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

COST Action TD1105

WGs & MC Meeting at SOFIA (BG), 16-18 December 2015

New Sensing Technologies for Indoor Air Quality Monitoring: Trends and Challenges

Action Start date: 01/07/2012 - Action End date: 30/04/2016 - Year 4: 1 July 2015 - 30 April 2016

CVD-GROWN NANOMATERIALS FOR HIGHLY SELECTIVE NO_2, H_2S OR H_2 SENSING

Eduard Llobet

Sub-WG Leader: Carbon nanomaterials

Universitat Rovira i Virgili / Spain

eduard.Llobet@urv.cat

COST EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

EUNETAIR

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

COST is supported by the EU Framework Programme

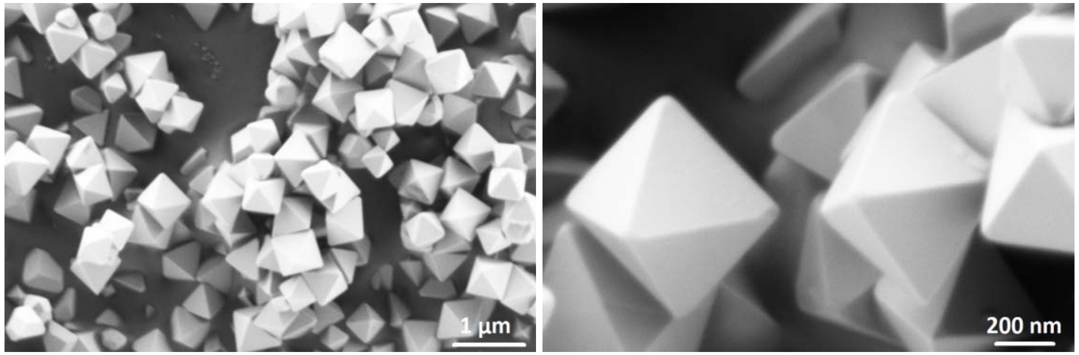
ESF provides the COST Office through a European Commission contract

Outline

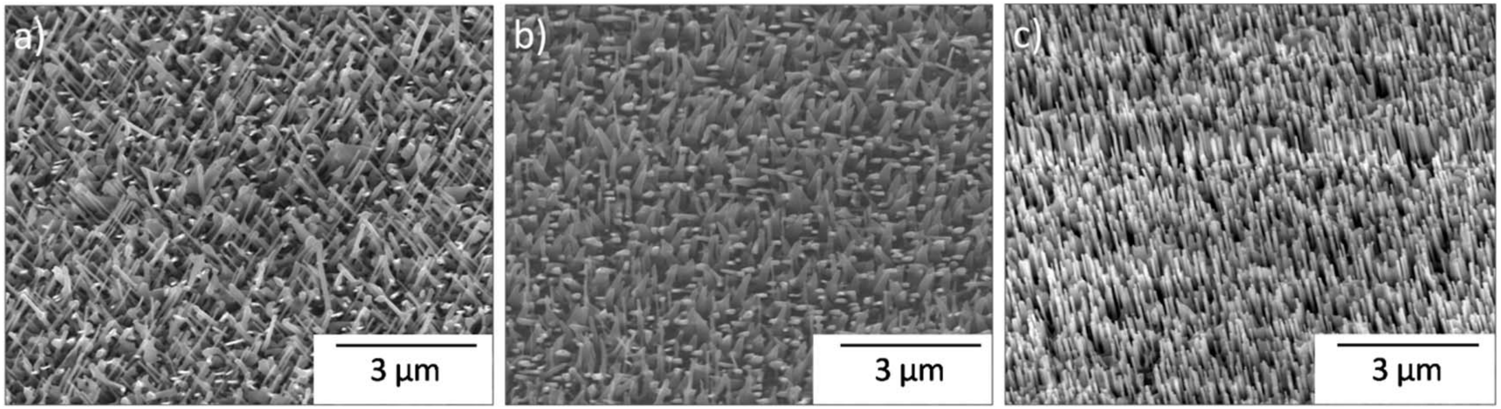
- CVD growth of metal oxide nanomaterials
  - Nanomaterial vs target species (NO_2, H_2S, H_2)
- Coupling of NMs to transducer platform
  - Direct growth vs. transfer
  - Placing electrodes
  - Results (response, selectivity and mechanisms)
- Conclusions

