

**SGS 2012**  
**VIII International Workshop on**  
**Semiconductor Gas Sensors**  
**September 11 - 15, 2012, Cracow, Poland**

Open Special Session:

## **Nanostructures & Sensing Technologies for Environmental Gas Sensors**

organized by COST Action TD1105 EuNetAir

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

### **SGS 2012 - VIII International Workshop on Semiconductor Gas Sensors**

*11 - 15 September, 2012, Cracow, Poland*

Visit link: <http://www.sgs.conrego.pl/>

#### **SPECIAL SESSION PROGRAM**

Session Chair(s): Prof. Eduard Llobet (MC Member) and Dr. Michele Penza (Chair Action)

### **Nanostructures & Sensing Technologies for Environmental Gas Sensors**

**Half-a-Day Session at one day during Conference on 11-15 September 2012**

#### **AIM of OPEN SPECIAL SESSION**

The **Open Special Session** aims to provide to the scientific community of Semiconductor Gas Sensors and Nanostructured Materials for Gas Sensing, as well as to anyone else interested, with information on the current state of play in new sensor technologies, advanced nanostructures for gas sensors, functional sensing materials and new sensing concepts for air quality control. The tutorial will be based on research results achieved by members of the COST Action TD1105 **EuNetAir** and is part of the Action's efforts for dissemination of results and for cross-domain scientific collaborations.

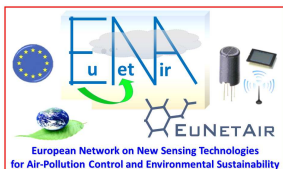
Current trend in the solid-state sensing technology is the development of nanomaterials and nanostructures with novel functionalities and innovative properties at the nanoscale for high-performance chemical sensing. In this direction, great efforts in the ongoing research have been doing to fabricate environmental sensors with advanced sensing nanostructures and high-resolution transducers coupled to proper electronic interfaces and new algorithms of pattern recognition and signal processing.

The key role for high-performance environmental sensors and sensor-systems is the engineering of sensing devices, ICT hardware, ad-hoc software/firmware, emerging transducers and sub-systems to develop air quality control applications with ubiquitous and mobile sensor-systems, including participating sensing and wireless sensor networks.

This **Tutorial** will be completely devoted to **Nanostructures & Sensing Technologies for Environmental Gas Sensors**. This event is based on Tutorial Session focussing environmental hot-issues from at least 3 Speakers from COST Action TD1105 EuNetAir and an Overview of the COST Action TD1105 from Chair (or a MC Delegate) towards large and specialized target audience with high benefit for COST Action TD1105.

#### **Call for papers**

This **Tutorial** openly calls for perspective and original contributions in the field of environmental sensors, sensor-systems, sensor technology and applications, from science and technology worldwide community,



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over COST Action and move towards new interested researchers and stakeholders working in the field of Action core-themes. These contributions related to Action-issues from extra-Action scientists would be submitted free of charge to the new open-access **Journal of Sensors and Sensor Systems (JSSS)** ([www.journal-of-sensors-and-sensor-systems.net](http://www.journal-of-sensors-and-sensor-systems.net)). The regular issue JSSS accepts contributions to cover a full range of sensors and sensor-systems such as theory, basic properties, design, fabrication, processing, calibration, measurements, integration, characterization, applications. We invite the submission of the manuscripts related to the fundamental and applied aspects for the environmental sensory, sensors science, sensor materials, nanomaterials and nanostructures processing, materials science and nanotechnology, gas sensors, air quality control sensor-systems applications, measuring systems, sensor technologies, environmental smart systems, sensing solutions, environmental ICT applications, mobile sensing, participatory environmental sensing, etc.

Topics of interest include, but not limited to:

- smart sensor materials
- advanced nanostructures for gas sensing
- nanomaterials processing
- functional nanomaterials
- environmental sensors
- outdoor/indoor air quality monitoring
- mobile sensing and participatory sensing
- sensor networks
- gas sensors and sensor arrays
- pattern recognition and signal processing
- electronic interfaces for sensors
- applications of sensor systems

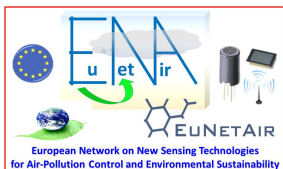
Authors should follow the Journal of Sensors and Sensor Systems (JSSS) manuscript format described at the open-access journal site [www.journal-of-sensors-and-sensor-systems.net](http://www.journal-of-sensors-and-sensor-systems.net). Prospective authors should submit an electronic copy of their complete manuscript. Papers should be submitted either in a doc or in a pdf form and they will be peer reviewed by at least 2 academic referees.

