive advantages.

It is very difficult to generate innovation, if a close collaboration among the different actors of the innovation process (researchers, businesses, the innovation community, and public authorities) does not exist. Communication, which is not always efficient between the world of research and that of the enterprise, does not guarantee a successful transfer of knowledge and innovation to the territory. Therefore, it is crucial to invest in the development of a close relationship between academia and industry, with the aim of adapting the knowledge and academic research to market and society needs in order to advance knowledge and innovation. As recommended by the new Cohesion Policy 2014-2020 for the strengthening of research, technological development and innovation, and requested by the *Smart Specialisation Strategies* [3], the key stakeholders are called upon to work in synergy in order to identify the real needs of the local economy for a greater impact on regional development, thus amplifying the research and innovation investments and their impact.

In this direction, the Universities should build more continuous and systematic relationships with the business world, putting know-how and innovative discoveries at the disposal of citizens and the territory.

A successful example of this 'marriage' is the spin-off of the University of Bari, LEnviroS, established in 2005 from the following ingredients: culture, creativity, innovation, dreams, the value of ideas and of people, team building and territorial vocation, with the aim of transferring the academic experience acquired in the environmental field to the territory. Its peculiarity lies in the offer of high value added services characterized by a meaningful scientific content, a guarantee of competence and versatility, which is difficult to find on the market. The company is a vehicle capable of transferring its technological know-how, generate innovative and unique products, thanks to its close connection with Academia, and for this reason it is a great resource for the development of the local and national territory.

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Oral Presentation

Inputs from Action TD1105: EuNetAir at COST Strategic Event Cities of Tomorrow - The Challenges for Horizon 2020 Turin (Italy), 17 - 19 September 2014

Anita Lloyd Spetz

Department of Physics, Chemistry and Biology, Linköping University, SE-58183 Linköping, Sweden; and

Microelectronics and Material Physics Laboratories,University of Oulu, FIN-90570, Oulu, Finland; Email: spetz@ifm.liu.se

Abstract

A number of COST network projects related to “Cities of Tomorrow” were reported in a workshop in Torino in September 2014. Smart cities and growing as well as shrinking cities and the special challenges connected to that were reported. We heard about challenges in urban transport and new service hubs instead of railway stations as well as innovative new transport vehicles like bikes with cover for weather protection. ICT connected homes is of course of high interest for a growing elderly population and even give business possibilities. New approaches for sustainable cities were suggested like using abandoned areas in the city as well as roof space for gardening. Another important area that was covered relates to safety aspects in future cities. It was pointed out that green areas like a park should be planned such that it constantly has visitors, for example people walking through to and from work. Finally, clean air and clean water are inevitable also in cities of tomorrow and requires use of smart gas sensor control systems and smart water recirculation systems.

Most of the talks at the workshop and a video are found on our web page: www.eunetair.it (Cities of Tomorrow 2014/ COST Cities of Tomorrow Turin Link)

Invited Talk

*SENSE*ABLE CITIES

M. Nyhan[1], R. Britter[1], C. Ratti[1]
[1]*SENSEable City Lab, Massachusetts Institute of Technology, Boston, United States;*
mnyhan@mit.edu

Abstract

Urbanisation is a serious global concern due to the environmental and human health challenges that it brings, not least the increasing number of people contributing and being exposed to air pollution. It is estimated that 50% of the world's population are living in cities currently, and this is set to rise to 70% of the world's population by the year 2050.

Clean air is considered a basic requirement of human health preservation and well-being. However, air pollution continues to pose a significant threat to public health worldwide. According to the World Health Organisation (WHO), ambient air pollution contributes to approximately 2.6 million premature deaths annually. This figure has increased significantly since a previous estimate in 2008 (1.3 million premature deaths annually), and this is due to increases in air pollution concentrations in cities, the total population affected as cities grow and also better assessment of human exposure to air pollutants.

Networks of environmental sensors can offer fine grained air quality information in cities. When air quality sensor data is combined with layers of digital information from the city, informative insights into the local sources of air pollution and urban population exposures are produced. Detailed real-time air quality maps allow citizens to make informed decisions regarding their behaviour (see Figure 1). Information on the sources of urban air pollution, and where people and pollution overlap can help municipalities implement targeted air pollution intervention strategies for the protection of human health. This may help to maximise efforts for reducing the number of people being exposed to air pollution levels exceeding the WHO recommended limits.

As layers of networks and digital information blanket our urban space, a new approach to the study of the built environment is emerging. The way we describe and understand cities is being radically transformed - as are the tools we use to design them. The mission of the Senseable City Laboratory is to anticipate these changes and study them from a critical point of view.

Figure 1. Visual explorations of urban data including air quality information from networks of sensors.

Invited Talk

ENVIRONMENTAL MEASUREMENTS USING LOW COST SENSORS: LATEST RESULTS AND FUTURE DIRECTIONS

V. Bright[1], R. Freshwater[1], I. Heimann[1]
O. Popoola[1], J. Shutter[1], P. Smith[1], R. L. Jones[1]
[1]*Department of Chemistry, University of Cambridge, Lensfield Road, Cambridge;*
vb323@cam.ac.uk, *rf10001@hermes.cam.ac.uk*, *ih280@cam.ac.uk*, *oamp2@cam.ac.uk*,
js2136@cam.ac.uk, *ps683@cam.ac.uk*, *rlj1001@cam.ac.uk*

Abstract
In this paper we begin by presenting comparisons of measurements obtained as part of the NERC funded Sensor Network for Air Quality (SNAQ) at Heathrow Airport project with appropriate co-located reference measurements and model results. For NO, the measurements (illustrated in figure 1 which shows time series of NO measurements for a three month period in 2012) show excellent agreement (R^2 values of 0.9 in hourly averages). Statistics for these and other species will be presented and assessed.

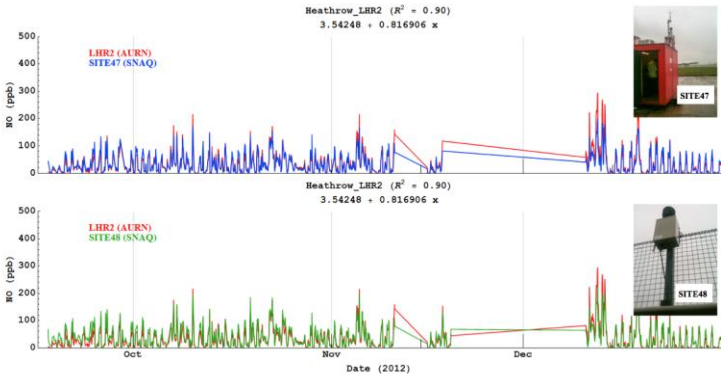


Figure 1. Comparison of time series of NO measurements obtained from two near co-located SNAQ boxes (see text) and a reference instrument for 3 months in 2012. Photographs of locations are inset.

We then discuss how sensor networks can be used for source attribution, and this is illustrated by figure 2 which shows CO data from a Cambridge network deployment separated by scale for different meteorological conditions. As expected, near field emissions become more prominent under anti-cyclonic conditions.

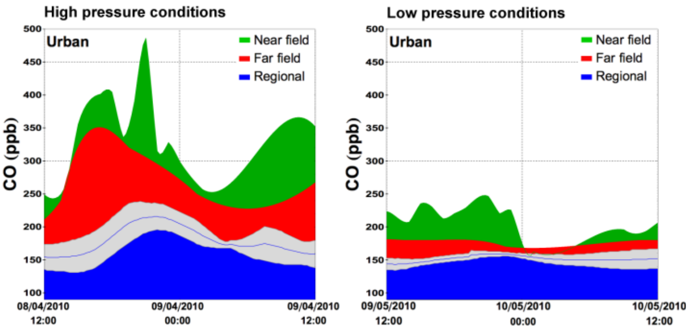


Figure 2. Time series for CO (ppb) to illustrate the regional, far field (red) and near field (green) contributions for an urban sensor node; highlighting the effects of different meteorological conditions.

Finally, we discuss a range of future developments, including greenhouse gas measurements (CO_2, CH_4) for fugitive emissions and upper atmosphere applications.

Invited Talk

APPLICATIONS AND TRENDS IN GAS SENSING FOR HOME AND HEALTH

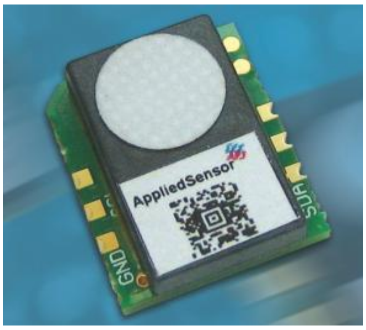
O. von Sicard[1], E. Magori[1], R. Pohle[1]
[1]*Siemens AG, CT RTC SET CPS-DE, Otto-Hahn-Ring 6, 81730 Munich, Germany*

Author to whom correspondence should be addressed: oliver.v.sicard@siemens.com

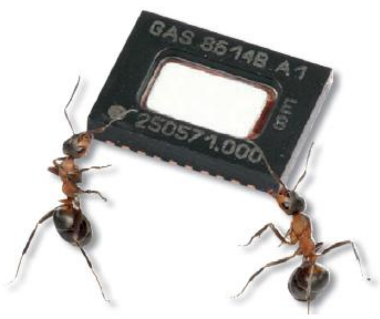
Abstract

So called MEGATRENDS – demographic change, urbanization and climate change – are affecting and defining lives and economies throughout the world. Modern society faces severe challenges due to the growing and aging population as well as due to the impact of the high energy consumption, which is required for the way we live today.
The apparent contradiction between the need for energy efficiency on the one hand and the desire for a healthy and comfortable way of living on the other hand opens up demand for sensors contributing to energy savings, comfort and health.
Since nearly all processes related to energy and health involve chemical reactions, chemical and especially gas sensors are suited to analyze and optimize these. The main focus in this area of research and developement needs to be on miniaturization and low cost.

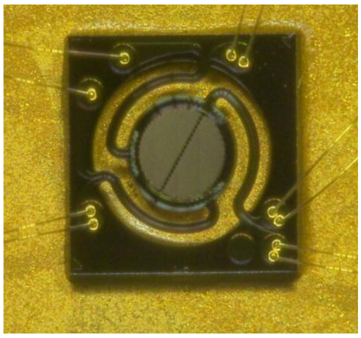
This presentation will give an overview on different areas of application for gas sensors related to health and indoor use. Different sensing principles will also be presented ranging from solid state metal-oxides to workfunction readout and optical detectors.



Applied Sensor (SnO_2)



Micronas (GasFET)



Siemens (Ga_2O_3)

Invited Talk

COMPARISON OF LOW COST SENSORS AND REFERENCE EQUIPMENT IN LABORATORY AND IN REAL-WORLD. FIRST EXPERIENCES IN OSLO, NORWAY

N. Castell, F.R. Dauge, P. Schneider
NILU- Norwegian Institute for Air Research, Kjeller, Norway; ncb@nilu.no

Abstract

The majority of the population in Europe lives in areas where air quality levels frequently exceed the WHO ambient air quality guidelines. Air quality data at street level is currently scarce or non-existent. This undermines citizens' awareness of their environment, and consequently limits their ability to recognize and change both their contribution and their exposure to air pollution.

Monitoring air quality is essential for understanding how pollutants are distributed in the atmosphere and how they affect human health and the environment as a whole. In Oslo there are only eleven stations distributed between background and traffic stations.

The emergence of low-cost, easy-to-use, portable air quality sensors allowing observations at high spatial resolution in near real-time, provides us with new opportunities to simultaneously enhance existing monitoring systems as well as enable citizens to engage in more active environmental monitoring. However there are challenges in the use of sensor data, mainly data quality, comparability and derivation of information from the data sets.

This work presents initial results of an evaluation of the performance of low cost sensor platforms under controlled conditions in a laboratory and under real-world conditions. The exercise has been conducted within the framework of two European projects, CITI-SENSE and Citi-Sense-MOB.

The sensor platforms consist of multiple individual electrochemical sensors monitoring the gas pollutants NO_2, NO, O_3, CO and meteorological sensors monitoring temperature, atmospheric pressure and relative humidity. We present the results obtained for static sensor platforms and mobile platforms, both carried by people and mounted on bicycles.

The results in laboratory show a good agreement between the sensor platform and the reference equipment ($r = 0.7$-0.9). Field results have lower correlations than those obtained in the laboratory, especially for NO_2, which is mainly due to the influence of temperature and humidity in the sensor response and the cross-interferences with other pollutants.

CITI-SENSE and Citi-Sense-MOB will test the feasibility of selected sensor technologies and different approaches to process the sensor data. They explore how the data generated can support green growth, smart cities and sustainable development, and enable citizens to contribute to environmental governance and community-based decision-making.

Oral Presentation

INDOOR AIR QUALITY MONITORING: GUIDELINES FOR SENSOR NETWORK DESIGN

J. Ginja[1], A. M. Costa[2], M. Coutinho[3], C. Borrego[4]
[1]*IDAD - Institute of Environment and Development, Aveiro, Portugal; joao.ginja@ua.pt*
[2]*IDAD -Institute of Environment and Development, Aveiro, Portugal; amcosta@ua.pt*
[3]*IDAD -Institute of Environment and Development, Aveiro, Portugal; miguel.coutinho@ua.pt*
[4] *IDAD and Department of Environment and Planning, University of Aveiro, Portugal; cborrego@ua.pt*

The effects of air pollution on health result from a chain of events, ranging from the emission of pollutants, through transport, dispersion, transformation, until the contact and absorption by humans. For exposure assessment, in addition to include the outdoor air quality, it is essential to consider indoor spaces, where people living in urban areas spend approximately 80-90% of their time, rising to 95% for more vulnerable groups, such as children and the elderly [1].