CVD: VS or VLS growth of nanomaterials

- **CVD requires high temperatures (≥ 850ºc), VLS**



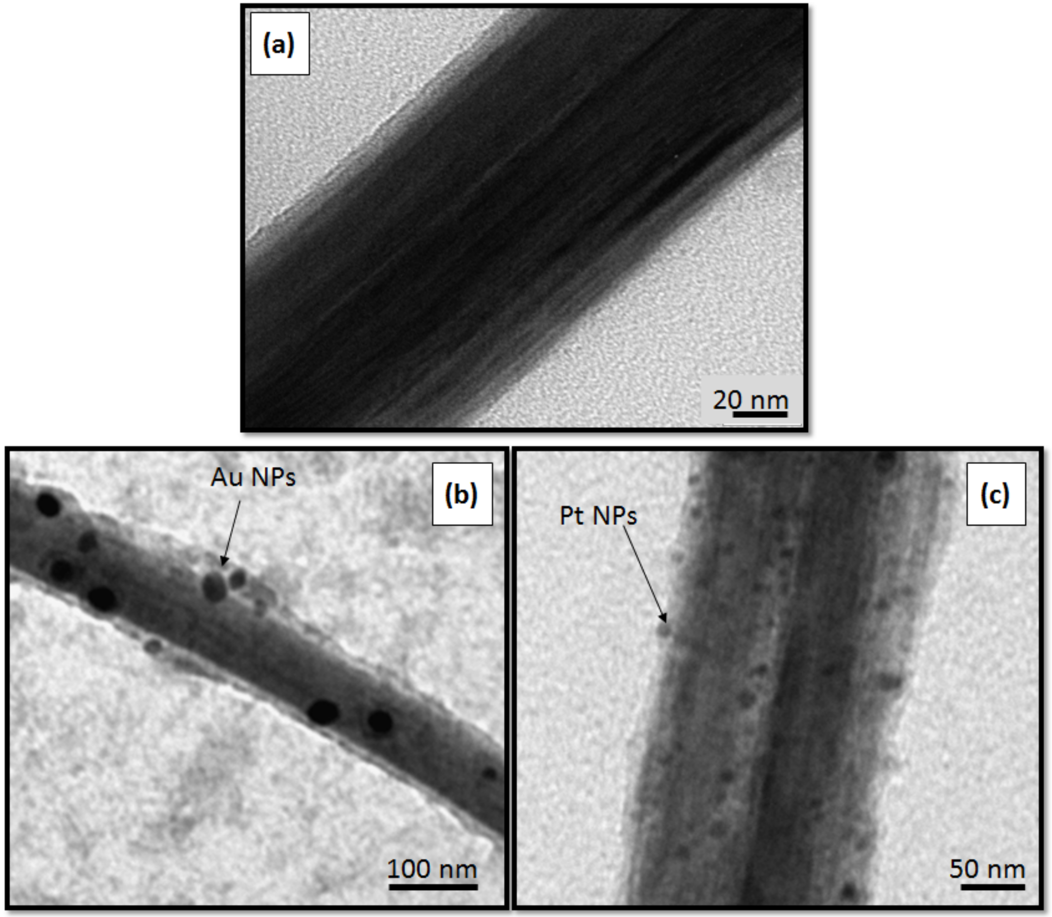
In_2O_3



ZnO NWs grown over a) c-, b) r-, and c) a-planes of sapphire

CVD: VS or VLS growth of nanomaterials

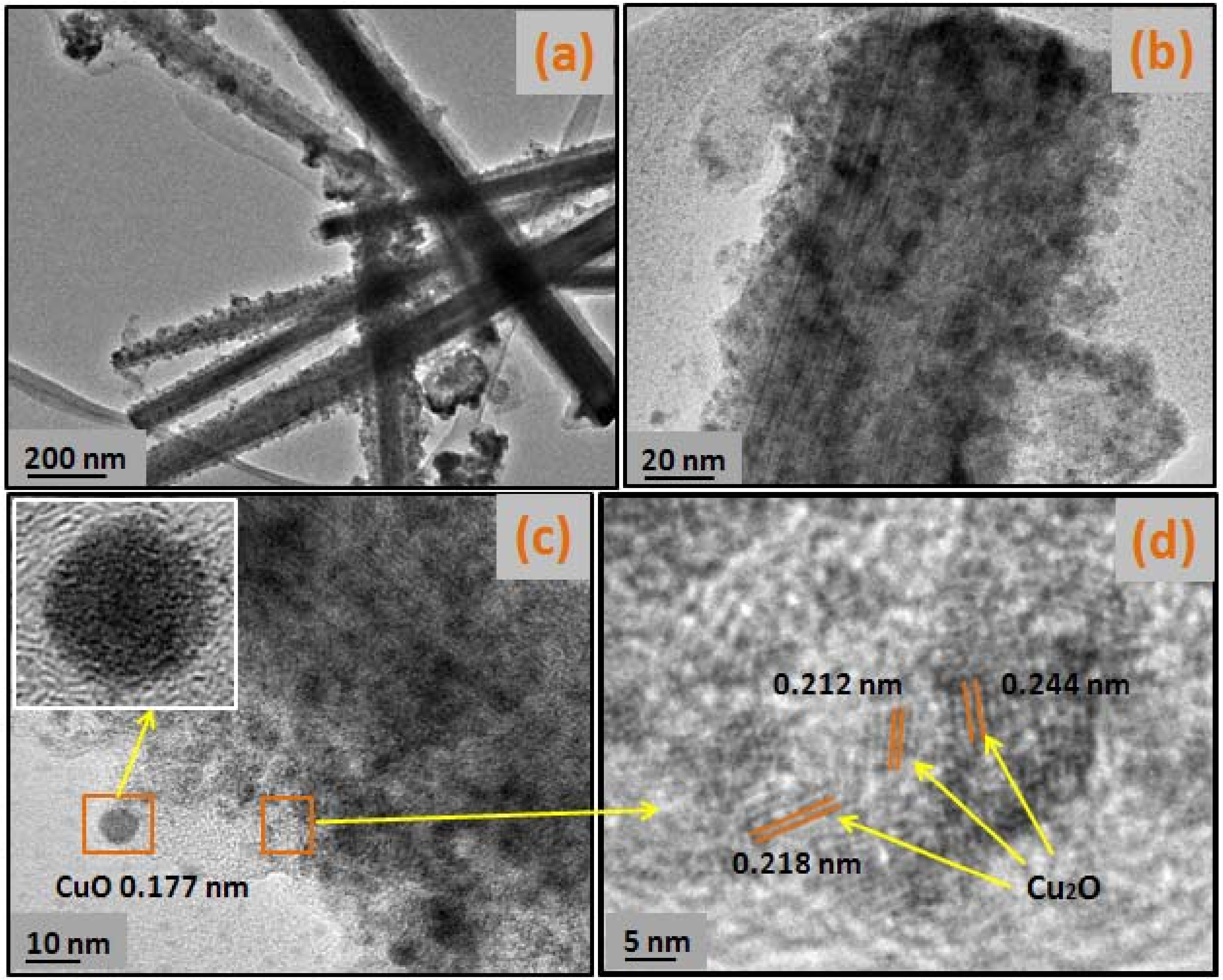
- **AA-CVD requires moderate temperatures (≤ 500ºC), VS**