A regular issue to be published in *Thin Solid Films* (Elsevier) will be also managed and edited by SGS-2012 Chairman/Organizers to publish peer-review papers, presented to SGS-2012 workshop, and devoted to gas sensor materials. Notice of submission from authors should be emailed to Open Special Session Chairs.

### Open Special Session Chairs

**Michele Penza**, ENEA - Italian National Agency for New Technologies, Energy, and Sustainable Economic Development, Technical Unit of Technologies for Materials Brindisi, Italy; [michele.penza@enea.it](mailto:michele.penza@enea.it)

**Eduard Llobet**, Universitat Roviri I Virgili, Tarragona, Spain; [eduard.llobet@urv.cat](mailto:eduard.llobet@urv.cat)



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### **Nanostructures & Sensing Technologies for Environmental Gas Sensors**

**Half-a-Day Session at one day during Conference on 11-15 September 2012**

30 minutes (14.00 - 14.30)

Tentative Title: *Overview of COST Action TD1105 EuNetAir*

Speaker: Dr. Michele Penza, ENEA, IT - [michele.penza@enea.it](mailto:michele.penza@enea.it) (or Chair Delegate such as a MC Member)

**CONFIRMED**

30 minutes (14.30 - 15.00)

Tentative Title: *Nanowires for low power consumption gas sensors*

Speaker: Dr. J. Daniel Prades, University of Barcelona, ES - [dprades@el.ub.es](mailto:dprades@el.ub.es)

**CONFIRMED**

30 minutes (15.00 - 15.30)

Tentative Title: *Carbon nanotubes-based gas sensors for pollutants: Elaboration methods for NO<sub>2</sub> and BTX detection*

Speaker: Dr. Amadou L. Ndiaye, LASMEA, Aubiere, France - [amal2005@yahoo.fr](mailto:amal2005@yahoo.fr)

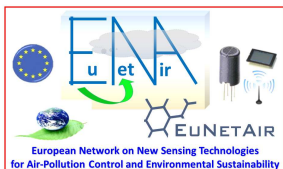
**CONFIRMED**

30 minutes (15.30 - 16.00)

Tentative Title: *TiO<sub>2</sub> Nanotubes Based Heterostructures For Gas Sensing Applications*

Speaker: Prof. Zafer Ziya Ozturk, GEBZE Institute of Technology, Kocaeli, Turkey - [zozturk@gyte.edu.tr](mailto:zozturk@gyte.edu.tr)

**CONFIRMED**



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Open Special Session:

## **Nanostructures & Sensing Technologies for Environmental Gas Sensors**

Invited Talk 1

### **Overview of COST Action TD1105 EuNetAir**

*Michele Penza* - ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development, PO BOX 51 Br-4, I-72100 Brindisi, Italy - [michele.penza@enea.it](mailto:michele.penza@enea.it)

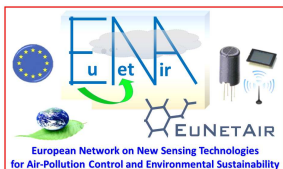
This is a short overview of the COST Action TD1105 EuNetAir - *European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability* - funded in the framework *European Cooperation in the field of Scientific and Technical Research* (COST) during the period 2012-2016. 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 60 big institutions from 21 COST Countries (EU-zone) and 5 Non-COST Countries (extra-Europe) to create a S&T critical mass in the environmental issues.

Invited Talk 2

### **Nanowires for low power consumption gas sensors**

*J. Daniel Prades*, MIND - Departament d'Electrònica, Universitat de Barcelona,  
Martí i Franquès 1, Planta 2, E-08028 Barcelona, Spain - [dprades@el.ub.es](mailto:dprades@el.ub.es)

Harnessing the advantages offered by 1D nanostructures has been one of the most successful strategies to improve of the power consumption of current gas sensors. In this talk, two recent findings will be overviewed: 1) the self-heating effect in nanowires can be used to dramatically reduce the power consumption in temperature-driven applications, as well as to develop a new kind of transient spectroscopy technique with analytic capabilities and 2) the integration of complementary functionalities in one single nanowire can be used to build up new devices with novel capabilities (zero-power consumption, ultra-high selectivity, faster response time, etc.) which were just unfeasible with conventional technologies.