Advanced air pollution control systems based on low-cost sensing technologies opened a new vision for air quality control and exposure assessment. Their performances allow for a new strategy, resulting in fast responses, low operating costs and high efficiencies that cannot be achieved with conventional approaches. In this context, buildings are beginning to use sensor networks for indoor air quality monitoring [2, 3, 4]. The information of these sensor systems is mainly used for ventilation control and to detect the presence of dangerous contaminants.

The raise of awareness on indoor air quality issues combined with the development of low-cost sensing technologies allowed to look to other potential utilizations of monitoring data. The real-time collected data can be used to inform occupants in addition to security or HVAC control purposes.

Measurements of different parameters were performed in different buildings, namely carbon dioxide (CO_2), carbon monoxide (CO), particulate matter with dimension less than 10µm (PM10), formaldehyde (HCHO), volatile organic compounds (VOC), ozone (O_3), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2). Based on this information it was possible to identify the principal pollutants and the typical concentrations ranges on this indoor spaces and also the importance of some sources with relevant contribution to indoor air quality.

This work allowed developing general guidelines for sensor network design, regarding the number, location and type of sensors that can be used as a valuable contribution to create healthy and comfortable living environments.

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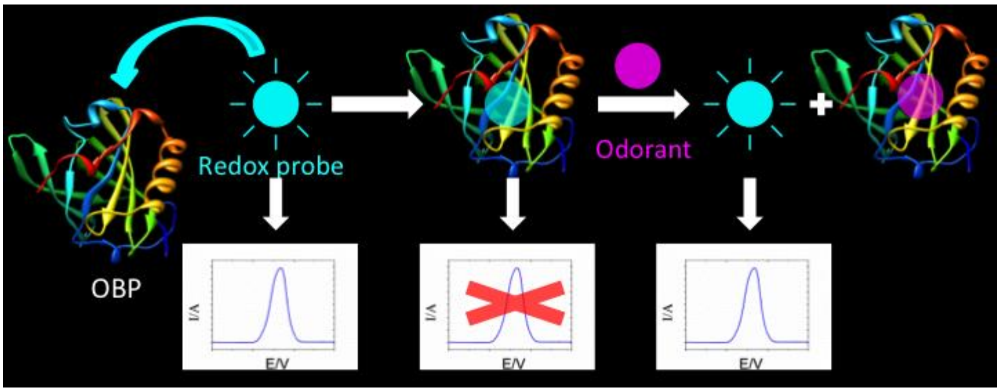
Invited Talk

ELECTROCHEMICAL DETECTION OF ODORANT MOLECULES BASED ON PROTEINS

M. Bouvet[1], E. Barou[1,2], L. Briand[2], R. Meunier-Prest[1]
[1]*Institut de Chimie Moléculaire de l'Université de Bourgogne, ICMUB, UMR CNRS 6302, Université de Bourgogne, Dijon, FRANCE; marcel.bouvet@u-bourgogne.fr*
[2]*Centre des Sciences du Goût et de l'Alimentation, CSGA, UMR INRA 1324, UMR CNRS 6265 Université de Bourgogne, Dijon, FRANCE*

Abstract

The detection of odorant molecules has become an important challenge in different domains such as food industry, medical diagnostics and homeland security. Indeed, the thousands of odorants in our environment give us access to numerous information by their chemical nature or their concentration. Our olfactory system is capable of discriminating thousands of different molecules thanks to biochemical mechanisms involving olfactory receptors and odorant-binding proteins (OBP) and a combinatorial coding. OBPs are small soluble proteins present in nasal mucus at millimolar concentrations. Their hydrophobic binding pocket gives them the ability to reversibly bind odorant molecules making them good candidates for the design of biosensors. In this work, we focused on the detection of odorant molecules associating OBPs as a bioreceptor and electrochemistry as a transduction method. We described a qualitative and quantitative method for the detection of volatile molecules using 2-methyl-1,4-naphtoquinone (MNQ) as an electrochemical probe. The amount of MNQ displaced from the binding pocket of rat OBP3 by the model odorant 3-isobutyl-2-methoxypyrazine (IBMP) was measured using square-wave voltammetry. Thus, we determined the dissociation constants of the rOBP3 / MNQ and rOBP3 / IBMP complexes, which were confirmed by a competitive fluorescent assay and isothermal titration calorimetry. By combining this new analytical method to rOBP3 variants with different and complementary binding profiles, we have selectively detected each of the components of a ternary mix of odorants. This work, that combines the engineering of OBPs and electrochemistry, paves the way for new perspectives in the field of electronic noses applied to air quality monitoring.



The Square Wave Voltammetry signal of a quinone appears when an odorant molecule replaced the redox probe in the hydrophobic cavity of odorant binding proteins (OBP).

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Invited Talk

MASTERING VOC DETECTION FOR BETTER INDOOR AIR QUALITY

D. Puglisi[1], C. Bur[1,2], M. Bastuck[2], A. Schuetze[2], M. Andersson[1,3], R. Yakimova[1], A. Lloyd Spetz[1], J. Eriksson[1]

[1]*Department of Physics, Chemistry and Biology, Linköping University, 581 83 Linköping, Sweden*
[2]*Lab for Measurement Technology, Saarland University, 66123 Saarbrücken, Germany*
[3]*SenSiC AB, Isafjordsg. 39 B, 164 40 Kista/Stockholm, Sweden*
Emails: donpu@ifm.liu.se; c.bur@lmt.uni-saarland.de; m.bastuck@lmt.uni-saarland.de; schuetze@LMT.uni-saarland.de; mikan@ifm.liu.se; spetz@ifm.liu.se; jenser@ifm.liu.se

Abstract

In this study, we use two different sensor technologies based on gas sensitive silicon carbide field effect transistors (SiC-FETs) and epitaxial graphene on SiC (EG/SiC) for highly sensitive and selective detection of trace amounts of three hazardous volatile organic compounds (VOCs), i.e. formaldehyde (CH_2O), benzene (C_6H_6), and naphthalene ($C_{10}H_8$), present in indoor environments in concentrations of health concern.

Iridium and platinum are used as sensing layers for the gate contacts. The FET sensors are operated at high temperature, under static and dynamic conditions. Excellent detection limits of 10 ppb for CH_2O, about 1 ppb for C_6H_6, and below 0.5 ppb for $C_{10}H_8$ are measured at 60 % relative humidity (r.h.) [1]. The selectivity of the sensors is increased by temperature cycled operation and data evaluation based on multivariate statistics. Discrimination of CH_2O, C_6H_6, and $C_{10}H_8$ independent of the level of background humidity is possible with a very high cross-validation rate up to 90 % [2]. These results are very encouraging for indoor air quality control, being below the threshold limits recommended by the WHO guidelines.

Graphene-based chemical sensors offer the advantage of extreme sensitivity due to graphene's unique electronic properties and the fact that every single atom is at the surface and available to interact with gas molecules. For this reason, uniform monolayer graphene is crucial [3], which is guaranteed by our optimized epitaxial growth process. Graphene-based chemical gas sensors normally show ultra-high sensitivity to certain gas molecules but suffer from poor selectivity. Functionalization or modification of the graphene surface can improve selectivity, but most such measures result in poor reproducibility. We demonstrate reproducible, non-destructive means of graphene surface decoration with nanostructured metals and metal oxides, and study their effect on the gas interactions at the graphene surface.

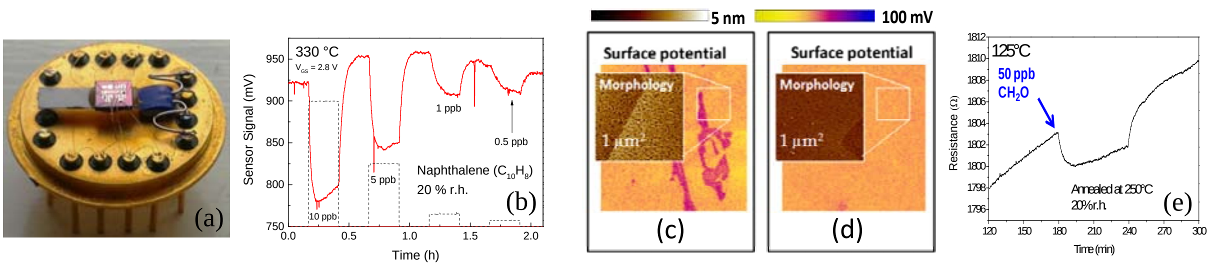

Fig. 1. a) Sensor chip mounted on a TO8 header, b) SiC-FET sensor response to naphthalene at 20 % r.h., c-d) effect of metallization on morphology and surface potential after deposition of (c) 2 nm porous Au and (d) 5 nm porous Pt on EG/SiC, e) EG-sensor response to formaldehyde at 20 % r.h.

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Oral Presentation

OUTLINE OF (ULg) CHEMICAL SENSORS APPLICATIONS FOR IAQ EVALUATION

AC. Romain

Department of Environmental sciences and management, University of Liège, avenue de Longwy, 185, 6700 Arlon, Belgium; acromain@ulg.ac.be

Abstract

The arrival of the European and National laws* concerning the official labelling of building materials (CE marking) and the respect of concentration values for some compounds regulations in public buildings as for instance schools, the emergence of the Environmental Assessments of buildings (Breeam, HQE,…) beside the energy performance, as well as the awareness increase of the impact of indoor air quality on the wellness and health (ie ENVIE and Healthvent projects [1]) lead inevitably to the development of new sensing technologies related to the IAQ evaluation.

Among the numerous existing measurement devices, electrochemical cells, NDIR and PID ones are the most encountered sensors on the market. The major uses are real time monitoring (CO_2) and "friendly" handheld devices.

Other applications are also studied in several research labs. Few years ago, the ULg research team investigated the interest of MOS chemical sensors arrays for IAQ evaluation. This presentation aims to review some of the results of those projects.

A first is the fast and simple diagnosis of moulds on building materials. The identification of contaminated materials among uncontaminated ones was successful [2-4]. However, the low concentration of the MVOC markers compounds (below 10 µg/m³) and the complexity of the background (material emissions, and VOC content of the indoor air) curbed the use of MOS sensors. Specific preconcentrations have to be developed to improve the diagnosis. Nowadays, with the emergence of new sensing materials and new measurement principles (eg IMS-ion mass spectrometry [5]), perspectives are again opened. Another project (HEMICPD, Belgian project "Horizontal evaluation method for the implementation of the Construction Products Directive"-Emissions to indoor air [5]) concerned the marking of building materials and one of the tasks was to test the sensors array principle to monitor the compounds emanation from different building material, during 28 days, in emission test chambers. Another goal was to investigate a classification of the materials including their odour level. The results on the use of sensors to evaluate the efficiency of "masking" products pulverised in wallpapers and to manage their use are also explained.

**Regulation (EU) No 305/2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC; standards EN 16516 and 16402 (2013); French decree on thresholds levels for HCOH and Benzene in public buildings (2013), French decree 2011-321 related to labelling of products (2011), Belgian Royal decree determining the threshold levels for emissions into the indoor environment of building products for certain intended uses (2014),…*

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Invited Talk

EYE SYMPTOMS FROM REACTIVE INDOOR AIR CHEMISTRY?

P. Wolkoff
National Research Centre for the Working Environment, Lersø Parkallé 105, Copenhagen Ø; pwo@nrcwe.dk

Abstract
Eye irritation related symptoms, e.g. dry or tired eyes, are among top-two reported symptoms in office-like environments. Two major hypotheses have been proposed, indoor air pollution and low relative humidity, in addition to a number of occupational and personal risk factors. Indoor air pollutants like VOCs generally have thresholds for sensory irritation in the eyes and upper airways that are at least one-two orders of magnitude higher than indoor concentrations except for formaldehyde. Thus, the reactive chemistry, *i.e.* ozone-initiated reactions with terpenes (fragrances in consumer products), was suggested as causative.

Within the EU project OFFICAIR (On the reduction of health effects from combined exposure to indoor air pollutants in modern offices) common ozone-initiated reaction products were measured before and after the replacement of the regular floor cleaning agent (with terpenes) with a preselected low emitting floor cleaning agent in four different EU offices with smooth flooring. One reference office with a textile carpet did not apply wet floor cleaning. Common terpene and terpenoid fragrances were targeted for measurement together with common terpene oxidation products that included formaldehyde. Two-hour air samples on Tenax TA and DNPH cartridges were taken in the morning, at noon, and in the afternoon before the intervention and four weeks after start of the replacement of the cleaning agent. Recovery studies were carried out for the target VOCs at low and high ozone levels.

The health index in a simulated office with measured maximum concentrations of the target compounds (either before or after the replacement) for sensory irritation was only 0.25. Thus, the contribution of the target compounds, which included formaldehyde (major contributor), could not explain the eye symptoms by chemesthesis. It was further concluded that other VOCs were unlikely to contribute substantially to the development of sensory irritation [1].

Occupational (e.g. PC work), thermal climate (temperature, relative humidity), and personal risk factors (e.g. age, gender, use of medication) should be considered for the assessment of reported ocular symptoms in offices [2, 3]. Furthermore, the exposure to reactive pollutants should be considered; for instance, deterioration of the ocular surface stability by combustion pollutants (e.g. traffic) [4]. Thus, the eyes may be susceptible already prior to start of office work. The risk assessment represents 2-hour averages; temporary elevated concentrations may occur, but they are not considered causative of the symptoms, even by a two-fold increase.