WO_3 NWs pure or decorated with Au or Pt NPs

CVD: VS or VLS growth of nanomaterials

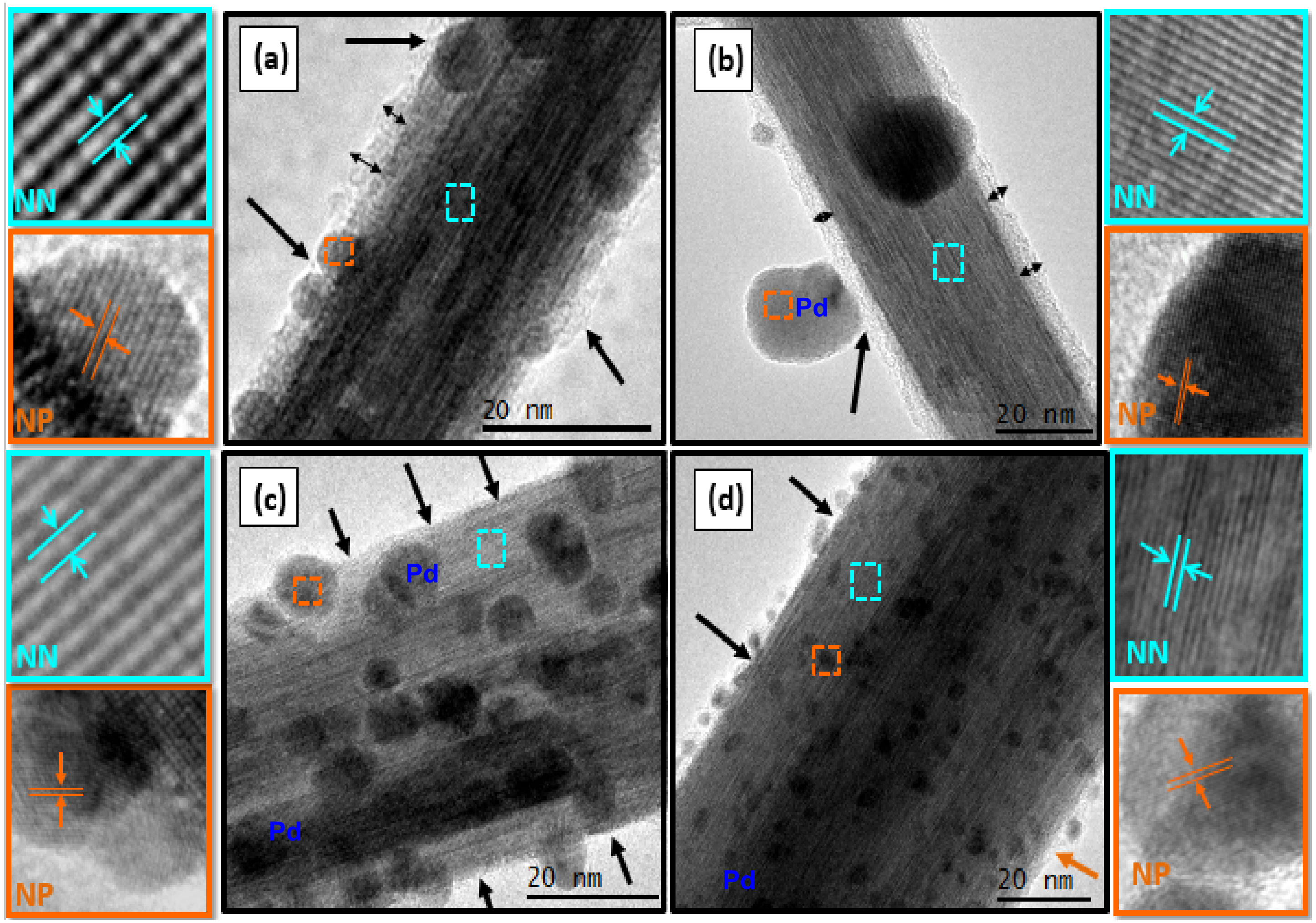
- **AA-CVD requires moderate temperatures (≤ 500ºC), VS**



WO_3 NWs decorated with copper oxide NPs

CVD: VS or VLS growth of nanomaterials

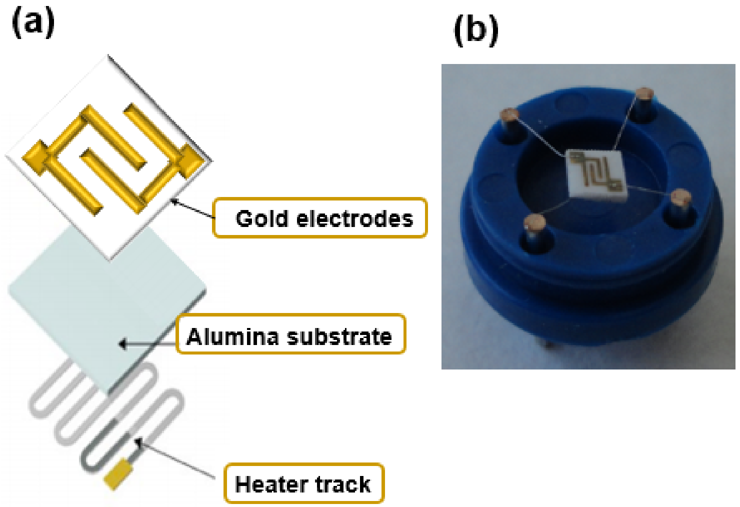
- **AA-CVD requires moderate temperatures (≤ 500ºC), VS**

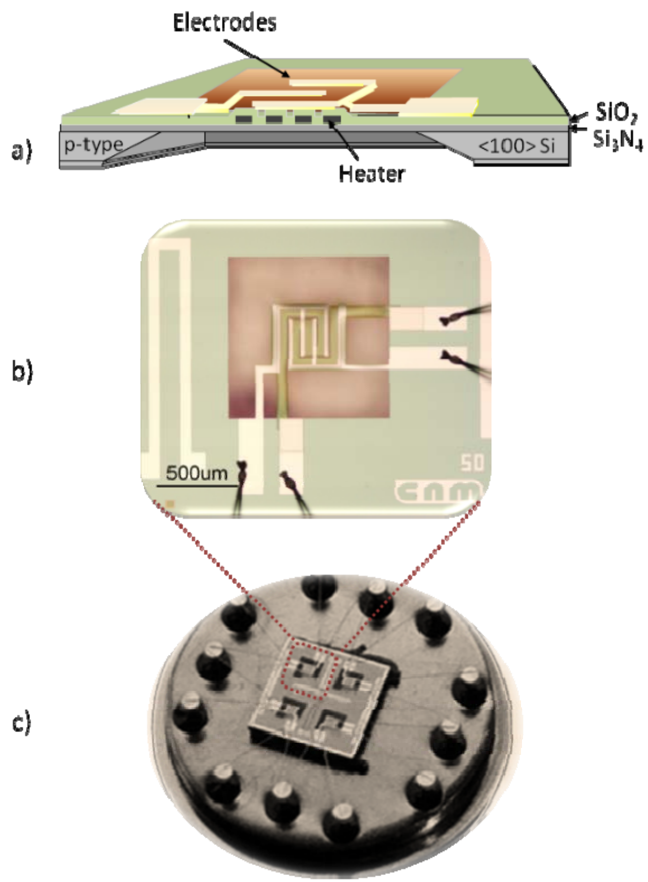


WO_3 NWs decorated with Pd NPs

Coupling of NMs to transducer

- Direct growth of nanomaterials can be done only when the temperature is compatible with the integrity of the transducer.
- High growth temperatures imply the use of transfer techniques.