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### Invited Talk 3

#### Carbon nanotubes-based gas sensors for pollutants: Elaboration methods for NO<sub>2</sub> and BTX detection

Amadou L. Ndiaye<sup>1,2</sup>, J. Brunet<sup>1,2</sup>, C. Varenne<sup>1,2</sup>, P. Bonnet<sup>3,4</sup>, A. Pauly<sup>1,2</sup>, B. Lauron<sup>1,2</sup>

<sup>(1)</sup> Clermont Université, Université Blaise Pascal, Institut Pascal, BP 10448, F-63000 Clermont-Ferrand, <sup>(2)</sup> CNRS, UMR 6602, Institut Pascal, F-63171 Aubière, <sup>(3)</sup> Clermont Université, Université Blaise Pascal, Institut de Chimie de Clermont-Ferrand, F-63000 Clermont-Ferrand, <sup>(4)</sup> CNRS, UMR 6296, Institut de Chimie de Clermont-Ferrand, F-63171 Aubière - [Amadou.NDIAYE@univ-bpclermont.fr](mailto:Amadou.NDIAYE@univ-bpclermont.fr)

The monitoring of pollutants for prevention or protection is nowadays an essential task and is the main objective of the COST Action "EuNetAir" in which we are involved.

Owing to their narrow size, nanomaterials present remarkable properties [1-2], which are especially related to their high surface area. Carbon nanotubes (CNTs) present peculiar transport properties which are sensitive to surface reaction (gas adsorption). As a consequence CNTs are a judicious choice for the development of efficient gas sensors. Recently, we have developed SWNTs-based sensors made from dispersions of raw SWNTs for NO<sub>2</sub> and O<sub>3</sub> detection and functionalized CNTs with phthalocyanines for BTX detection. The sensing materials are prepared and characterized by standard techniques. The first results have provided information on the ability of these CNTs to be used as matrix to reach higher sensitivities as well as the macrocycles for targeting the detection.

#### References

- [1] J. Hilding *et al.*, J. Disp. Sci. Technol. 24/1 (2003) 1.
- [2] V. Derycke *et al.*, C. R. Physique 10/4 (2009) 330.

### Invited Talk 4

#### TiO<sub>2</sub> Nanotubes based Heterostructures for gas sensing applications Erdem SENNIK<sup>1</sup>, Sadullah OZTURK<sup>1</sup> Necmettin Kılınç<sup>1</sup>, Zafer Ziya Öztürk<sup>1,2</sup> \*

<sup>1</sup> Gebze Institute of Technology, Department of Physics, 41400 Gebze Kocaeli, Turkey

<sup>2</sup> TUBITAK Marmara Research Center, P.O. Box 21, 41470 Gebze Kocaeli, Turkey - \*[zozturk@gyte.edu.tr](mailto:zozturk@gyte.edu.tr)

For monitoring air quality, metals, metal oxides, organic compounds, polymers in different forms such as powder, thin and thick films, nanostructures etc. have been used as gas sensors. With increasing necessity for gas sensors, studies were focused on fast, low cost, lower power consumption. Metal oxides semiconductors are very good candidate with high sensitivity for improving gas sensor technology Metal oxide films have played an increasing role in the last years as sensing devices for various gases. TiO<sub>2</sub> and ZnO nanostructures have been investigated as gas sensors by many groups. TiO<sub>2</sub> based gas sensors have been widely used because of their inert surface properties and high sensing abilities. Recently, many nanotechnology approaches have been followed to enlarge the surface area of TiO<sub>2</sub> without increasing the device dimensions. Highly-ordered titania nanotubes were firstly synthesized by Grimes *et al.* [1].

In this study, we fabricated titanium dioxide (TiO<sub>2</sub>) nanotubes based heterostructures by coating copper oxide (CuO) and zinc oxide (ZnO) thin films on the titania nanotubes. We synthesized highly ordered self-organized TiO<sub>2</sub> nanotubes arrays. Ti by anodical oxidation of titanium foil in a HF electrolyte at 20°C. CuO and ZnO thin films were coated on nanotubes with sol-gel methods. Fabricated heterostructures tested to toxic and explosive gases as hydrogen (H<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and some of the volatile organic compounds (VOCs) and sensor properties of CuO/TiO<sub>2</sub> and ZnO/TiO<sub>2</sub> will be investigated in different temperatures and gas concentrations.

- [1] D. Gong, C.A. Grimes, O.K. Varghese, W. Hu, R. S. Singh, Z. Chen, E. C. Dickey, Titanium oxide nanotube arrays prepared by anodic oxidation, J. Mater. Res., 16 (2001) 3331.

#### ACKNOWLEDGMENT

This work has been funded by The Scientific and Technological Research Council of Turkey (TUBİTAK), Project Number: 111M261 (ongoing National Project in frame of COST Action TD1105).