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Invited Presentation

THE NEW FORMED CLUSTER ON INDOOR ENVIRONMENT QUALITY (IEQ) AND HIS RESEARCH AGENDA

J. Frick[1]
[1]*Materials testing institute, University of Stuttgart, Pfaffenwaldring 32, D-70569 Stuttgart; juergen.frick@mpa.uni-stuttgart.de*

Abstract
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. Additional an overview on planned research fields and cluster activities for Indoor Environment Quality within Horizon 2020 were given by Monique Levy (European Commission). The participants agreed to establish a cluster on Indoor Environment Quality and accepted the invitation of the COST Action TD1105 *EuNetAir* to the meeting in Istanbul 3rd to 5th December 2014. A first action was the generation of a first version of research topics for IEQ contributing to the new HORIZON 2020 flagship: “*Renaturing Cities: Addressing Environmental Challenges and the Effects of the Economic Crisis through Nature-based Solutions*” and “*Materials & technologies for improved Indoor Environment Quality*” within EU Horizon 2020. The paper was given to the EC in July 2014. It includes research topics of the Indoor Environment Quality sector for the following themes:

- Emissions from materials
- Influence of outdoor pollution on indoor environment
- Controlling the indoor environment quality
- Management, maintenance and monitoring the IEQ
- Influence of human behaviour and perception on IEQ
- Benchmarking and assessment strategies

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 in folder ECTP-conference 2014 - Indoor Environment Quality (IEQ) Session.

Figure 1. Monique Levy (EC) presenting the views of EC at the IEQ session at the ECTP/E2BA conference 2014 in Brussels.

Invited Talk

ENVIRONMENT AND HEALTH IMPACT OF NANO-MATERIALS FOR CULTURAL HERITAGE

A. Bernardi
Institute of Atmospheric Sciences and Climate (ISAC), National Research Council (CNR), Corso Stati Uniti 4, 35127 Padova (Italy);
a.bernardi@isac.cnr.it

Abstract
The contribution of nano-sciences to the conservation of Cultural Heritage radically grown up in the last years, mainly thanks to the advancements in the knowledge of the physico-chemical composition and properties of the works of art, and to the development of several innovative physical devices and nanomaterials for conservation. These new functional materials and advanced technologies will allow the conservators to overcome the shortcomings often presented by traditional products/methods. As a good example of possible impact of this research topic is represented by the development of dispersions of nanoparticles, nanostructured fluids and gels to consolidate stones and wall paintings, remove old polymeric treatments, clean mural and oil paintings, de-acidify paper, wood and canvas. The use of this technology ensure the physico-chemical compatibility between the restoration product and the substrate, granting a long-term stability to the treated works of art.

The NANOMECH CLUSTER - ***Nano and advanced materials for Cultural Heritage*** [1] aims at defining collaboration, synergies and productivity overlap between five FP7 projects involved in the ENV-NMP.2011.2.2-5 and ENV-NMP.2011.3.2.1-1 FP7 calls: HEROMAT, IMAT, NANOFORART, NANOMATCH and PANNA.

The five projects grouped in NanomeCH Cluster have prototyped nano and advanced materials for a sustainable conservation of Cultural Heritage, ensuring the safe development of these nanotechnologies through a sound understanding of their potential impact on health and environment, and through the development of tools for risk assessment and risk management.

The Cluster is structured into highly interlinked working groups that covers the main domains of MATERIALS and APPLICATIONS (WG1), TECHNOLOGIES and TOOLS (WG2), MARKET (WG3), PERFORMANCE (WG4), ENVIRONMENT and HEALTH (WG5), OPPORTUNITIES for SMEs (WG6).

The Working Group 5 is aimed at bridging the activities performed by each project member of the NanomeCH cluster within the domain "Environment and health impact", in order to demonstrate the reduced impact of these newly developed materials in term of hazardous chemicals and nanoparticles exposure, assess their impact on the environment and human health, promote and assure the safe use of engineered nanomaterials and their technological applications.

The collaboration and transfer knowledge between research teams of different projects is meant to ensure that the investment into the development of nanotechnologies result in long-term benefits and sustainable, smart and healthy products which meet the targets of human well-being and safety, eco-compatibility and respect of the environment.

References

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Oral Presentation

New Methods for Control of Nanoparticles in Indoor Environment

Anita Lloyd Spetz[1,2], Maciej Sobocinski[2], Christian Bur[1,3], Heli Jantunen[2], Andreas Schütze[3], Jari Juuti[2] and Mike Andersson[1,2]

[1]*Department of Physics, Chemistry and Biology, Linköping University, SE-58183 Linköping, Sweden; Email: spetz@ifm.liu.se, mikan@ifm.liu.se*

[2]*Microelectronics and Material Physics Laboratories,University of Oulu, FIN-90570, Oulu, Finland*; Email: maciej@ee.oulu.fi, heja@ee.oulu.fi, jajuu@ee.oulu.fi

[3]*Laboratory for Measurement technology, Saarland University, 66123 Saarbrücken, Germany; Email: c.bur@LMT.uni-saarland.de, schuetze@lmt.uni-saarland.de*,

Abstract

Recently it has become clear that (nano)particles pose a threat to our health. Bulky detectors that measure size and concentration are available commercially, however, there is also a need for personal portable detectors. Apart from detecting size and concentration, due to their possible toxicity also content or adsorbates on particles is of interest to measure. Low Temperature Co-fired Ceramics, LTCC, is an established technology well suited for development of such a device [1]. Geiling *et al.* measured the influence of the electric field by particles in capacitive LTCC based devices [2], while Kita *et al.* developed a miniaturized calorimeter in LTCC [3].

We utilize the LTCC technology to develop a miniaturized particle detector with integrated functionality enabling collection, separation, and detection of particles, including heater and gas sensors for detection of particle adsorbents, see Fig. 1. The latter was demonstrated in the laboratory with the heater and gas sensor separated in different chambers [4]. Ammonia from fly ash particles, originating from a power plant, could be detected by heating the fly ash to 430°C, see poster presentation by C. Bur *et al*.

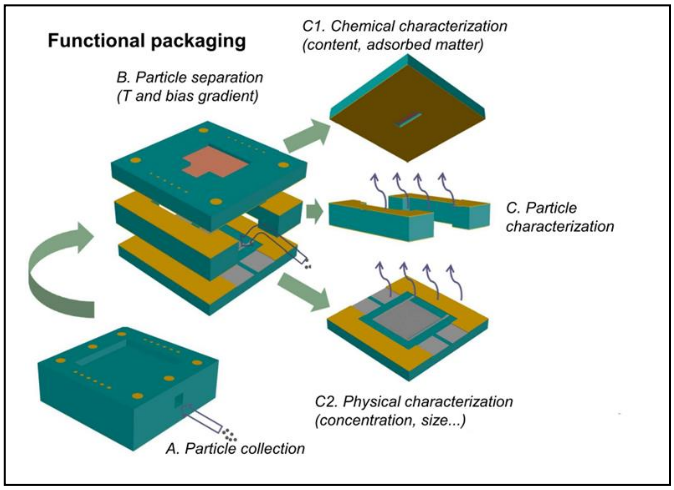

Figure 1. Schematic layout of particle detector processing using LTCC technology

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Invited Talk

INTEGRATED NANOSENSORS FOR INDOOR AIR QUALITY APPLICATIONS

J.R. Morante[1,2],
1 Catalonia Institute for Energy Research (IREC), E-08930 Sant Adrià del Besòs, Spain
2 Department of Electronics, University of Barcelona, E-08028 Barcelona, Spain

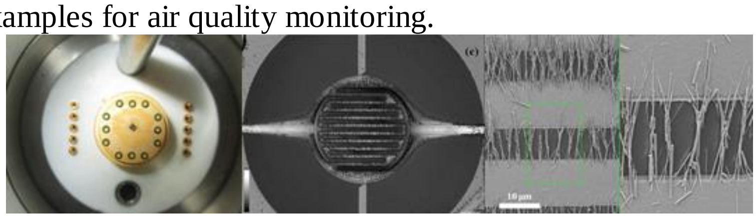
Abstract

It is well recognized that solid state gas sensor devices improved their characteristics as nanostructured materials are well tailored at the nanoscale level according to the expected chemical-to-electrical-signal transduction mechanisms. In this scenario simple individual metal oxide nanowires have been reported as powerful gas sensor platforms with much better advantages than many other of the widespread reported resistive gas sensors. So, among many other properties, one can highlight that: *i*) individual MOx nanowires allow self-heating operation procedure saving up the heaters integration; *ii*) they show shorter response and recovery time solely limited by the thermal inertia of the hotplate and the chemical reaction taking place onto the sensing material surface as there is not any gas diffusion time; *iii*) they have also a total capability for being fully activated by UV illumination as all the volume of the nanowire is included in the absorption zone; *iv*) their low thermal inertia allow to apply pulsed operational mode with the consequent advantage for controlling, cleaning and determining the starting point of the surface conditions; and *v*) finally, the use of nanowires opens an interesting low cost fabrication pathway for reliable solid state gas sensors.

Nevertheless, in spite of these improvements, individual nanowires have not yet used for fabricate real sensors as there is not available suitable nanotechnologies allowing their nanomanipulation. Alternatively, serious efforts have been performed for growing them directly on micro hotplate obtaining something like a “mat” of nanowires that present very different performance than those described for individual nanowire. In parallel, the use of nanoparticle suffers from many weaknesses that involve difficulties in undertaking the required levels of reliability and feasibility such as control of grain size, thicknesses, porosity degree and surface cracks or suitability of heater design as part of the hotplate development.

In this contribution, a methodology for allocate an individual nanowires distribution between the interdigitated electrodes of a SOI-CMOS microhotplate is presented as procedure for obtaining multiple individual nanowires integrated in SOI-CMOS valid even for high temperature gas sensors and retaining those properties expected for individual nanowires.

It is based on a dielectrophoresis process using a deposited drop solution containing the previously growth nanowires under well know conditions for controlling their properties as effective doping level and physical size as length and diameter. Electrical contacts are improved by in-situ thermal treatment. In this way, combining SOI-CMOS micro hot plate and multiples individual nanowires as sensing material distributed between the interdigitated electrodes, it is possible to obtain a high performant configuration suitable for environment gas sensing on the base of the robustness of both sensing material and microhotplate. Sensor prototypes and their characteristics will be presented taking different metal oxide nanowires as referential examples for air quality monitoring.



ABSTRACTS OF POSTER PRESENTATIONS

Poster Presentation

TITLE ACETYLENE DETECTION BY FIBER LOOP RING-DOWN TECHNIQUE

M. Fatih Danışman[1], Okan Esentürk[1], Md. Abu Sayed[1], Alim Yolalmaz[2]
[1]*Department of Chemistry, Middle East Technical University, Ankara;*
[2] *Micro and Nano-Technology Program, Middle East Technical University, Ankara;*

Abstract
Fiber loop ring down (FLRD) spectroscopy is a technique that combines high sensitivity of cavity ring down spectroscopy and elasticity of fiber optic cables. FLRD is a time domain technique that measures optical losses of a light pulse in a fiber loop. In FLRD spectroscopy, detection of a sample is performed by measurement of leaking light at each round trip within an optical cavity. Intensity of leaking light has an exponential decay where it is reduced by absorption of sample and scattering of light. FLRD technique is utilized for characterization of different chemicals and sensing various physical properties such as pressure, temperature, refractive index etc. via remote control. Here we present an initial set-up that was designed at 1535 nm and its application on acetylene detection. The sensing region/element in our FLRD set-up is constructed by using free-space collimators and a commercial quartz gas cell. Though the detection limit is pretty high with the current set-up, our ultimate aim is to be able to perform trace detection at visible region by employing different sensing elements such as micro-structured optical fibers.

Poster Presentation

SIMULATION OF AIR POLLUTION IN THE CROSS-BORDER REGION BULGARIA – TURKEY

D. Syrakov[1], M. Prodanova[1], V. Nikolov[1], I.Oruc[2], E. Georgieva[1], K. Slavov[1]
[1]*National Institute of Meteorology and Hydrology - Bulgarian Academy of Sciences, 66, Tzarigradsko chausse, 1784 Sofia, Bulgaria, emilia.georgieva@meteo.bg*
[2]*Kirklareli University, Vocational College of Technical Sciences, Kültür Merkezi A Blok, Kirklareli, Turkey, ilkeroruc@klu.edu.tr*

Abstract

Preliminary results of a project on joint study of air pollution in the cross border region Burgas (Bulgaria)-Kirklareli (Turkey) funded with the assistance of the European Union through the Bulgaria-Turkey IPA Cross-Border Programme CCI number 2007CB16IPO008, [1] are presented. The region is known for its natural parks with rich biodiversity and tourism activities in summer. The main emission sources are located to the "outer limits" of the cross-border, where also the biggest urbanized areas are found (Burgas, Edirne and Istanbul).

The Bulgarian Chemical Weather Forecast System, based on WRF-CMAQ models [2] is applied with 9 km resolution for air pollution simulations in the months of February and June 2014. Model results are compared to observations from 5 surface air quality monitoring stations (3 in Burgas, 1 in Edirne and 1 in Kirklareli) focussing on daily mean PM10, daily max O_3, hourly NO_2 and daily mean SO_2. The analysis, based on evaluation of some main statistics (mean, bias, correlation, temporal variation), reveals that the model system performs well for ozone in summer, while PM10 and NO_2 concentrations are underestimated. Both observations and model results indicate some of the air quality problems of the region – high ozone concentrations in summer, high SO_2 values in parts of the Turkish territory in winter and high PM10 concentrations in winter, often exceeding EU daily mean limit values of 50 μgm^{-3}. The maximum observed NO_2 hourly values for both months are about 70-80 μgm^{-3}, and thus well below the EU limit hourly value of 200 μgm^{-3}. Based on mean monthly values model underestimation for NO_2 is about 50%, and most probably this is due to shortcomings in representation of local emissions in the model. The model captures well the winter SO_2 pollution episodes, although the simulated values are by about 2-3 times lower than the observed ones, especially at Edirne station. The high SO_2 concentrations observed at this station are related to fossil fuels used for domestic heating. PM10 concentrations are also underestimated (by about 2 times in winter), but the correlation coefficient is relatively high – 0.6. Further efforts will be put on gathering of more detailed information for the emissions in this cross-border region of South-eastern Europe.