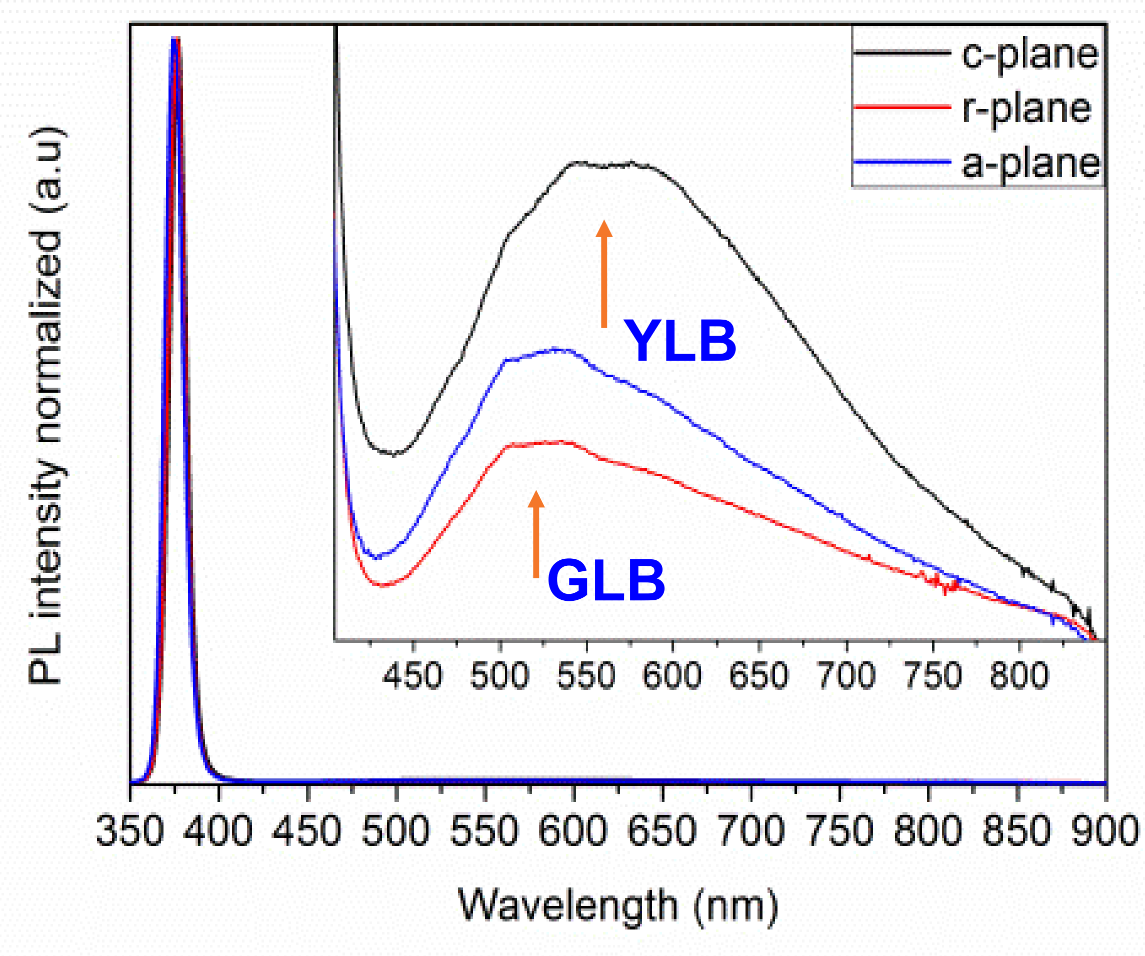


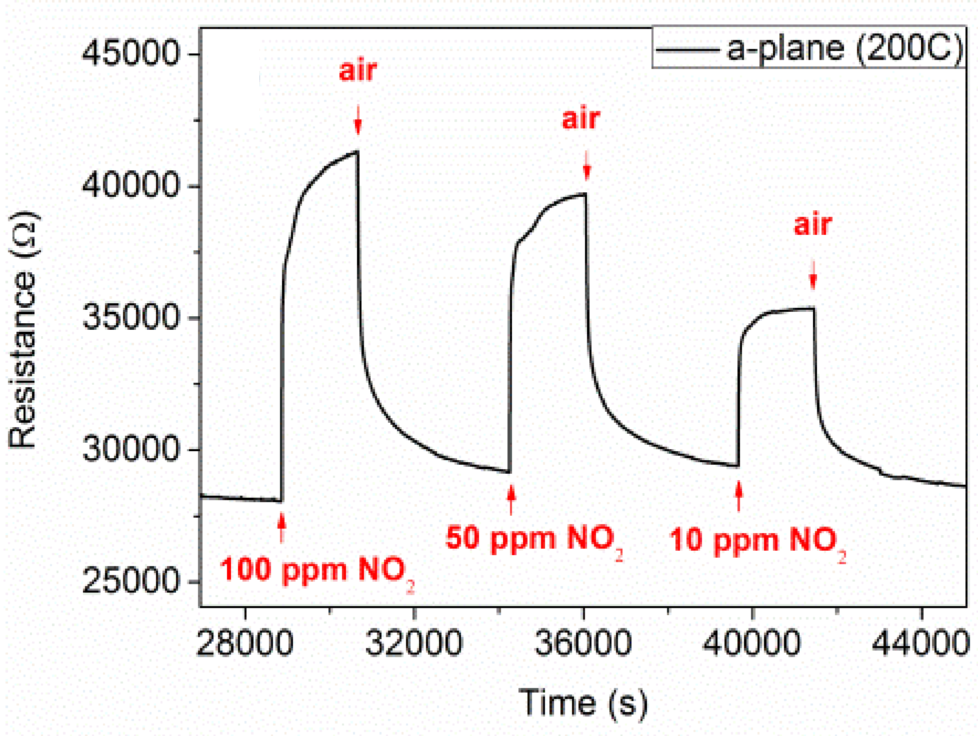


Direct growth possible provided T≤ 500ºC

Coupling of NMs to transducer

- Different orientations of ZnO NWs result in different types of defects. Gronw by VLS method. Au NPs used as catalyst.

