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

COST Action TD1105

Sensor Materials and Nanotechnology

Rome, 4-6 December 2012

Action Start date: 01/07/2012 - Action End date: 30/06/2016

Year: 2012-2013 (*Starting Action*)

Prof. George Kiriakidis

Metal oxides nanostructrures for AQC gas sensors

Action Sub-WG1.1 Leader

FORTH, Crete, Greece

COST is supported by the EU Framework Programme

ESF provides the COST Office through a European Commission contract

Sensor Materials and Nanotechnology (Sub-WG1.1)

- Metal Oxides gas sensor characteristics (the 3-Ss):
  - **Sensitivity**
    - **Selectivity**
      - **Stability**

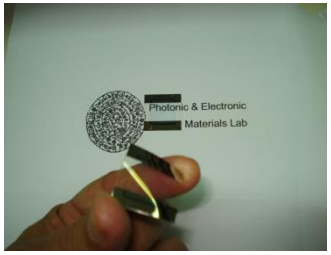
According to the World Health Organization (WHO) and FDA/EU standards, reliable MO gas sensors should be able to detect reliably:

✓ 40 ppb O_3

✓ 50 ppb NO_2

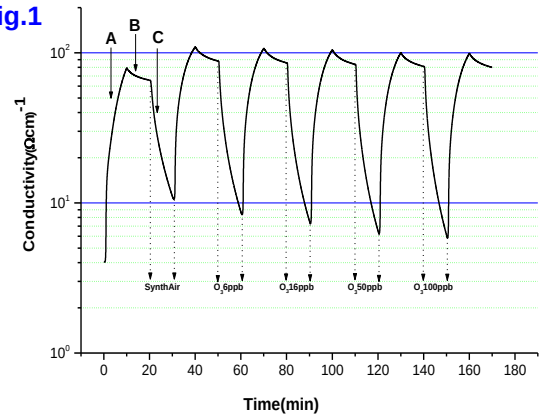
✓1 ppm Formaldehyde (HCHO)

InOx by DC Magnetron Sputtering sensing 6ppb of O3 @RT



InOx#RUN641#PETsub#O3 sensitivity@SynthAir#6ppb#16ppb#50ppb#100ppb

Fig.1



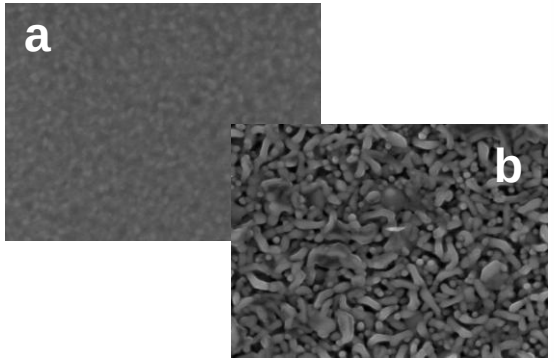


Fig.2

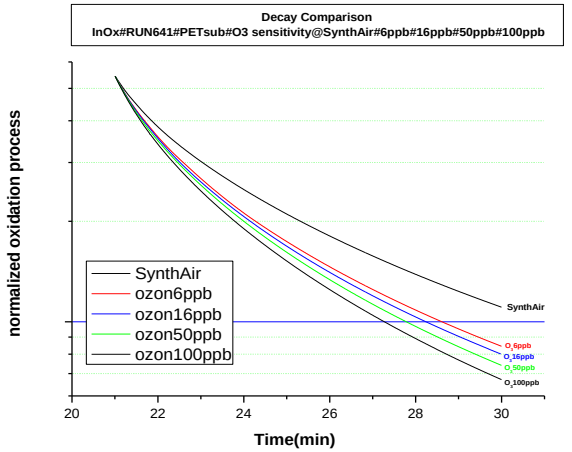
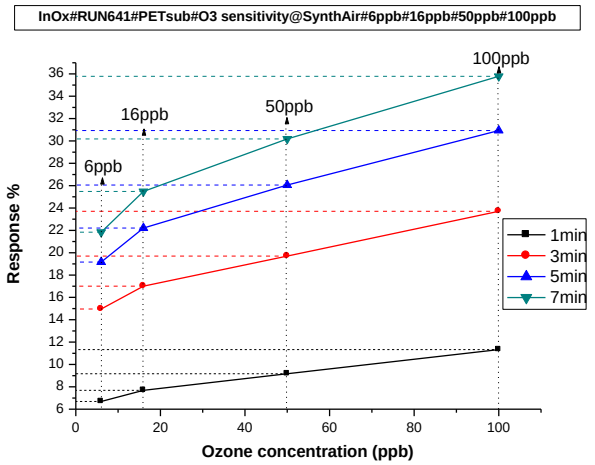