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Poster Presentation

DISTRIBUTED ONLINE GAS SENSOR SIMULATOR FOR INDOOR AIR QUALITY MONITORING

Deniz Balta and Ahmet Özmen
Department of Computer Engineering, University of Sakarya, Esentepe Campus, Sakarya
ddural@sakarya.edu.tr, ozmen@sakarya.edu.tr

Abstract

Gas sensors are widely used from food freshness to indoor air quality analyzing in many fields. Online distributed gas sensor systems provide a solution when many different regions are necessary to be analyzed simultaneously. At such systems however, increasing sensor counts/sensor cells, data processing requirements and real-time nature of sample data forwarding makes the problem more complex.

In this study, a software simulator will be developed for finding optimal design parameters of online gas sensor systems. The simulator will provide a pre-examination tool to simplify distributed gas sensor studies. In the simulator, mostly used gas sensors will be modeled and implemented as software functions to form virtual sensors which behave like the real ones. Thus, users can plug as many as they wish to sensor cells to form a detector unit. Adding multiple detectors, a virtual distributed sensor system can be created in a short amount of time. Then, various parameters such as data processing algorithms or message form of the data etc. can be tested on this virtual system. All virtual sensor cells will be connected to a central server via network backbone as if they are real. In the server, collected sensor data is going to be analyzed using various graphical interface tools implemented in software. Once the virtual sensors are replaced with the real ones, the system can also be used for measurements.

During the study, the simulator system will be implemented as software and tested with real sensors for validation. Indoor air quality monitoring is selected as an example application for the simulator system.

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Poster Presentation

INDOOR MODELLING AND SIMULATOR DEVELOPMENT FOR MEASUREMENT SYSTEMS AND GAS SENSORS

N. Yalçın[1], A. Özmen[2]

[1]*Department of Computer Engineering, University of Bilecik Şeyh Edebali, Gülümbe Campus, Bilecik, Turkey; nesibe.yalcin@bilecik.edu.tr*

[2]*Department of Computer Engineering, University of Sakarya, Esentepe Campus, Sakarya, Turkey; ozmen@sakarya.edu.tr*

Abstract

In the developed world, people spend most part of their days at indoors. Existence and/or high concentrations of biological agents (such as mould, fungus), gas (such as CO, SO_2, O_3), particulate pollutants, explosives and combustibles indoor environments can affect the air quality, in turn, human health, comfort, security and performance. Indoor air is so important for human life, hence it must be clean.

There are numerous studies to determine indoor air quality, to compute the indoor pollutants' concentrations and to analyze the dispersion of the pollutants [1, 2]. In these studies, many mathematical models that accounts for the effects of filtration, ventilation, direct emission and deposition have been developed and used to predict the concentrations of the pollutants [3, 4, 5, 6].

In this study, the goal is to develop a modelling tool to predict interested gas pollutants' concentrations at indoor environments as a function of temperature, humidity, pressure and odour sources. For this purpose, a modelling software tool has been developed using GUI Toolbox in MATLAB. The graphical output of the software shows emitted gas amount with respect to time and position depending on the physical and chemical properties of the gas and gas pollutant sources. The graphical interface provides parameter input for environment such as temperature, pressure, relative humidity, concentrations of other indoor gas pollutants etc. In the next step, the predicted values are going to be compared with the real measurements to validate the model.

The model will provide a platform to analyze airflows and describe the distributions of gas pollutant concentrations for solving indoor air quality problems. It will also be used for developing smart control units for "Heating, Ventilating and Air Conditioning" (HVAC) systems.

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Poster Presentation

GRAPHENE SHEETS AND SILICON CANTILEVERS EMPLOYED IN LASER PHOTOACOUSTIC SPECTROSCOPY FOR GAS SENSING

M. Dostál[1,2], J. Suchánek[1,2], P. Janda[1], Z. Zelinger[1]

[1] *J.Heyrovský Institute of Physical Chemistry, v.v.i., Academy of Sciences of the Czech Republic, Dolejškova 3, 182 23 Praha 8, Czech Republic., zdenek.zelinger@jh-inst.cas.cz*

[2] *Technical University of Ostrava, Faculty of Safety Engineering, Lumírova 13, Ostrava-Vyškovice, 700 30 Ostrava, Czech Republic*

Micromechanical properties of micro/nanomaterials for their use as gas sensors have been explored in this work. Cantilevers and graphene sheets have been used as sensitive pressure sensors in combination with laser **P**hotoacoustic **A**bsorption **S**pectroscopy (PAS) - a highly specific and sensitive detection method. In PAS, the laser radiation is absorbed by a gas in a cuvette and subsequently converted to heat, which leads to the gas expansion. If the laser radiation is chopped or modulated, pressure waves emerging in the cuvette can be sensed by a microphone. All relevant indoor air pollutants have available absorption bands in infrared region. By increasing the sensitivity of the microphone, the powerful expensive laser source could be replaced by a much cheaper IR diode laser source or a thermal radiation source.

To increase the sensitivity of this method, Kauppinen *et. al.* [1] have proposed an optical microphone instead of the conventional one. The movement of a membrane - silicon cantilever, is sensed via a laser beam reflected onto a position sensitive detector.

Herein, we test new sensing elements - graphene sheets and cantilevers (home-made and commercial) - with the potential to further enhance the sensitivity. Graphene sheets have outstanding electromechanical properties and impressive sensitivity as a mass detector [2]. The main benefits of a cantilever are a very low string constant and extremely wide dynamical range in the cantilever movement.

These elements have been employed in conventional laser PAS method as an optical microphone, supported by a capacitive microphone, allowing us to compare the response of both. We have demonstrated, for the first time to our knowledge, the feasibility of using the graphene membranes in optical microphone for PAS. The first optimization steps of the system have been done. The optical path of the reflected beam from the tested elements has been prolonged by the mean of multireflexion arrangement to increase the sensitivity. In order to find the best response, the dependence of the amplitude of the photoacoustic signal on the frequency of the chopper has been measured. The cantilevers exhibit better signal/noise ratio compared to the graphene sheets. So far, the sensitivity of these elements is worse than the top-class microphone (Brüel&Kjaer), but there are indications for further enhancement of sensitivity by adjusting the elements together with the whole photoacoustic system.

Acknowledgement:

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Poster Presentation

Magnetic and optical properties of biogenic nanostructured iron materials for sensoric applications

I. Nedkov[1], R. Angelova[2], L. Slavov[1],V. Groudeva[2]

[1]*Institute of Electronics, BAS, 72 Tsarigradsko Chaussee blvd, 1784 Sofia, Bulgaria, e-mail:nedkov@ie.bas.bg*

[2]*Faculty of Biology, University of Sofia, 8 Dragan Tsankov Blvd., 1164 Sofia, Bulgaria, e-mail:angelova87@abv.bg*

Abstract

Biogenic ferric oxides/(oxy)hydroxides were synthesized from artificially cultivated natural isolates identified as *Leptothrix* spp. The genera *Sphaerotilus – Leptothrix* are typical β-Proteobacteria capable of oxidizing Fe^{2+} and Mn^{2+} and are commonly found in water soluble salts in water basins. They grow as chains of cells in filaments 0.4-7μm in width. As a result of their metabolism, the bacteria form an extracellular material of biogenic iron oxides/(oxy)hydroxides accumulated in their “sheaths”. The nanostructured biogenic tubular structures containing ferric hydroxide particles of lepidocrocite (*γ-FeOOH*) discretely dispersed into the organic matrix and nanosized powder containing magnetite (Fe_3O_4) and lepidocrocite were systematically investigated. In the tubular structures we observed a magnetic phase transformation at helium temperatures and 1,T magnetic field. Optical properties deviations have been observed at sub-products in the presence of heavy metals in water and as air aerosols. The hybrid structure of nanoparticles of lepidocrocite and magnetite showed superparamagnetic behavior and the optical absorption (in the 800 - 1000 nm range) after interactions with media containing a heavy metals, thus being attractive for applications when optical and magnetic fields are combined. The materials are promising candidates for optical bio-sensors in water and air treatment processes, as their behaviour could be controlled and the functional structure fixed with the magnetic field. Preliminary models of sensor bio-chips based on bio-nanotubes are also discussed.

Acknowledgement: This work was supported by the Bulgarian National Science Fund under project DID 02/38/2009.

Poster Presentation

Preparation, growth, and gas sensing properties of nonvacuum Er doped ZnO thin films

L. Arda[1], D. Akcan[1], S. Ozturk[2], O. Sisman[2], A. Gungor[1], Z. Z. Ozturk[2]

[1]*Departmen of Mathematics Engineering, Bahcesehir University, Besiktas, 34100, Istanbul*
lutfi.arda@bahcesehir.edu.tr
[2]*Departmen of Physics, Gebze Institute of Technology, Gebze, 41400, Kocaeli*

Abstract

Preparation, growth, structure and ethanol sensing properties of Er doped ZnO nanoparticles and thin films were studied. $Zn_{1-x}Er_xO$ (x=0.0, 0.01, 0.02, 0.04, and 0.05) precursor solutions were prepared by sol-gel synthesis using Zn, and Er based alkoxide which were dissolved into solvent and chelating agent [1]. $Zn_{1-x}Er_xO$ thin films with different thickness were produced on glass substrate using sol-gel dip coating. Thin films were annealed at various temperatures and times, were tried to observe the doping ratio, temperature, time and thin films effect on structural and gas sensing properties. The particle size and crystal structure of nanoparticles and thin films were characterized by X-Ray diffraction (XRD) and Scanning Electron Microscope (SEM). The surface morphologies and microstructure of all samples were investigated by SEM, AFM and XRD. Ethanol sensing properties of the films were investigated at 250 °C in the concentration of 1000 ppm. The surface morphology of the $Zn_{1-x}Er_xO$ films depend on substrate nature and sol-gel parameters such as withdrawal speed, drying, heat treatment, deep number (film thickness) and annealing condition. Surface morphologies of Er doped ZnO thin films are dense, without porosity, uniform, crack and pinhole free. The particle size, surface morphology, film thickness, and gas sensing properties of the thin films with different doping ratio, thickness, temperature and time of annealing process are presented.

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Poster Presentation

Structural, electrical and gas sensing properties of Mg-doped ZnO Films

D. Akcan[1], L. Arda[1], S. Ozturk[2], O. Sisman[2], A. Gungor[1], Z. Z. Ozturk[2]

[1]Departmen of Mathematics Engineering, Bahcesehir University, Besiktas, 34100, Istanbul
dogan.akcan@bahcesehir.edu.tr
[2]Departmen of Physics, Gebze Institute of Technology, Gebze, 41400, Kocaeli

Abstract

$Zn_{1-x}Mg_xO$ (x=0.00, 0.01, 0.02, 0.03, 0.04 and 0.05) solutions were prepared by sol-gel synthesis using acetate precursors which were dissolved into methanol as solvent and Triethanolamine as stabilizing agent [1-2]. $Zn_{1-x}Mg_xO$ thin films with different Mg doping concentration were grown on glass substrates using sol-gel deep coating. The thin films were then annealed at 600C for 30 mins, were tried to observe the effect of doping ratio on structural, electrical and gas sensing properties. The particle size, crystal structure and surface morphology were characterized by X-ray diffraction, and Scanning Electron Microscope. The electrical properties of Mg-doped ZnO were considered within wide temperature range from 20 to 200 ºC under the dry air flow and ethanol sensing properties investigated under 1000 ppm ethanol flow at 250 °C.

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Poster Presentation

PALLADIUM MODIFIED TIO_2 NANORODS TO METHANOL SENSING DEVICE

Onur Alev[1], Erdem Sennik[1], Z.Z. Ozturk[1,2]
[1]*Gebze Institute of Technology, Department of Physics, Kocaeli, Turkey*
[2]*TÜBITAK-Marmara Research Center, Materials Institute, Kocaeli, Turkey*

Abstract

Metal oxides nanomaterials have been extensively studied in following areas; piezoelectric, optoelectronic devices, solar energy, and gas sensors In addition, metal oxides are preferred in gas sensor because of important gas sensing properties such as sensitivity[6], selectivity[7] and recovery time[8]. Among metal oxide based gas sensors, TiO_2 has excellent sensing properties to H_2, VOC, NO_2 and CO. To improve their gas sensing properties especially selectivity and working temperature, metal oxides can be modified with additives.

In this study, Pd modified TiO_2 nanorods were synthesis on FTO coated glass substrate in order to investigate sensing characteristic to VOC. TiO_2 nanorods were fabricated by hydrothermal method. In order to modify TiO_2 nanorods with Pd, CVD method was used. The samples were characterized by X-ray diffraction (XRD) and scanning electron microscope (SEM). VOC gas measurements have been investigated in the 2000ppm at 200ºC. The results show that Pd modification increases sensitivity to methanol.