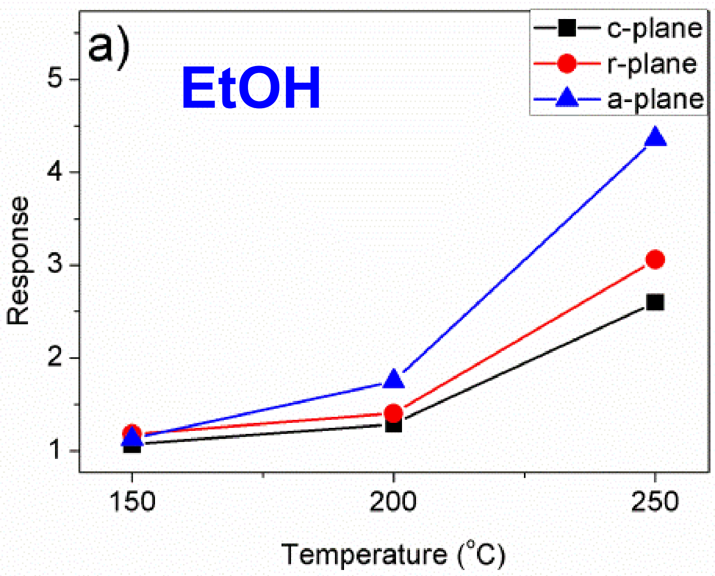


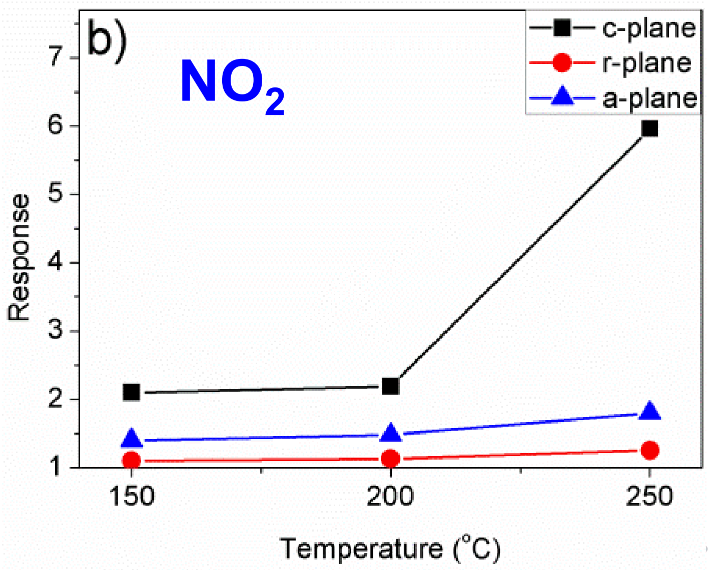


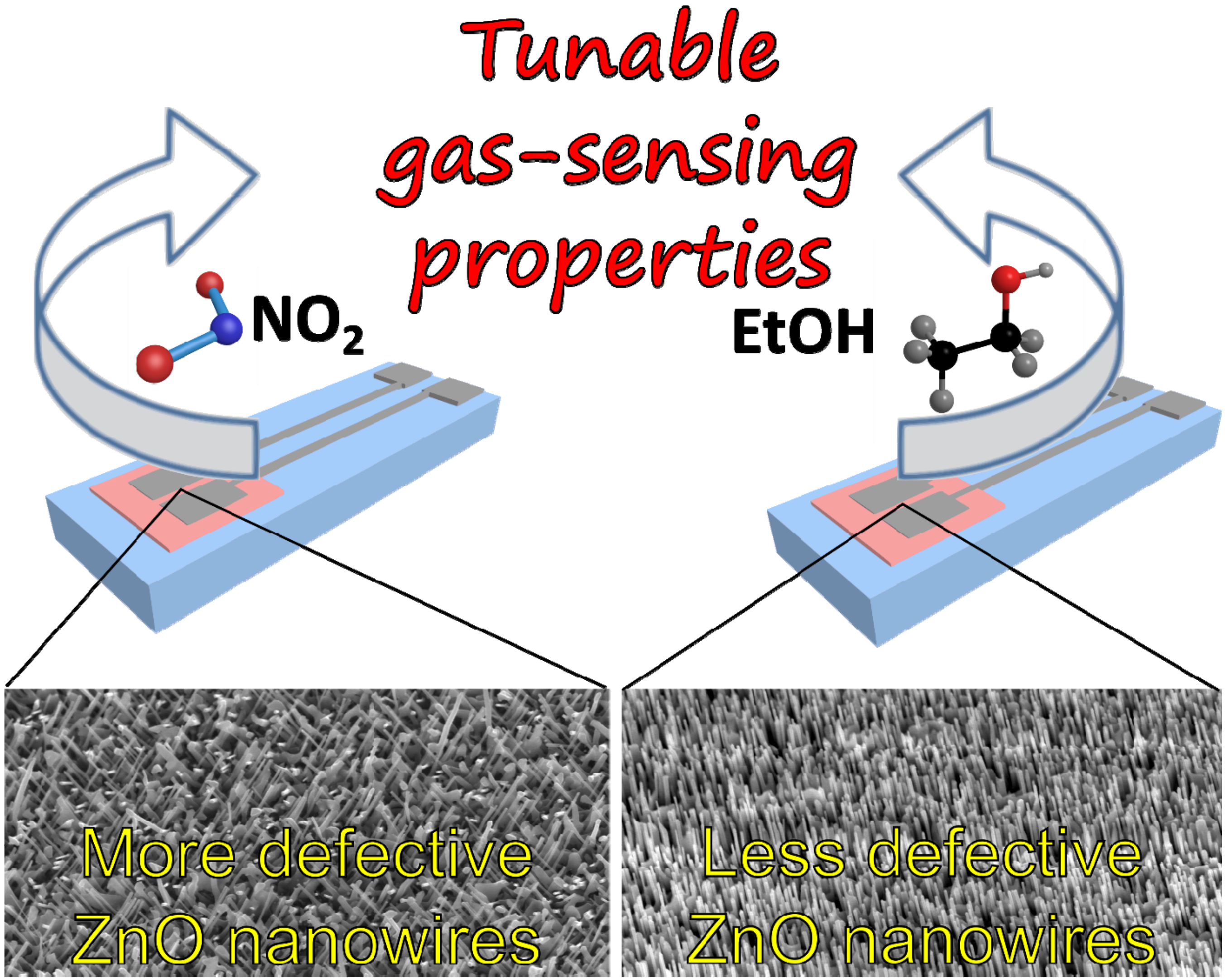
Electrodes patterned on top

Coupling of NMs to transducer

- Different orientations of ZnO NWs result in different types of defects.

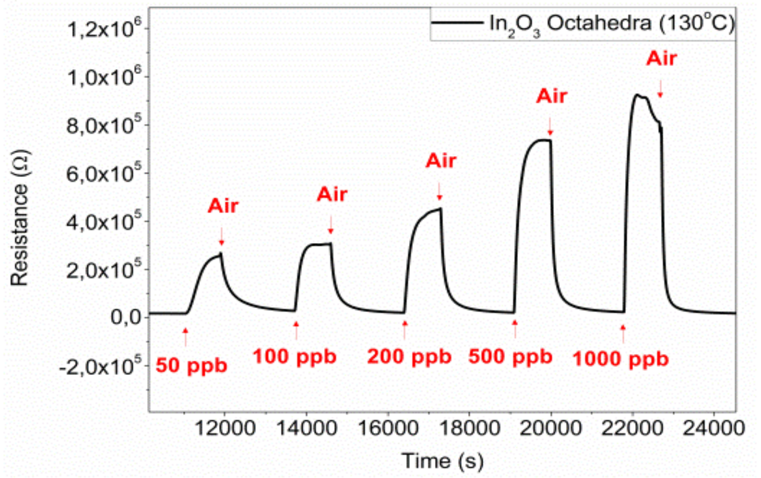


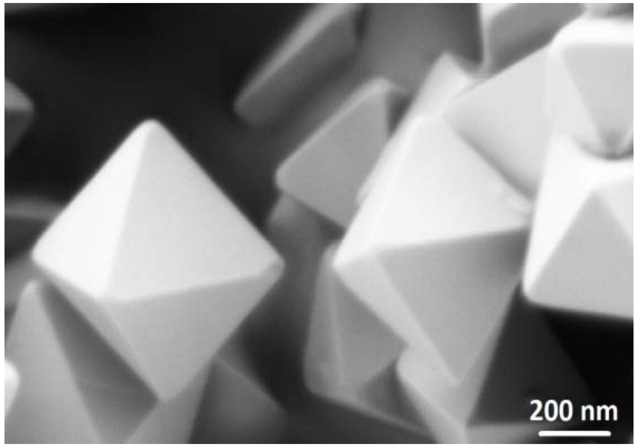




Coupling of NMs to transducer

- In_2O_3 nano-octahedral grown by VS at 800ºC. Then screen-printed onto alumina transducer.