Fig.3



ZnO by ASP detected 100ppb of H_2@RT

500 sccm flow of CH_4@RT

Fig.4

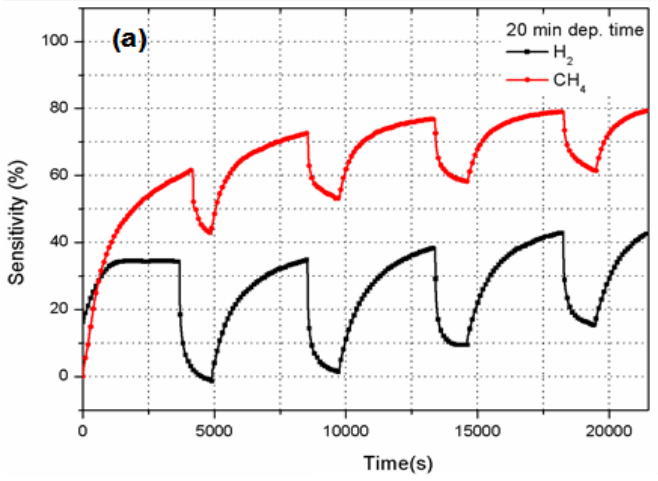
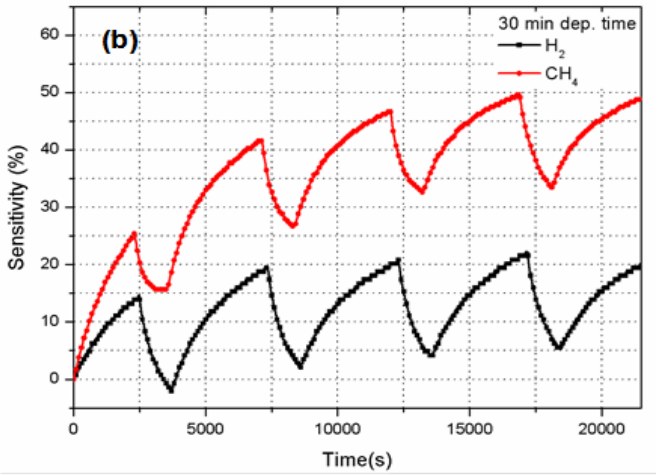
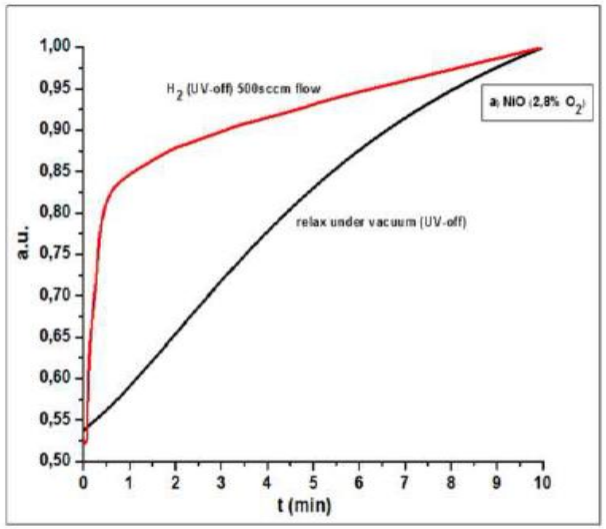