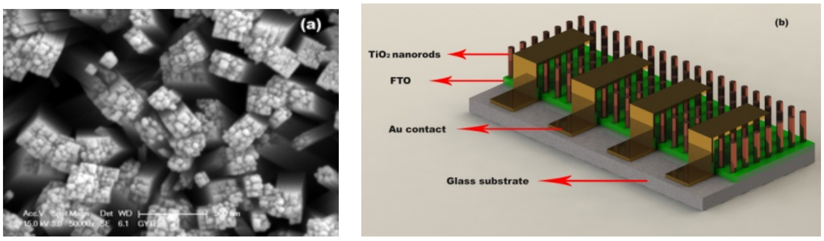

Figure 1. Pd modified TiO_2 nanorods SEM image (a), illustration of sensor device (b)

Acknowledgements

This study was partially supported by Scientific and Technological Research Council of Turkey (TUBITAK) entitled ‘‘Development of Automotive Gas Sensors Based on Nano-Metal–Oxide Semiconductor with increased Selectivity, Sensitivity and Stability’’ (Project No. 111M261).

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Poster Presentation

SIMPLE FABRICATION OF NETWORK-LIKE CUO NANOWIRES WITH THERMAL OXIDATION ON GLASS SUBSTRATE AND THEIR ETHANOL SENSING PROPERTIES

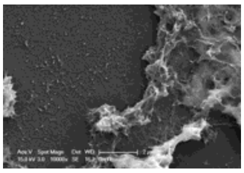
O. Sisman[1], E. Sennik[1], S. Ozturk[2], N. Kilinc[3], Z.Z. Ozturk[1]
[1]*Department of Physics, Gebze Institute of Technology, KOCAELI*
[2]*Department of Physics, Fatih Sultan Mehmet University, ISTANBUL*
[3]*Department of Mechatronics Engineering, Nigde University, NIGDE*

Abstract

In this study, we focused on fabrication and characterization of CuO nanowires on glass substrate and then investigation of their gas sensing properties. Cupric oxide is a valuable p-type semiconductor with narrow band gap of ~1.2 eV at room temperature and its close connection to high-T_c superconductors [1]. Our motivations were rareness of nano-structured CuO on different substrates like microscope glass and gas sensing properties of these structures in literature [2].

After thermal evaporation of Cu thin film ~400nm on glass substrate, sample thermally oxidized in air at 450 C for 4 hour. Cu thin film evaporated again on CuO-glass substrate then with a second thermal oxidation, CuO network-like nanowires fabricated on glass substrate.

a)



b)

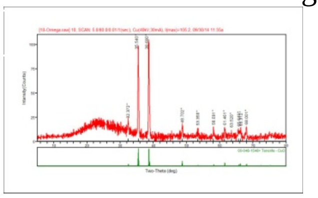


Figure 1. a) SEM image of CuO network-like nanowires b) XRD result of a sample.

SEM and XRD result of samples were given at Figure 1. After fabrication of network-like nanowires, samples were coated with Au interdigital transducer (IDT) contact. Resistive based ethanol sensing measurements were done in a specially designed system. Network-like nanowires are successfully fabricated on glass substrate. The resistive gas sensing results will be compared with previous studies with different nanostructures such as nanorods and nanoplates on different substrates in literature [4,5].

Acknowledgements

This study was partially supported by Scientific and Technological Research Council of Turkey (TUBITAK) entitled ''*Development of Automotive Gas Sensors Based on Nano-Metal–Oxide Semiconductor with increased Selectivity, Sensitivity and Stability*'' (Project No. 111M261).

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Poster Presentation

IN SITU MONITORING OF OXIDATION PROCESS OF TIN OXIDE NANOLAYERS BY THE NOVEL DEPOSITION TECHNIQUE BASED ON RHEOTAXIAL GROWTH AND VACUUM OXIDATION

M. Kwoka
Institute of Electronics, Silesian University of Technology, 44-100 Gliwice, Poland
Email: monika.kwoka@polsl.pl

Abstract

The aim of this work is a new approach in the preparation of tin dioxide (SnO_2) nanolayers based on their in situ rheotaxial growth in ultrahigh vacuum conditions in order to obtain the maximal extension of their internal surfaces for potential gas sensor application. This procedure is a novel and original modification of the method well known in the literature since 1990 used for the deposition of thin films of transparent conductive oxides like SnO_2 by the rheotaxial growth of metallic droplets with a subsequent thermal oxidation (RGTO) [1-3].

The main approach consists in deposition of ultrathin films (nanolayers) of the rheotaxial transparent conductive oxides like SnO_2 by rheotaxial growth of metallic droplets with their subsequent oxidation during dry oxygen exposure under ultrahigh vacuum conditions (RGVO). The attempt is to obtain the RGVO SnO_2 nanolayers deposited at the clean Si(100) substrate prepared with RCA technology of controlled thickness (at the level of a few nm) and of precisely defined stoichiometry. For the control of quality of deposited RGVO SnO_2 nanolayers, mainly their surface purity, stoichiometry and morphology, the surface sensitive analytical methods were used like X-ray photoelectron spectroscopy (XPS) and atomic force microscopy (AFM). For the obtained RGVO SnO_2 nanolayers the studies of sensor properties in nitrogen dioxide NO_2 atmosphere was also performed with a special emphasis on their dynamic sensor characteristics (response and recovery time, respectively).

A special emphasis was given to control the oxidation conditions in order to obtain the RGVO SnO_2 nanolayers of controlled stoichiometry/nonstoichiometry for the potential application as the oxidizing/reducing toxic gases sensors. Our XPS studies showed that the obtained RGVO SnO_2 nanolayers are completely pure (without any C contaminations) and exhibit the controlled nonstoichiometry depending on the conditions of additional oxidation. However, what is even more important, only after additional *in situ* oxidation with increasing oxygen exposure up to 10^8 L one can obtain the RGVO SnO_2 nanolayers, which consist a mixture of SnO and SnO_2 phase with a domination of the second one, what is crucial for sensors application. In turn, our AFM studies confirm that the obtained RGVO SnO_2 nanolayers exhibit nanograin-type surface morphology with dimension and height of the grains strongly related to their surface nonstoichiometry.

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Poster Presentation

CHARACTERIZATION OF DUST AND ASH PARTICLES WITH A MICRO HEATER AND GAS SENSITIVE SIC FIELD EFFECT TRANSISTORS

C. Bur[1,2], M. Bastuck[1], A. Schütze[1], J. Juuti[3], M. Andersson[2], A. Lloyd Spetz[2]
[1]*Lab for Measurement Technology, Saarland University, Saarbrücken, Germany;*
[2]*Div. of Applied Sensor Science, Linköping University, Sweden;*
[3]*Microelectronics and Material Physics Laboratories, University of Oulu, Finland*

Abstract

Particle emission from traffic, power plants or, increasingly, stoves and fireplaces poses a serious risk for our health. The harmfulness of the particles depends on their size and shape, but also on adsorbates (PAH, VOC) [1]. Particle detection for size and concentration are available on the market while determining the content is still a challenge.

In this work, a measurement setup for characterization of dust and ash particles, respectively adsorbates, is presented. For the proof of concept, ammonia contaminated fly ash samples from a coal fired power plant equipped with a SCR system were used. The fly ash sample was placed on top of a heater substrate and heated up to several hundred degrees. A gas sensitive SiC based field effect transistor (SiC-FET) [2] was used to detect desorbing species as well as combustion products by transporting the headspace of the heater chamber to the gas sensor with a small gas flow. In addition, the heater chamber can be by-passed with two valves and a gas line in order to achieve a stable baseline of the gas sensor, e.g. during placement of the particles in the heater chamber. Accumulation of desorbing species in the heater chamber followed by transfer to the gas sensor is also possible.

A mass spectrometer (MS) was placed downstream of the sensor as a reference. A clear correlation between the SiC-FET response and the ammonia signal of the MS was observed. In addition, different levels of contamination can be distinguished. Thus, with the presented setup we are able to characterize ash particles, especially adsorbates, which contribute significantly to the harmfulness of the particles.

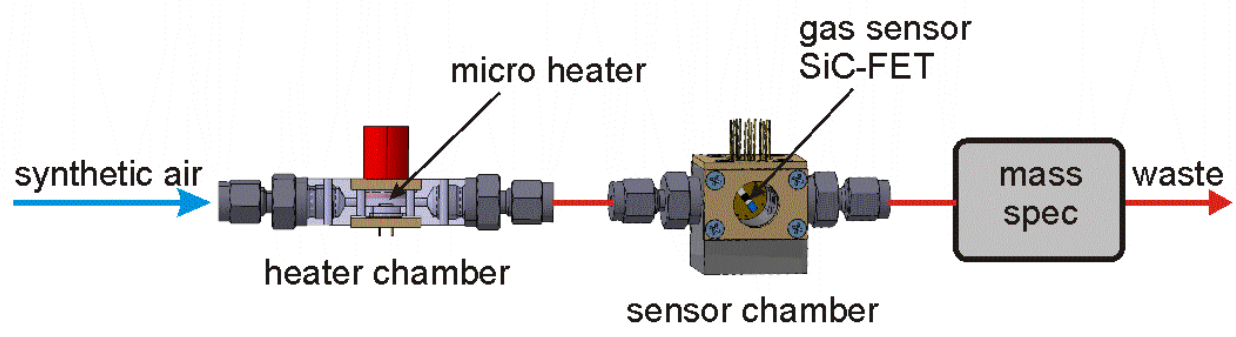

Figure 1. Experimental set-up for characterization of dust and ash particles.

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Poster Presentation

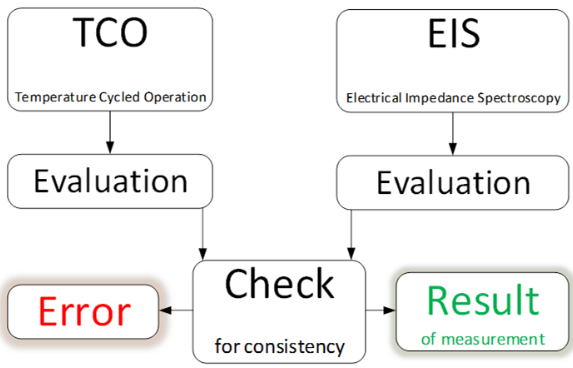
GAS SENSOR SELF-TEST USING FOURIER-BASED IMPEDANCE SPECTROSCOPY

Marco Schüler, Tilman Sauerwald, Andreas Schütze
Lab for Measurement Technology, Saarland University, Saarbrücken, Germany
{m.schueler, t.sauerwald, schuetze}@LMT.uni-saarland.de

Abstract

For the self-test of semiconductor gas sensors we combine two multisignal processes: TCO (temperature cycled operation) and EIS (electrical impedance spectroscopy). This combination enables the discrimination between irreversible changes of the sensor, i.e. poisoning, and changes in the gas atmosphere [1]. When combining EIS and TCO, impedance spectra should be acquired in a short time period, in which the sensor can be considered time-invariant (i.e. milliseconds or less). For this purpose we developed a Fourier-based high speed, low cost impedance spectroscope [2]. It provides a binary excitation signal through an FPGA (field programmable gate array), which also acquires the data. To determine impedance spectra, it uses the ETFE (empirical transfer function estimate) method, which calculates impedance by evaluating the Fourier transformations of current and voltage. Thereby, an impedance spectrum from ca. 60 kHz to 125 MHz is acquired in approx. 16 µs.

We carried out TCO – EIS measurements with a GGS 1330 gas sensor (UST GmbH, Germany) using this spectroscope with a temperature cycle consisting of six equidistant temperature steps between 200 °C and 450 °C . Discrimination of different gases is possible by LDA (linear discriminant analysis) using only one type of data, thus enabling a validation of results by comparison of both methods. Finally, field tests of the novel system were performed in an underground parking garage.



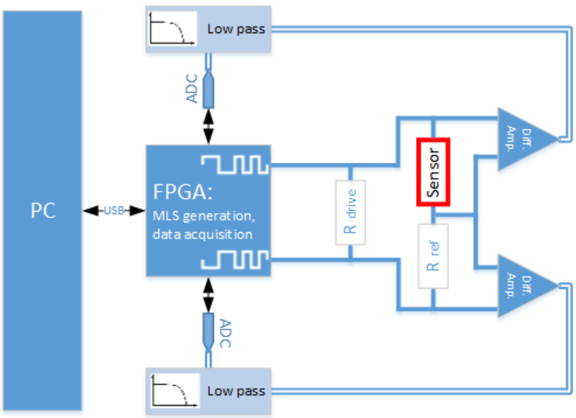


Figure 1. Left: Scheme of the sensor self-test strategy; Right: Hardware setup of the FoBIS (Fourier-based impedance spectroscopy) measurement system. The measurement is based on an Empirical Transfer Function Estimate (ETFE) approach [3], using the voltage signals across R_{ref} and the sensor.

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Poster Presentation

ILLUMINATION COMFORT IN A RETROFITTED SHOPPING CENTER IN SOPRON HUNGARY

L. Pockelé[1], A. Whang[2]

[1] *R.E.D. Srl, Viale dell' Industria 58 B, 35129 Padova, Italy;* luc.pockele@red-srl.com

[2] *National Taiwan University of Science and Technology, Keelung Rd., 43 (Sec. 4), Da'an Dist., Taipei City 106, Taiwan (R.O.C.);* whang@mail.ntust.edu.tw

Abstract

EcoShopping stands for Energy efficient & Cost competitive retrofitting solutions for Shopping buildings [1]. The project is co-funded by the European Union within the 7th Framework Program (FP7-2013-NMP-ENV-EeB). The objective is to build a holistic retrofitting solution for commercial buildings to reduce primary energy consumption down to less than 80kWh/m^2 per year and increase the share of RES (Renewable Energy Sources) more than 50% compared to the state of the art. The approach will be systemic by developing: 1) novel thermal insulation solutions using cost effective materials to further reduce the thermal losses and lower the energy consumption; 2) easy to install and cascadable day-lighting technologies based on a novel Natural Light Illumination System (NLIS) (Figure 1) [2] to reduce energy billing and improve comfort; 3) HVAC Retrofitting systemic approach based on RES direct powered DC variable speed heat pump and harnessing the Building Thermal Mass for reducing the energy consumption; 4) integrated solution way based on the Intelligent Automation Unit (IAU) concept and Mobile Robot.