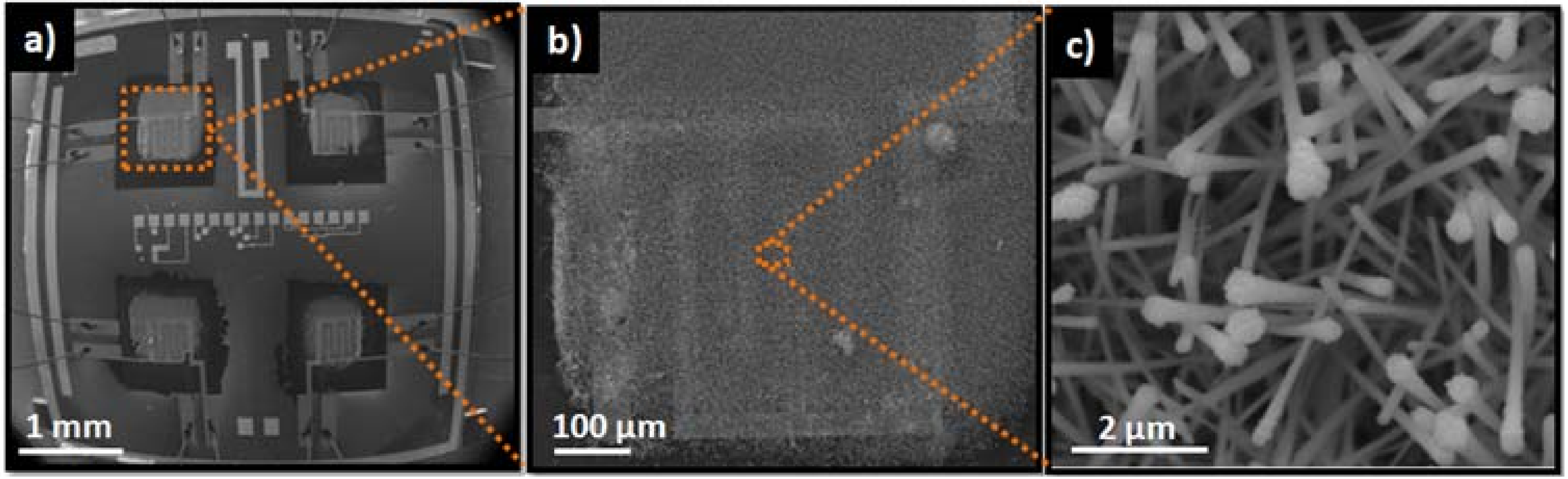


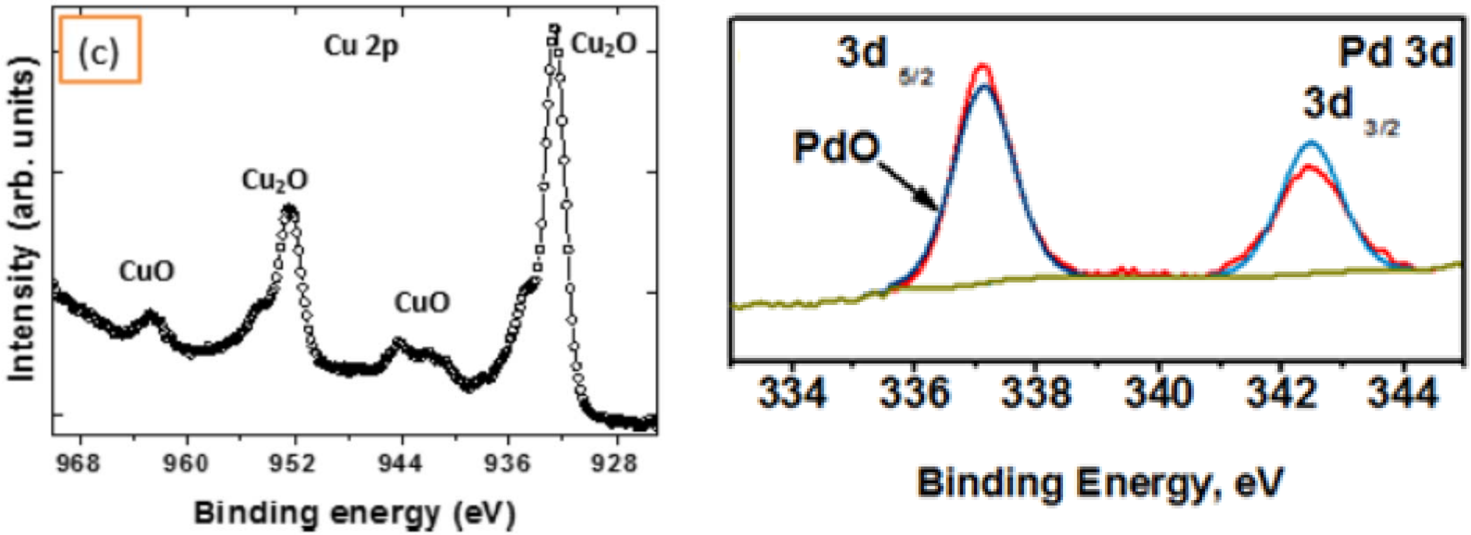


H_2

Coupling of NMs to transducer

- WO_3 NWs (pure or metal loaded) grown by VS at 380 to 500ºC onto MEMS transducers.