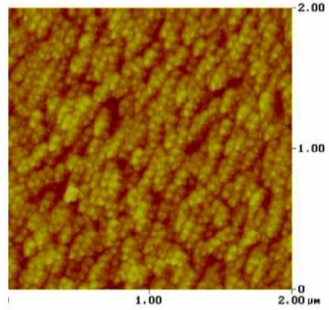
Fig.5



NiO and NiAlO films by DC Sputtering sensing 100ppm H_2@RT

Fig.1





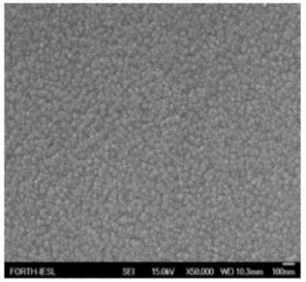


Fig.2

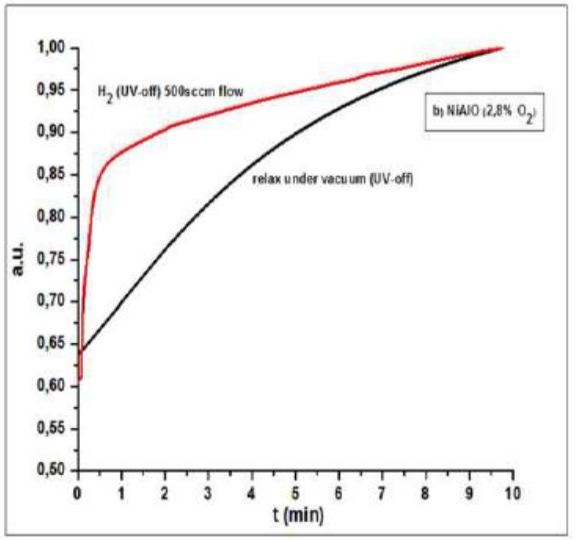