The demonstration part of the project will include the retrofitting of the illumination system and the installation of the NLIS in one area of the shopping center.

As part of the evaluation of this demonstration, the performance of the lighting systems in terms of homogeneity and level of illumination will be monitored using illumination sensors. Also, through the use of the correlated temperature of light sensor, developed by RED, the day-lighting system will be monitored on its efficiency to reproduce day-light conditions in the area where the NLIS is installed.

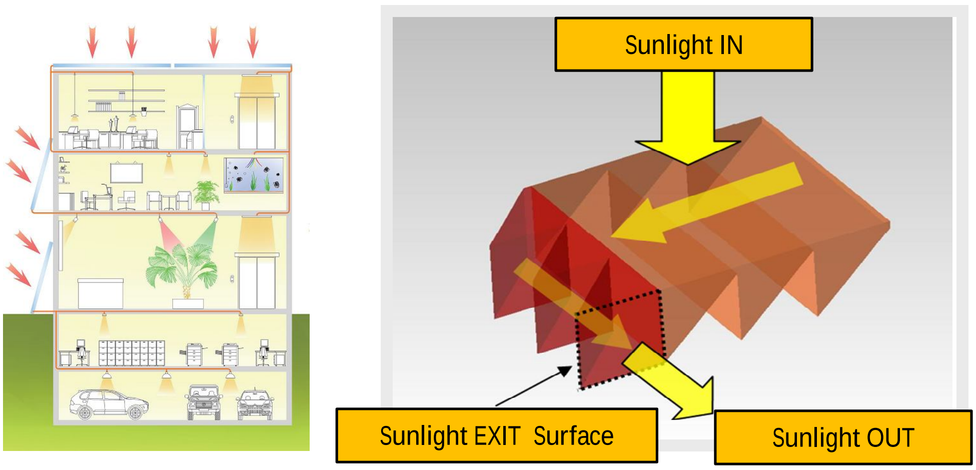

Figure 1. NLIS theory: collect and compress solar radiation

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Poster Presentation

INDOOR COMFORT DETERMINATION IN APARTMENTS DESIGNED ACCORDING TO PASSIVE HAUS STANDARDS IN ECO-SILVER HOUSE, A HIGH RISE BUILDING IN LJUBLJANA

Luc Pockelé[1], Adriana Bernardi[2], Paolo Bison[3],
G. Cadelano[3], A. Bortolin[3], G. Ferrarini[3], M.C. Di Tuccio[2,4]
[1]*R.E.D. Srl, Viale dell' Industria 58 B, Padova, Italy; luc.pockele@red-srl.com*
[2]*CNR-ISAC and* [3]*CNR-ITC, Corso Stati Uniti 4, Padova, Italy;*
a.bernardi@isac.cnr.it Paolo.bison@itc.cnr.it,
[4] *Physic Department, University of Milan (Italy), Via G. Celoria 16, Milano (Italy);*

Abstract

EE-HIGHRISE stands for ENERGY EFFICIENT DEMO MULTIRESIDENTIAL HIGH RISE BUILDING and is a research and demonstration project supported by the European Commission within the 7th Framework Programme (FP7-2011-NMP-ENV-ENERGY-ICT-EEB) [1]. The overall objective of the project is to demonstrate and validate new technologies, concepts and systems for sustainable, low-energy building in order to test and assess the technological and economical feasibility of innovative energy solutions in high rise multi residential building Eco Silver House.

One of the objectives is to reach a very high level of indoor quality and comfort. The highly insulated building envelope was constructed according to passive house standards, the apartments are airtight and mechanical ventilation units in each apartment are providing ample air changes regulated by a CO_2 sensor in the living room. Automatically controlled external blinds enable shielding of sunlight in summer and provide solar gains in winter. Each apartment is equipped with an individual intelligent building automation and control unit.

The indoor thermal comfort will be evaluated in one pilot apartment using the traditional set up with globe temperature sensor, air temperature and velocity sensors, relative humidity sensor in respectively a winter and summer campaign. The Predicted Mean Vote and the Percentage People Dissatisfied factors as defined by Fanger [2] will be determined during these periods.

The plan is to use in parallel an innovative measuring system called aIRview [3]. This system is based on an accurate thermo-graphic camera mounted on a pan and tilt system in combination with a grid equipped with targets. The grid is placed at about 10 cm from the wall being monitored. The air velocity in proximity of the wall is defined through a methodology patented by the CNR [4]. The system is able to show after some data processing the conductive, convective and radiative heat fluxes. Also the homogeneity of the wall and the corresponding surface temperatures can be determined this way. These are important inputs to calculate on one hand the above mentioned comfort factors through the method of view factors and on the other hand to identify vertical air temperature differences and radiant temperature asymmetries. The data capturing is done in a matter of minutes.

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Poster Presentation

ENVIRONMENTAL IMPACT OF PCMS INCORPORATED IN GYPSUM PANEL FOR CULTURAL HERITAGE APPLICATION

A. Bernardi[1], F. Becherini[1], A. Vivarelli[1], M. Favaro[2], M.C. Di Tuccio[1,3]
National Research Council (CNR), [1]ISAC- [2]IENI, Corso Stati Uniti 4, Padova (Italy);
[3] Physic Department, University of Milan (Italy), Via Giovanni Celoria 16, Milano (Italy);
a.bernardi@isac.cnr.it,

Abstract

Latent heat storage materials such Phase Change Materials (PCMs) are commonly used in the civil field as short-term energy storage systems [1]. Experimental and numerical studies about the incorporation of PCMs in building materials for interior climate control have been recently presented by several authors. When applied to Cultural Heritage (CH), PCM technology needs to be adapted to the specific requirements of conservation, besides to the important objectives of economy and people comfort. The application of the PCMs to the CH field has been firstly studied within the European project MESSIB (Multi-source Energy Storage System Integrated in Buildings), funded by the 7th FP. In particular, gypsum panels incorporating micro-encapsulated paraffin based PCMs were characterized in laboratory and also tested in the field in the S. Croce Museum in Florence [2].

It is well known that the volatile organic compounds (VOCs) have adverse effects on human health, such as eye, nose and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney and central nervous system. Moreover, some are known (benzene) or suspected to cause cancer [3]. Even if a systematic study on the effect of VOCs on the heritage materials hasn't been carried out so far, some VOCs can be considered potential damage accelerating agents. For example formaldehyde, formic and acetic acids may contribute to the deterioration and formation of efflorescences on glass and enamels; efflorescences on calcareous materials; corrosion of metals (lead); depolymerization of cellulose; degradation of artificial and synthetic polymers, and so forth [4].

Hence, laboratory tests were set up to evaluate VOCs emissions by PCMs, in the form of powder, as well as incorporated in gypsum panels. The PCMs were exposed in controlled atmosphere as well as in real environment and their VOCs emissions were collected by means of a radial diffusive sampler (Radiello ®), that was successively thermally desorbed and analyzed. The VOCs emission from PCMs incorporated in gypsum panels were also measured in real heritage environment, i.e. the S. Croce Museum in Florence. In conclusion, all the VOCs concentrations measured in laboratory and in the heritage site were of the same order of magnitude of the typical values of indoor environments, but several orders of magnitude below the reference values for human health and also than the values supposed to have adverse effect on heritage materials. Nevertheless, further research about interactions of VOCs and heritage substrates is necessary.

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Poster Presentation

TOWARDS AIR QUALITY INDICES IN SMART CITIES BY CALIBRATED LOW-COST SENSORS APPLIED TO NETWORKS

Domenico SURIANO, Mario PRATO, Gennaro CASSANO, Michele PENZA*
ENEA, Technical Unit Brindisi Technologies for Materials
*S.S.7 Appia Km 706, I-72100 Brindisi, Italy; * domenico.suriano@enea.it*

Abstract

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 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 [1-4]. This system is the last result of our researches in the area of tiny and portable system for air quality control based on cost-effective solid state gas-sensors. The main goal of the system designed and built in our laboratory is the development of a 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.

In order to give our equipment a high flexibility grade, we have designed it in a modular style: it is composed by the main board, one or more sensors boards, an USB port hub and the power module. Main board is a *Raspberry PI* module which is in charge to interface the end-user with the sensor boards, providing the necessary services which implement all the equipment functionalities. Sensor boards communicate with main module via USB ports hub following the master-slave scheme. The end user interface is given by a web browser page by which operators can get machine full remote control. This is possible by connecting any PC with the web server running on the Raspberry board via Wi-Fi or LAN or GPRS-UMTS connection. AIR-SENSOR BOX can operate with several sensor boards at the same time by means of the USB hub and, therefore, it can run a great variety of sensors. In this occasion, we are using electrochemical sensors by *Alphasense*, an Optical Particle Counter (OPC) by *Shinyei*, a humidity sensor by *Honeywell*, and a temperature sensor by *Microchip*.

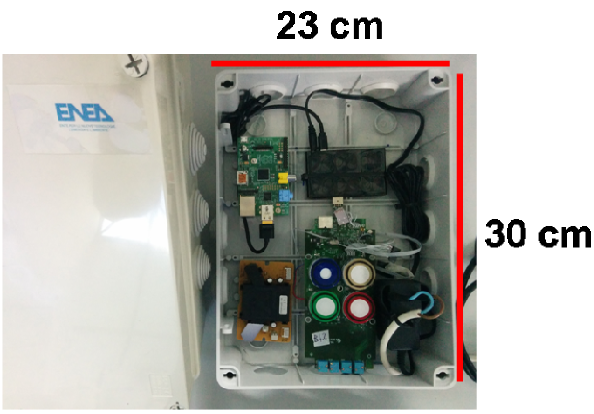

Figure 1. Air-Sensor Box system by ENEA, Brindisi.

Several tests in collaboration with ARPA-Puglia, (public agency for pullution monitoring and control) and the Joint Research Center (JRC), Institute for Environment and Sustainability (IES) in Ispra (Italy) were performed. In these tests, we compared our sensor response with the data given by traditional chemical analyzers placed in the fixed stations provided by ARPA-Puglia and JRC in terms of mean and maximum error between the data given by our sensor-device and the data given by reference equipment in the time domain. They gave us encouraging results for CO detection in terms of mean error and maximum error with respect to the reference equipments (see Figure 2), but we found that interfering gases effects are still an open problem (Figure 3) for NO_2 detection with O_3 as an interfering gas.

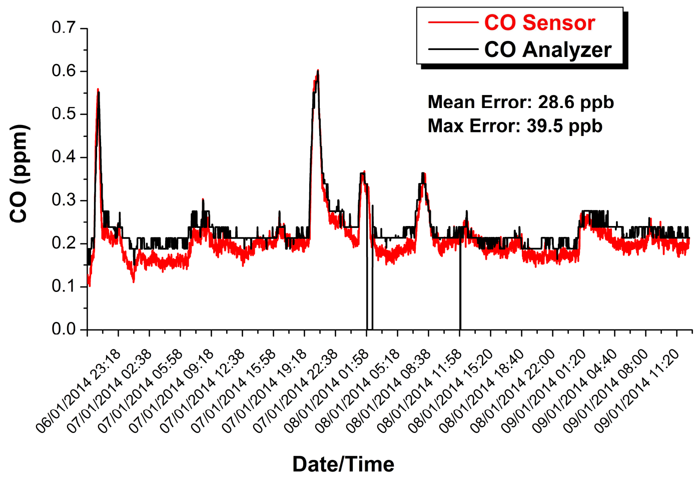

Figure 2. Electrochemical CO sensor response in real scenario.

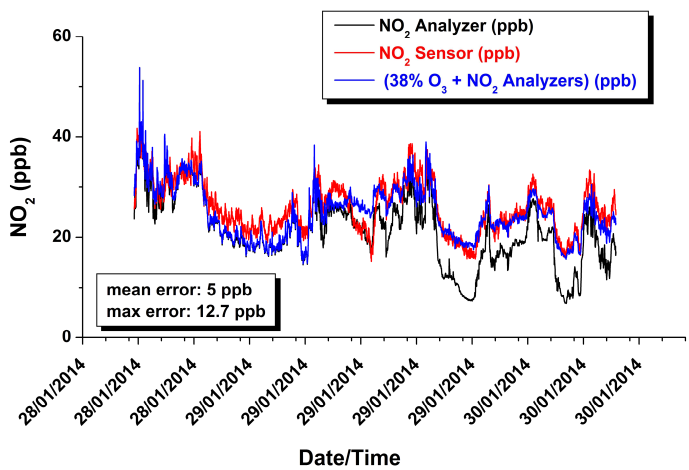

Figure 3. Electrochemical NO_2 sensor response in real scenario.

We are planning more systematic tests in order to better investigate interfering gases effects, sensor stability and lifetime in real scenario, and moreover, the proper maintainance procedures (e.g. sensor re-calibration rates).