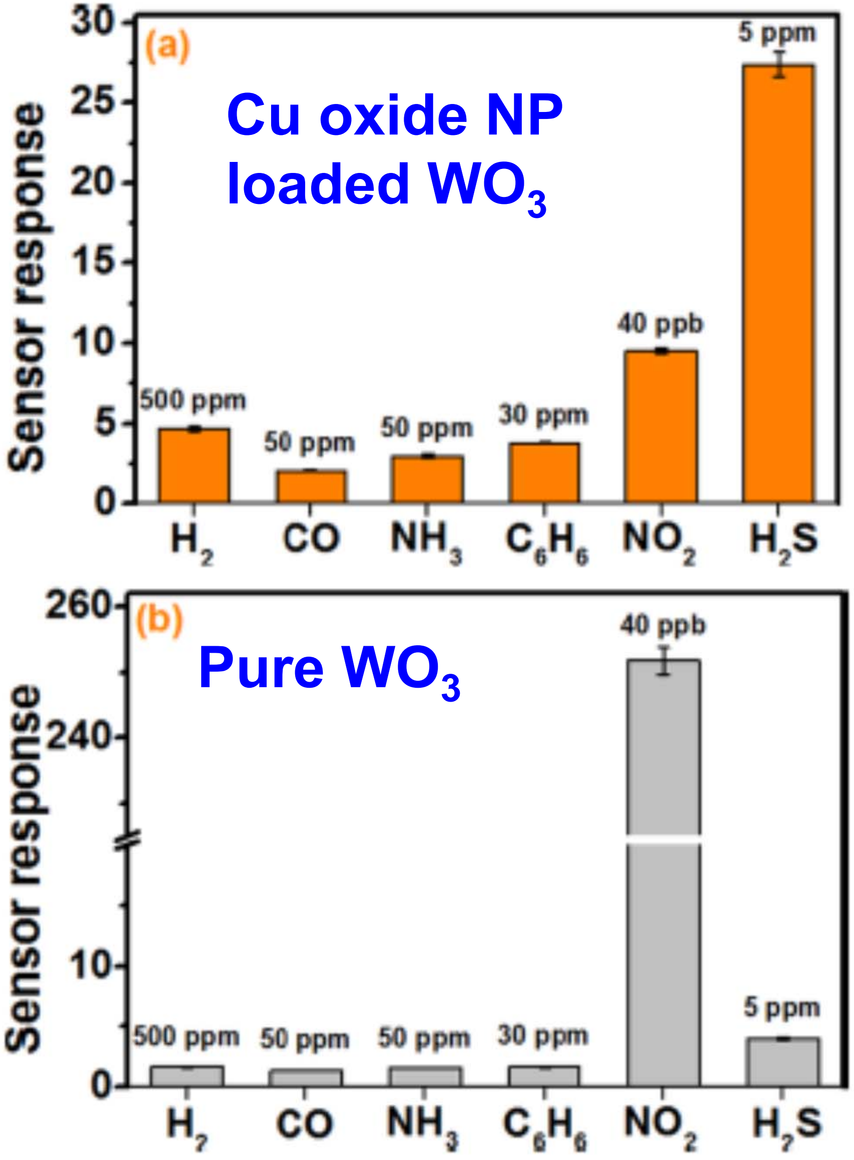


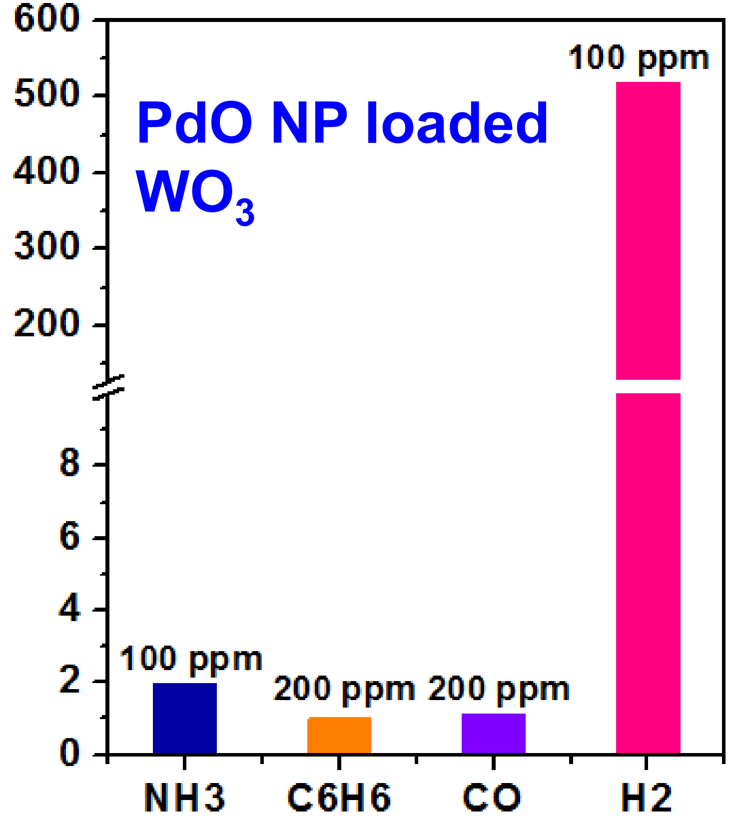


Cu or Pd oxide NP loaded

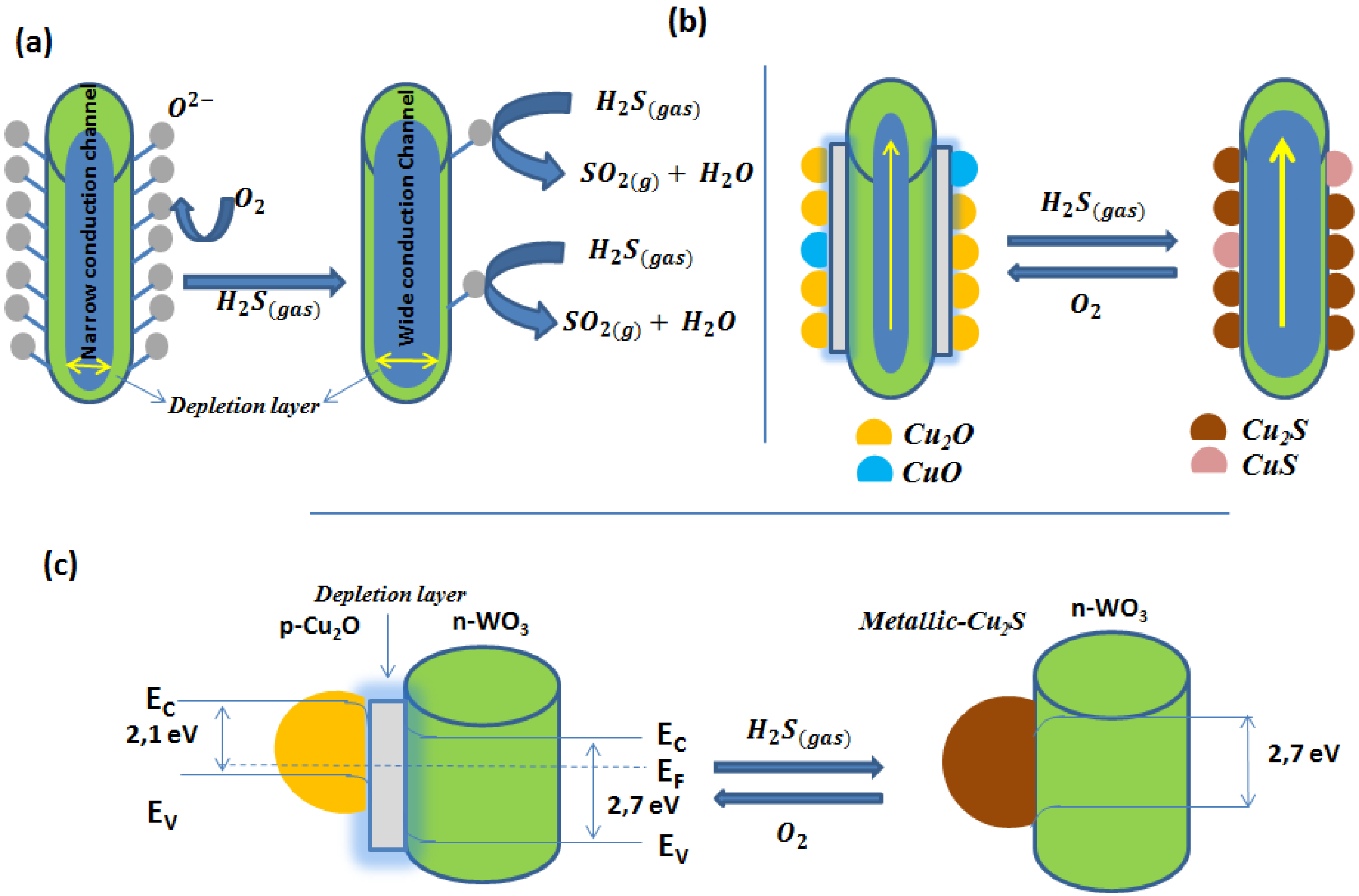
Selectivity analysis

- WO_3 NWs (pure or metal loaded) grown by VS at 380 to 500ºC onto MEMS transducers.

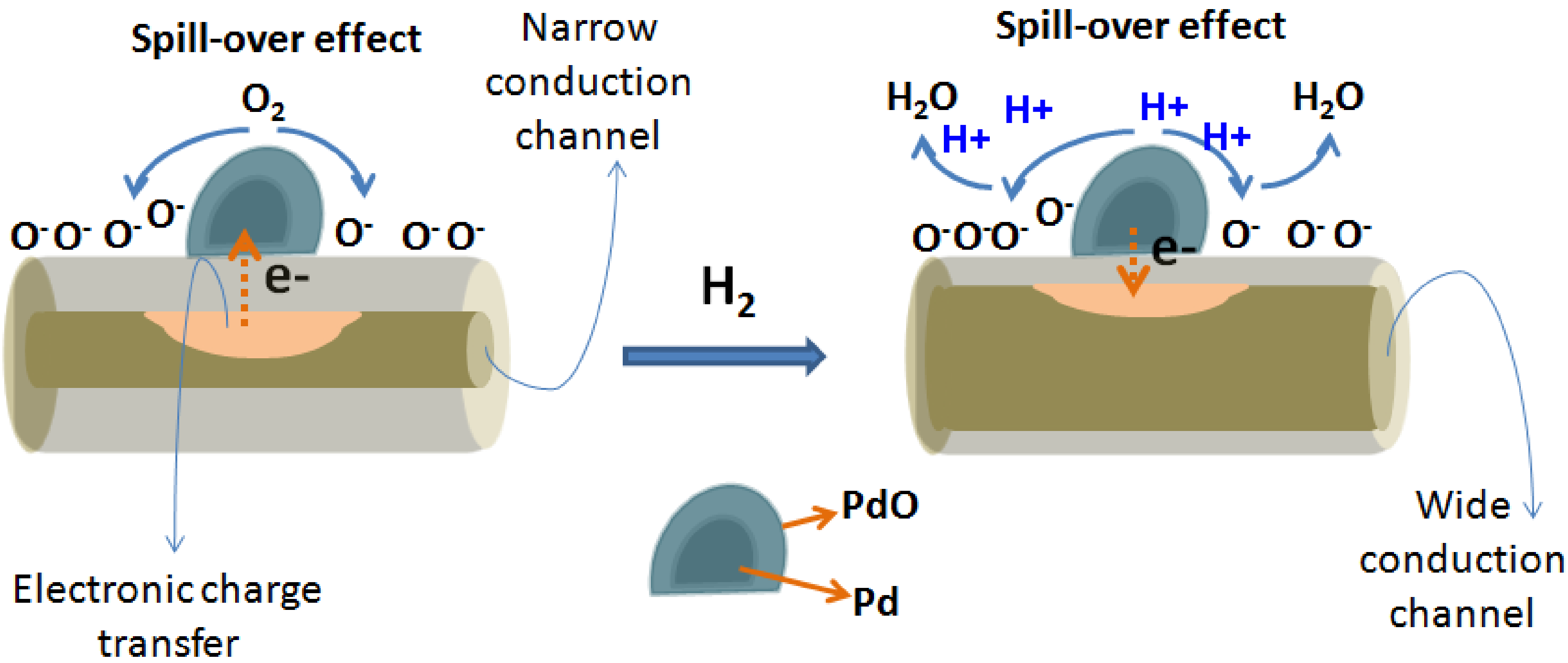




Detection mechanisms



Detection mechanisms



Conclusions

- CVD enables the growth of a wide range of single crystalline NMs with different morphologies

- The integration of these NMs into transducers not always simple

- Engineering of defects may be a way for tailoring sensitivity and selectivity

- Some niche solutions exist for the selective detection of H_2S, H_2 and NO_2 (if we filter out O_3).

Acknowledgements

Sergio Roso

Fatima E. Annanouch (former PhD student)

C. Bittencourt, UMONS, Belgium

P. Umek, JSI, Slovenia

C. Cané, I. Gràcia, IMB-CNM-CSIC, Spain

C. Blackman, UCL, UK

S. Vallejos, BUT, Czech Republic

***Funded by*:**

- **ICREA Academia Award**
- **MINECO grant no. TEC2012-32420**
- **NATO under the Science for Peace Programme grant no. SPS 984511**
- **Autonomous Government of Catalonia grant no. 2014 SGR 1267.**
- **European Science Foundation grant COST TD-1105 'EuNetAir'**
- **European Commission, H2020 Project 'TROPSENSE'**