Fig.3

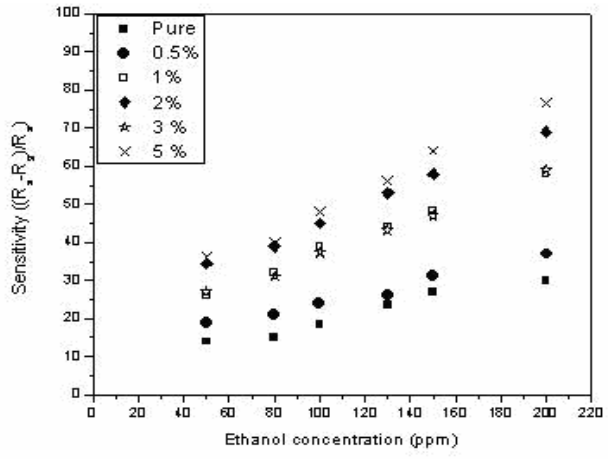


Fig.4

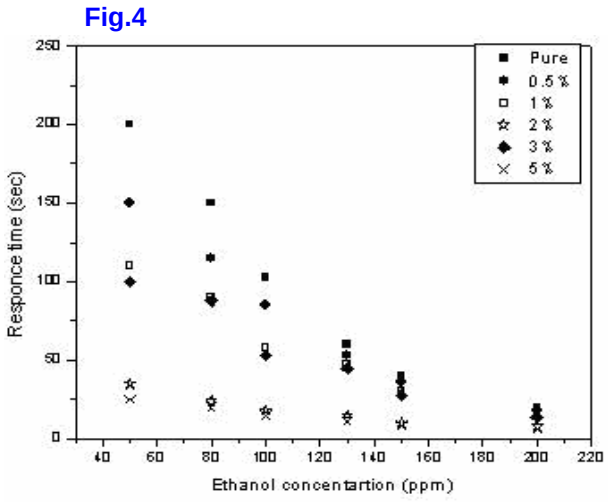
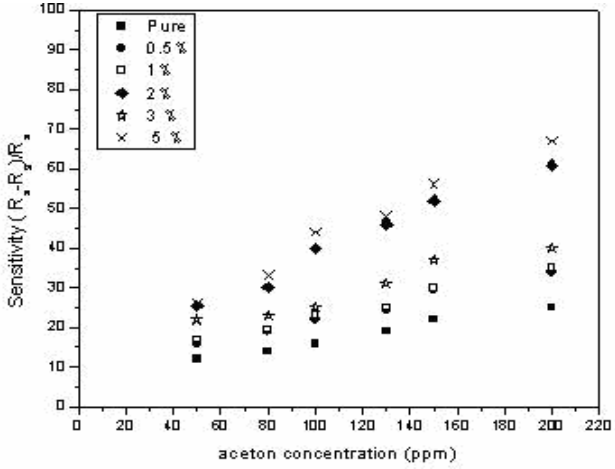
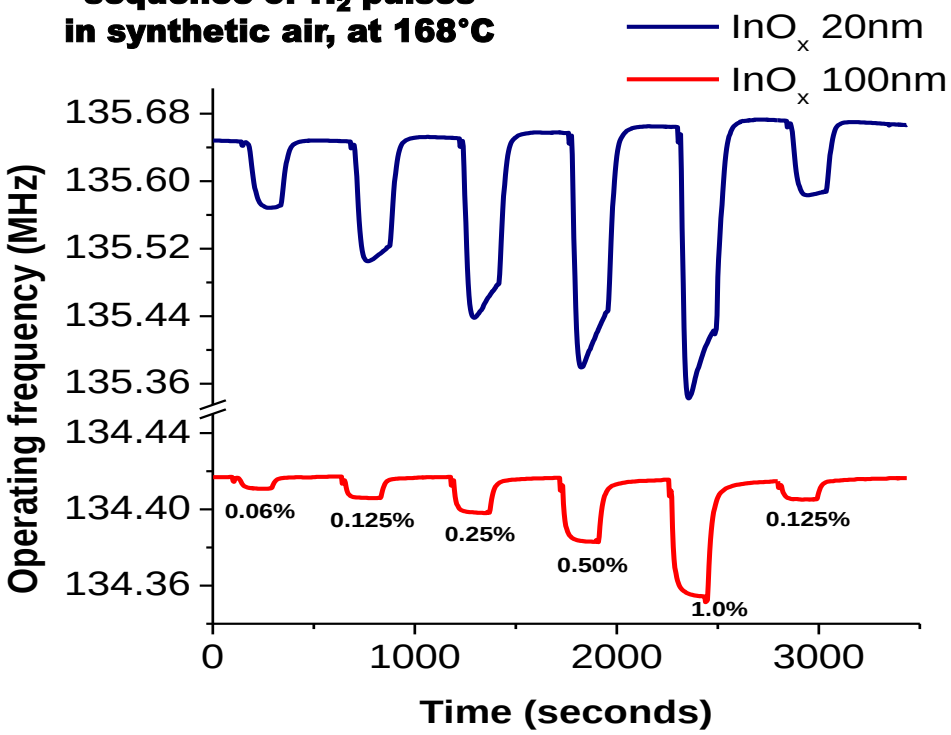