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Poster Presentation

ELECTROCHEMICAL MODIFICATION OF NANOSTRUCTURED METAL-OXIDES BY GOLD NANOPARTICLES FOR GAS SENSING APPLICATION

E. Dilonardo[1*], M. Penza[2], M. Alvisi[2], C. Di Franco[3], F. Palmisano[1], L. Torsi[1], and N. Cioffi[1]

[1]*Department of Chemistry, Università degli Studi di Bari Aldo Moro, Bari, Italy*
[2]*ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Technical Unit for Materials Technologies - Brindisi Research Center, Italy.*
[3]*CNR-IFN Bari, Bari, Italy*

*elena.dilonardo@uniba.it

Abstract

Since today air pollution has been becoming a serious problem with the development of industry and the increase of people life, an urgent assignment is the development of small and portable gas sensors with high sensitivity and excellent selectivity to pollutant gas at low concentrations. Recently many metal oxides (MOx) have been widely investigated as sensing materials for gas detection [1]; among these, ZrO_2 and ZnO have been considered as a promising sensing material of solid-state semiconductor gas sensors for gas monitoring because of their excellent sensitivity and selectivity [2]. A very efficient strategy to improve the gas sensing properties of MOx-based gas sensors is to functionalize MOx with noble metals, as sensitizer or promoter of sensing reactions [3].

In this contribution, a facile one-step strategy based on sacrificial anode electrolysis is proposed to functionalize the surface of nanostructured ZnO and ZrO_2 powders, previously synthesized by sol-gel method and subjected to thermal annealing prior to the electrosynthesis step, with stabilized gold nanoparticles (Au-NPs) with controlled dimension of 12 nm in diameter.[4] Au NPs/MOx nanocomposites, after thermal stabilization at 600°C, were morphologically and chemically characterized using transmission and scanning electron microscopies and X-ray photon spectroscopy respectively, revealing the successful decoration of MOx with nanoscale gold at the elemental oxidation state. The hybrid nanocomposites were used as active layer in chemiresistive gas sensors for low-cost processing. The gas sensing performance of sensors based on Au-doped and undoped MOx nanostructures towards the common gaseous pollutants was evaluated at a fixed sensor temperature of 310°C; the cross-sensitivity in presence of gases mixture was also examined; in particular, the effect of the metal oxide composition and of the Au-doping on the sensor performance (e.g., gas response and response time) were studied.

Acknowledgements. The authors thank the Ministry of University and Scientific Research (MIUR) of Italy, for funding *INNOVHEAD - Tecnologie innovative per riduzione emissioni, consumi e costi operativi di motori Heavy Duty* - PON 2007-13 (N. contract PON-02_00576-3333604).

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Poster Presentation

VASCULAR AND LUNG FUNCTION RELATED TO ULTRAFINE AND FINE PARTICLES EXPOSURE ASSESSED BY PERSONAL AND INDOOR MONITORING

Y.Olsen[1], D.Karottki[1], D.Jensen[1], G.Beko[2], B.Kjeldsen[2], G.Clausen[2], L.Hersoug[1], G.Holst[4], A.Wierzbicka[3], T.Sigsgaard[4], A.Linneberg[5], P.Møller[1], S.Loft[1]

[1]*Department of Public Health, University of Copenhagen, Denmark, Copenhagen;* stl@sund.ku.dk

[2]*Deparment of Civil Engineering/Technical University of Denmark,Denmark, Lyngby;* gc@byg.dtu.dkl

[3]*Division of Ergonomics and Aerosol Technology, Lund University, Sweden, Lund;* aneta.wierzbicka@design.lth.se

[4]*Department of Public Health, Institute of Environmental and Occupational Medicine, University of Aarhus, Denmark, Aarhus;* ts@ph.au.dk

[5]*Department of Clinical Experimental Research, Glostrup University Hospital, Denmark, Glostrup,* allan.linneberg@regionh.dk

Abstract

Background: Exposure to ambient air particulate matter (PM) has been linked to decline in pulmonary function and cardiovascular events. However, little is know about personal exposure.

Methods: Associations between vascular and lung function, inflammation markers and exposure in terms of particle number concentration (PNC; size range10÷300nm) were studied in a cross-sectional design with personal and home indoor monitoring by Aerasense NanoTracer particle counters Philips. During ≈48-h, PNC and $PM_{2.5}$ were monitored in living rooms of 60 homes with 81 non-smoking subjects (30÷75 yrs old), 59 of whom carried personal monitors during the entire time of the experiment. Exposure was assigned as average PNC in the living room for the entire time of the experiment, average PNC from personal monitoring for the entire time of the experiment, furthermore data from personal monitoring was divided into two 2 sets for the periods a subject spent at home and away from home and integrated personal exposure for each period was calculated. The information on occupancy periods was provided by subjects in the individual diaries.

Lung function was measured as the FEV_1/FVC ratio, microvascular function (MVF) was measured by digital artery tonometry (EndoPat-2000), and biomarkers of inflammation including C-reactive protein, and leukocyte counts with subdivision in neutrophils, eosinophils, monocytes, and lymphocytes in blood.

Results: PNC from personal and stationary home monitoring showed week correlation. Integrated personal exposure calculated for the period when subjects were away from home was significantly inversely associated with MFV (1.3% decline per $10^3/cm^3$*h exposure, 95% CI: 0.1-2.5%) and positively associated with leukocyte and neutrophil counts. The leukocyte and neutrophil counts were also positively associated with average personal PNC for the entire time of the experiment. No significant association between the health-related outcomes and indoor particle levels was observed, except for an inverse association with eosinophil counts.

Conclusions: The inverse association between personal PNC exposure while subjects were away from home and MVF supports the hypothesis of negative effects of ambient particle air pollution on cardiovascular health. The effects could be related to inflammation. The results emphasize the power of combining personal time-resolved exposure monitoring and employing non-invasive equipment (EndoPat-2000) applicable in field studies.

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Indoor Environment Quality Cluster

Contribution of research topics from the Indoor Environment Quality sector to "Renaturing Cities: Addressing Environmental Challenges and the Effects of the Economic Crisis through Nature-based Solutions" and "Materials & technologies for improved Indoor Environment Quality" within EU Horizon 2020

An initiative resulting from the Session on Indoor Environment Quality at the ECTP-E2BA conference at 19th June 2014.

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Jürgen Frick

Dr. Jürgen Frick
Coordinator of IEQ-session at ECTP-E2BA-conference
c/o Materials Testing Institute
Pfaffenwaldring 32
D-70569 Stuttgart
Germany
Email: juergen.frick@mpa.uni-stuttgart.de
Tel.: +49-711-685-63381

Research topics of the Indoor Environment Quality sector for meeting the challenges of "Renaturing Cities: Addressing Environmental Challenges and the Effects of the Economic Crisis through Nature-based Solutions" and "Materials & technologies for improved Indoor Environment Quality" within EU Horizon 2020

Emissions from materials:

- The use of special building materials (e.g. insulation) for the construction of nearly zero energy buildings may lead to IEQ problems due to the materials' emissions. Emphasis should be given to new materials, used for this cause, and to the relationship between their emissions and Indoor Air Quality (IAQ). There should be a balance between energy efficiency and IAQ.
- The use of nature based or recycled materials (renewable sources, waste, etc.) is recommended due to lower embodied energy and resource efficiency. Nevertheless to reach building standards (fire resistance, mould prevention, stability, etc.) the use of additional compounds (flame retardants, biocides, etc.) is often needed. Some of them increase the emission of Volatile Organic Compounds (VOC). This could influence the Indoor environment Quality (IEQ) by emissions. Research is needed to improve products to meet the building regulations without further emissions.
- Hybrid materials: Combining the properties of natural material and artificial ones takes advantages of both worlds. An example is concrete/hemp. In addition aging and treatment (compounds for flame retardants, biocides) can be optimised limiting both VOC emission and costs. Composite mixture or layer superposition (example phase-change materials (PCM)) can improve or tune the water vapour permeability, energy transfer, energy storage (reinventing Trombe wall or passive cooling and PCM together, etc.) and filtering of indoor/outdoor pollutants at large scale.
- Use of chemicals for conservation, cleaning and other products are main sources of pollution, VOC's in particular. Research is needed to develop conservation, biocides and other treatment products for wood and stone on the basis of green chemistry and nature based materials. Nanostructured surfaces are good candidates for biocidal surfaces.
- Realistic test scenarios: The climate change is anticipated to increase the ground ozone level and the relative humidity. Based upon this, two aspects are relevant for IEQ. Emission testing of materials and consumer products should be carried out in conditions that mimic realistic atmospheric conditions for proper risk assessment, rather than artificially clean air conditions. The reason is that new pollutants with possible adverse health effects are produced by the induction of ozone, nitrogen dioxide, and/or humidity.
- There is a strong need for harmonization of emission test conditions of construction and consumer products, and risk assessment procedures. These developments need to be accompanied by development of appropriate measurement techniques and especially calibration standards for assessment of specific VOC emissions.

Influence of outdoor pollution on indoor environment:

- Outdoor pollution influences the IEQ. A renaturing of cities could reduce the outdoor pollution. Research is needed for nature based measures to reduce pollution, modelling of districts and cities and the possible influence on IEQ, impact control by advanced online monitoring and measures which influences the transport of pollution form outdoor to indoor (e.g. advanced filter technologies combined with thermal recovery for HVAC systems, etc.). There is a need to research and monitor which kind and forms of pollution transport happen from outdoors to indoor and which kinds of pollutants are present, in addition to the most cited ones, as the varying climate and outdoor environment change the types of pollutants. Also bio-pollutants should be accounted for.

- The outdoor/indoor interface with particular focus on ozone and nitrogen dioxide initiated reactions on materials and interior surfaces in general should be investigated for the impact upon material sustainability and production of potentially new reaction products.
- There is a need for advanced, pervasive and flexible new monitoring approaches, developed according to different perspectives. E.g. one of the most dangerous outgassing is related to formaldehyde; a sensor solution for online monitoring of formaldehyde is a priority. In order to implement it widely, the sensor solutions should be low cost.
- Filters catching mechanical particles are state of the art in HVAC systems. There is a need to develop more advanced filter materials which can filter gaseous chemical pollution without disturbing the system performance. The focus should lie on cost-efficient solutions to guarantee a wide distribution.
- Further development of innovative insulation materials to improve the indoor conditions and isolate from the outdoor changing climatic conditions is necessary. The solutions have to ensure higher insulation with sufficient water vapour permeability, end users' adaptability, lightweight and low environmental impact. Advanced monitoring is needed with an additional focus on the long term performance of the new materials and natural materials. The developed solutions will need a LCA.
- Nature based waste materials to filter and reduce indoor pollution and smell due to cooking, furniture emissions, and pollution from outdoor need to be developed for a higher, effective and low cost indoor air cleaning.
- Active air treatment technologies (e.g. filtering, chemical oxidation with ozone, photocatalysis) need to be studied to allow optimal ventilation schemes both from outdoor to indoor as well as indoor recirculation with cleaning/filtering. These measures also require appropriate monitoring technologies for optimal efficiency in terms of IAQ as well as energy consumption.

Controlling the indoor environment quality:

- The indoor environment quality is strictly connected with the ventilation systems, which also are strictly connected with the thermal conditioning. Furthermore, the thermal conditioning is connected with the human behaviour area. In this field, the research should aim to the development of methodologies and tools for efficient personal comfort systems to complement the central conditioning in indoor environments.
- Self-cleaning capacity: Extensive research and development has been done on TiO_2 based photo catalytic self-cleaning but with varying and usually low success rates in terms of efficiency and cost. Further research is needed on solutions which do effectively work, improve the efficiency, improve the safety and reduce the costs. Further researches should consider not only the improvement of the efficiency, but also the elimination of dangerous intermediates in photocatalytic reactions. In conjunction with Photo-catalysis cleaning strategies, appropriate measurement technologies - id est. sensors/sensor arrays – are

required; besides the individual development of both systems, there is a need for the development of a holistic approach combining them.

- Illumination systems to date are not providing the full daylight spectrum. The increased use of LED's will further worsen this situation. Natural daylighting systems are improving the indoor illumination quality next to saving energy but are to date limited in their application (light pipes, reflectors, etc.) due to the need to have windows nearby or due to the high cost of existing solutions (fibre optic transmission from concentrators). Research is needed on such natural daylighting systems to increase their efficiency and their application potential but also to limit possible harmful parts of the spectrum or discomfort aspects.
- Relative humidity content in the Indoor Environment is a crucial key-factor for comfort and health (e.g. mould). There is a need to develop innovative ambient conditioning systems based on new technologies and materials able to stabilize the desired relative humidity**.** Innovative solutions will have the potential to penetrate competitive markets such as Europe, Asia and the US.
- Controllable properties in structural materials: While some manufacturers have introduced dynamically changing properties of material (for example glass changing their light transfer spectrum) the domain of controllable properties is quite unexplored, or quite hidden in the research labs of big material or panel manufacturers. The question of measuring flux of any kind (thermal, humidity, air, chemicals), controlling the transfer properties, adsorption properties of smart materials is an open question which may be driven in the near future by M2M revolution. Also active noise camouflage has been explored but combination with tuned noise adsorption can be envisioned (tuned damping material).
- With attention to Cultural Heritage environments, in addition to end users comfort, also "well-being" of objects, collections and surfaces are of interest, including reconciliation of "comfort" between human beings and such objects.

Management, maintenance and monitoring the IEQ:

- During the retrofit of a building it needs to reach the indoor comfort and IAQ levels expected by end-users. It is necessary to establish the most suitable management and maintenance strategies, tools and monitoring the environmental conditions. This includes systems (RFID, BIM, etc.) allowing traceability of products and substances imputed in buildings during entire lifetime.
- Improved energy efficiency – often connected to reduced air exchange rates and increased humidity – could drastically increase the formation of moulds, especially in renovated, retrofitted buildings. Appropriate on-spot measurement or continuous monitoring solutions are required to detect mould formation at an early stage.
- There is a need for controlling the efficiency/impact of ventilation strategies by using distributed air quality sensors based on both VOCs and CO_2 detection principles. The target VOCs should be chosen according to the building use, i.e., schools, offices, etc.
- Forms and origin of dust and particles (e.g. PM10) and their consequences on indoor health should be monitored and investigated. Studies could also address specific living/work environments and public spaces.
- With reference to historic Indoor Environments, but not only, there is a need to analyse the building in a holistic perspective, defining a "model of life" in which are actively combined

technological components and elements of bio-architecture (for minimum intervention and compatibility of materials and measures taken).