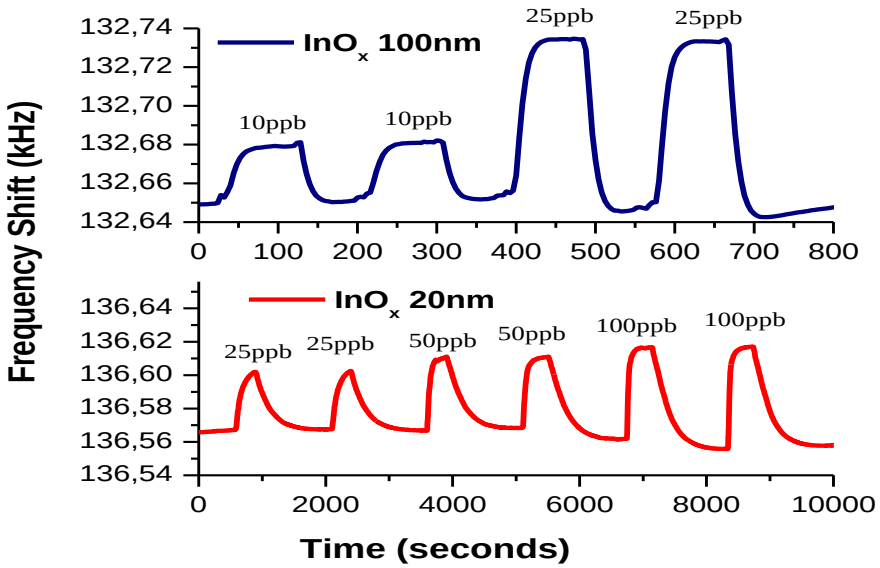
Fig.5



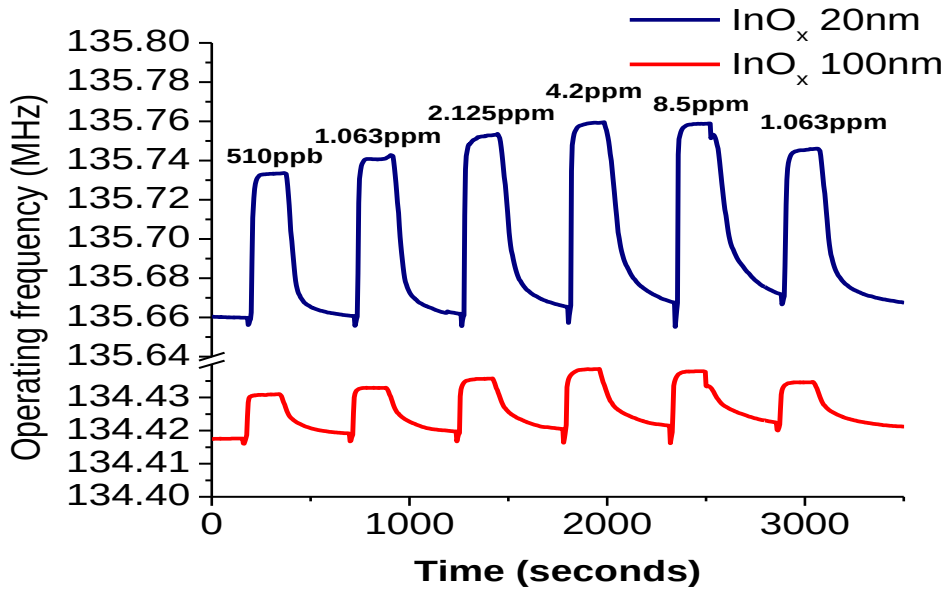
Low F SAW tests

sequence of H_2 pulses in synthetic air, at 168°C





sequence of NO_2 pulses in synthetic air, at 168°C



sequence of O_3 pulses in synthetic air, at 168°C

FORTH/TCM Research Facilities

Metal Oxides as Gas Sensor deposition techniques

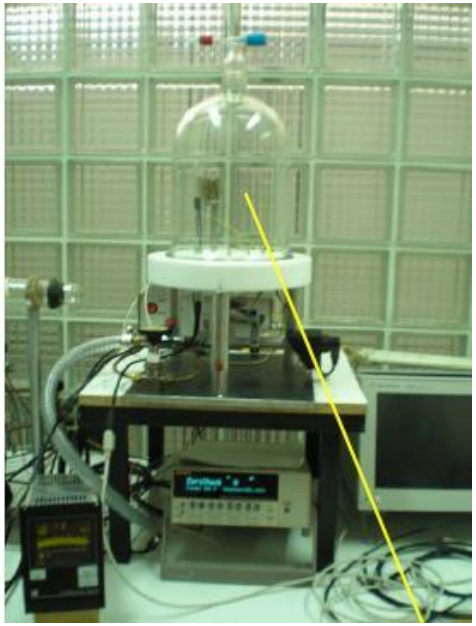
DC and RF Magnetron Sputtering, Aerosol Spray Pyrolysis, Sol-Gel (Spin-Coating, Dip-Coating), Thermal Evaporator, Aqueous Chemical routes (Hydrothermal)