- There is a strong need to assess the health implication of indoor generated particles (e.g. secondary organic aerosols) in comparison with ambient particles.
- Measures taken to improve IEQ need to be implemented following a holistic approach and taking into account different aspects such as light, noise, comfort and air quality, among others. The problems related to each aspect have to be measured (advanced sensing systems), the remedial actions implemented (i.e. improved HVAC control), and also the long-term effect of the approaches on citizen's health needs to be addressed. Although many studies about the mentioned problems on people's health have been carried out, the involvement of health experts is important to verify the efficiency of the measures.
- There is a strong need for an integrated understanding of the overall toxicological impact of single as well as mixtures of pollutants (in a cost effective way) in defined scenarios, which also includes comfort and productivity from adverse IEQ and concerted with other risk factors (occupational, environmental, and personal).

Influence of human behaviour and perception on IEQ

- Human behaviour has an important influence on the indoor environment quality together with pollutant's source properties and other attributes such as building characteristics. Behavioural effects are relevant not only during the operational phase but also on the overall life cycle of the building (from the design to the demolition). The research topic in this area should detect which are the main human IEQ impacts in relation to the behaviour and study the occupant and operator behaviours and their impact on IEQ and energy use in different classes of buildings.
- Each indoor microenvironment is unique and is characterized by the outdoor air, the indoor building characteristics and the indoor activities. The human perception of IEQ is subjective and depends on various sensory processes, that is why each person may perceive differently the IEQ of the same environment. Research is needed on the relationship between measured IEQ vs perceived IEQ in respect of comfort, spaces, behaviour, etc.
- There is a strong need for methods to identify adverse odour (IEQ) perception and its implication and impact on health perception and productivity as well as to assess "chemophobia" in view of alleged adverse health effects of selected SVOCs.

Benchmarking and assessment strategies

- Benchmarking and assessment is an important topic. As done for the energy, it is important to develop a procedure to measure progress and identify changes in the indoor environment. Benchmarking and monitoring changes in IEQ offers considerable challenges due to the complexity of the indoor environment and the amount of variables needed to assessing IEQ.
- There is a strong need to develop socio-economic approaches as tools to identify the better solutions to improve IEQ for the stakeholders, particularly the policy makers.

Please consider the following questions, citing any available evidence such as foresight and other assessments of research and innovation trends and market opportunities:

1) What is the biggest challenge in the field concerned which requires immediate action under the next Work Programme? Which related innovation aspects could reach market deployment within 5-7 years?

Biggest challenges:

1. **Impact of material emissions on the Indoor Environment Quality (IEQ).** New Materials for construction, conservation, cleaning, etc. could emit VOCs, especially if they are treated with compounds to meet building requirements (flame retardants, biocides, etc.). This could be a major hindrance for the use of new nature based or recycled materials. There is a need to develop realistic test scenarios and harmonised tests.
2. **Outdoor pollution influences IEQ.** Renaturing cities could lower this impact. There is a need to simulate, model and assess this effect on district level. Advanced approaches and tools for monitoring, air treatment and filtering should be developed.
3. **New control strategies to improve IEQ.** This includes methodologies and tools for efficient personal comfort systems (thermal, moisture, illumination, and noise), reduction of pollutants by advanced self-cleaning capacity and smart materials with controllable properties (adsorption, transport).
4. **Management, maintenance and monitor the IEQ.** There is a need of reliable and diffuse sensing systems for specific pollutants (VOCs, dust, particulates, biological and chemical). This includes new monitoring approaches, according to different perspectives and standardisation of sensor technologies. Assessment of health and toxicological impacts of pollutants (single, mixtures and secondary generated).
5. **Human behaviour and perception** has an important influence on the IEQ together with pollutant's source properties and other attributes such as building characteristics. A special regard should be dedicated to the subjective human IEQ perception comparing with the real IEQ measured.
6. **Benchmarking and assessment strategies** to develop procedures to measure progress and identify changes in IEQ. This includes socio-economic approaches as tools to identify the better solutions to improve IEQ for the stakeholders, particularly the policy makers.

2) What are the key assumptions underpinning the development of these areas (research & innovation, demand side and consumer behaviour, citizens' and civil society's concerns and expectations)?

In developed societies, people spend on average over 90% of their time indoors[1]. Therefore indoor environment quality is a major impact factor of the health and comfort situation of people, which influences productivity and wellbeing. The indoor environment quality cluster will develop a roadmap and strategic research agenda to define the needs for research and innovation. The identified research topics mentioned in the first part are the starting point of this development.

[1] De Bruin et al. *Environ SciPoll Res*15 (5), pp. 417-430.

3) What is the output that could be foreseen, what could the impact be, what would success look like, and what are the opportunities for international linkages?

The transfer and implementation of research results into daily practice will boost the related industrial sectors, with a high percentage of innovative SMEs. Improving IEQ is a global challenge; therefore innovative products will be competitive on international markets (e.g. Asia and US).

4) Which are the bottlenecks in addressing these areas, and what are the inherent risks and uncertainties, and how could these be addressed?

The IEQ sector is highly trans-disciplinary from advanced sensing, materials and systems to health assessment as well as behavioural and socio-economic issues. The newly formed IEQ cluster will help to generate a common approach by involving the stakeholders in this sector.

5) Which gaps (science and technology, markets, policy) and potential game changers, including the role of the public sector in accelerating changes, need to be taken into account?

A common EU legislation on IEQ would boost first the research and then implementation of all the proposed technologies.

6) In which areas is the strongest potential to leverage the EU knowledge base for innovation and, in particular, ensure the participation of industry and SMEs?

1 To design adequate calls for proposals with the relevant stakeholders and make it attractive for industry and SMEs. Research institutions have proven in the past to be the partners looking strongly for industrial participation and this should be further enhanced.

2 Development of sustainable solutions for improving IEQ on the basis of new technologies

3 Development of new materials/ technologies/methods for IEQ.

What is the best balance between bottom-up activities and support to key industrial roadmaps?

The IEQ sector is dominated by small and medium enterprises. The use of the HORIZON 2020 SME instrument allows a bottom-up approach for research affine companies in this sector. There is a need to address the IEQ theme in HORIZON 2020 SME calls. Collaborative research of trans-disciplinary partners should support the key industrial roadmaps.

7) Which areas have the most potential to support integrated activities, in particular across the societal challenges and applying key enabling technologies in the societal challenges and vice versa; and cross-cutting activities such as social sciences and humanities, responsible research and innovation including gender aspects, and climate and sustainable development? Which types of interdisciplinary activities will be supported?

The area of IEQ has been funded through various framework programmes. This development should be further enhanced through continuous funding as well as to invest into the younger professionals and experts who are needed for the future. Therefore it is necessary to have also funding schemes for conferences, workshops and advanced training activities.

COST Office
Avenue Louise 149
1050 Brussels, Belgium
t: +32 (0)2 533 3800
f: +32 (0)2 533 3890
office@cost.eu

www.cost.eu

COST Action TD1105

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

6th Management Committee and Working Groups Meeting
Istanbul, 3 - 5 December 2014

Third Scientific Meeting

organized by
GEBZE Institute of Technology and Bahçeşehir University
hosted at Bahçeşehir University, Beşiktaş Campus
Istanbul, 3 - 5 December 2014

Workshop Venue:

Bahçeşehir University
Beşiktaş Campus
Çırağan Caddesi No 4
Beşiktaş İstanbul 34353 Turkey

Local organizer:

Prof. Dr. Zafer Ziya ÖZTÜRK
Gebze Institute of Technology
PO. Box 141, 41400 Gebze/KOCAELI TURKEY
Tel: +90 262 605 1306
Fax: +90 262 605 1305
Email: zozturk@gmail.com

Meeting and Travel Information

VISA FORMALITIES

All formalities for each citizenship are detailed on the following link:
http://www.mfa.gov.tr/visa-information-for-foreigners.en.mfa.
Concerned people should apply by clicking on https://www.evisa.gov.tr/en/

ENTERING THE COUNTRY

Visa policy of Turkey depends on the origin country. Details on this topic can be found at http://www.mfa.gov.tr/visa-information-for-foreigners.en.mfa.
We will be happy to provide more details on request, do not hesitate to ask us for any remaining question mark on this topic.

ARRIVAL ROUTES TO ISTANBUL

There are two international airports in Istanbul: Atatürk Airport on the European side of the city and Sabiha Gökçen Airport on the Asian side.
Connections from these airports offer easy means to join the city center, by taxi, shuttles, metro & tramway public transportation. Boats ("vapur") are other means to cross the Bosphorus in a highly enjoyable way.

EXPECTED WEATHER

Weather Averages for Istanbul in December

Temperature	8°C 46°F
Low Temperature	6°C 43°F
High Temperature	10°C 50°F
Sunshine Hours	5 hrs
Rainfall	100mm
Rainfall days	17 days
Sea Temperature	14°C 57°F

TIME ZONES: Turkey is two hours ahead of Greenwich Mean Time (GMT) and seven hours ahead of Eastern Standard Time (EST).

CURRENCY: Turkish Lira

INTERNATIONAL TELEPHONE CODE: +90

ELECTRIC CURRENT: 220V AC with a frequency of 50 Hertz. European standard plugs with two round pins are used.

Hotel Information

Hotels within a five/ten-minute walk from the Bahçeşehir University Venue:

You can click here to find more hotels in Besiktas, Istanbul

La Maison(***)

Müvezzi Caddesi No:43 Çırağan, Beşiktaş, 34349 İstanbul
Tel: +90 212 227 42 63
Faks: +90 212 258 87 29
Email: mail@lamaison.com.tr
Web-page: http://www.lamaison.com.tr/istanbul/index_tr.html
Prices:
Single Room (75€/night/person/Breakfast)
Single-Use Double Room (95€/night/for two people)
Including Breakfast and local Taxes.

Cheya Besiktas Hotel - Boutique Class Istanbul (***)

Barbaros Bulvarı No:77 D:2
34353 Beşiktaş - TURKEY

P. +90 212 258 34 26
F. +90 212 258 34 25
WEB: http://www.cheyaresidences.com
Prices:
Single Room (69€/night/person)
Single-Use Double Room (85€/night/person)
One person Superior Double Room (110€/night/person)
Including Breakfast and local Taxes.

Palanga Bosphorus (***)

Palanga Caddesi No:24 Ortaköy / İST.
Tel: +90 212 327 20 93 - 94 - 95
Fax: +90 212 327 20 96
Email: info@palangabosphorus.com
Prices:
One Person Superior Double Room (85€/night/person)
Single-Use Double Room (95€/night/person)
Including local Taxes & Breakfast

Other Information about Beşiktaş and its location in the following map:

You can see the location of the BEŞİKTAŞ and İstanbul ATATURK International Airport in MAP-1.

In MAP-2, you can see **TAKSİM Square** and **conference venue**.

Istanbul railway transportation map is in the following link:

http://www.istanbul-ulasim.com.tr/passenger-services/network-maps.aspx

Travel Information

Travelling to Beşiktaş

Transportation from Airport to Bahçeşehir University (Beşiktaş)

There are two international airport; **Ataturk International Airport (IST)** and **Sabiha Gokcen International Airport (SAW)** in Istanbul as mentioned before. Ataturk airport is closer to Bahçeşehir University in Beşiktaş.

There are three main transportation routes from Ataturk Airport to Bahçesehir University (Beşiktaş Campus);

1. You can use HAVATAS and city bus. (Total payment: 15 TL~5€)

   HAVATAS is a **shuttle bus** for reaching to different points of İstanbul. Firstly, you will use **HAVATAS TAKSİM bus**. It costs 8 or 10 turkish liras (TL) equal to 2 or 3 euros. When you arrive the Taksim Square, you can use local buses **DT1, 28, 30A** to transport to Beşiktaş square with 2.5 Turkish liras. You will get of the city bus at the Beşiktaş bus stop**.** There are **information screen** about stations in the city bus**.**

2. You can use metro, metrobus and city bus. (Total payment: 10 TL ~3€)

   You can get on the metro which is in the airport at down stairs in international side of airport. You will get off from metro at the **ATAKOY interchange station** to metrobus line. You need to take **Zincirlikuyu Metrobus** and get off at the **last station** and you have to go to upstairs (**Beşiktaş direction**). Finally, you can take city bus to reach Beşiktaş.

3. You can use Taxi (Total payment: 70TL~25€)

   You can take taxi in front of exit doors of airport.

There is one route form Sabiha Gökçen Airport to the Bahcesehir Universtiy (Beşiktaş Campus).

You will get on HAVATAS and then city bus. (Total Payment: 15 TL~5€)

You can use HAVATAS **TAKSİM** bus is **written in the information table on bus**. It costs 8 or 10 turkish liras (TL) equal to 2 or 3 euros. When you arrive the Taksim Square, you can use local buses **DT1, 28, 30A** to transport to Beşiktaş square with 2.5 Turkish liras. You will get of the city bus at the Beşiktaş bus stop**.** There are **information screen** about stations in the city bus.

Bahçeşehir University is in the in the middle of the BEŞİKTAŞ and opposite side of bus stop.

http://www.cost.eunetair.it/cost/documents/meetings.php?where=Istanbul
http://www.cost.eunetair.it/cost/meetings/docIstanbul/WG-MC-MEETING_ISTANBUL_AGENDA_V1.pdf