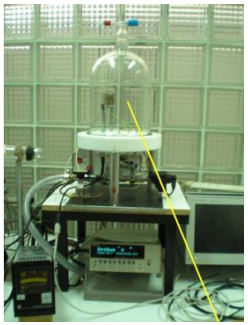
Characterization Techniques

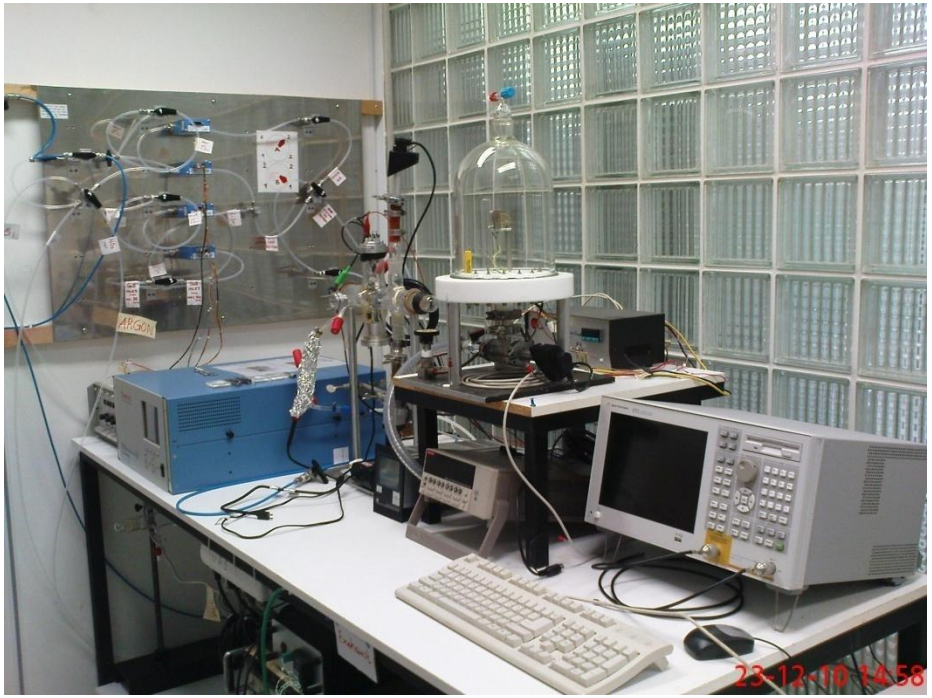
XRD,AFM, SEM, HRTEM, UV-Vis, Electrical Properties (Hall-Seebeck), Gas Testing Station

Gas Sensing Techniques

- Conductometric RT, f(t)
- SAW (Surface Acoustic Waves/ Low-high f)







cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Future Priorities research prospects

- Best practices for applying state-of-art surface science techniques to oxide nanostructures as a new class of gas sensors (Spray Pyrolysis, Hydrothermal, etc…).

- Understanding in depth processes of those low-cost MOs nanostructures deposition techniques, such as:

✓ Metal nucleation and growth

✓ Molecular adsorption and following changes in surface morphology

✓electronic structure with repeated adsorption/desorption cycles at the present of different gases

✓P-type vs n-type gas sensing

✓ Conductometric vs SAW (low vs high f response)

Innovations for future research

Low-cost fabricated metal oxides nanostructures demonstrating low gas detection limits of indoor air pollutant (CH_4, HCHO, VOCs, Ozone, CO_2,) at RT