PANEL on ALLSENSORS

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Trends and Challenges in using Micro and Nano-technologies for (all)Sensors

Moderator:

Sandrine Bernardini, Université d'Aix-Marseille, France

Panelists:

Almudena Rivadeneyra-Torres, Institute for Nanoelectronics, Technical University of Munich, Germany

Antonio Valente, INESC TEC, Portugal

Sandrine Bernardini, Université d'Aix-Marseille, France

Institut Matériaux Microélectronique Nanosciences Provence

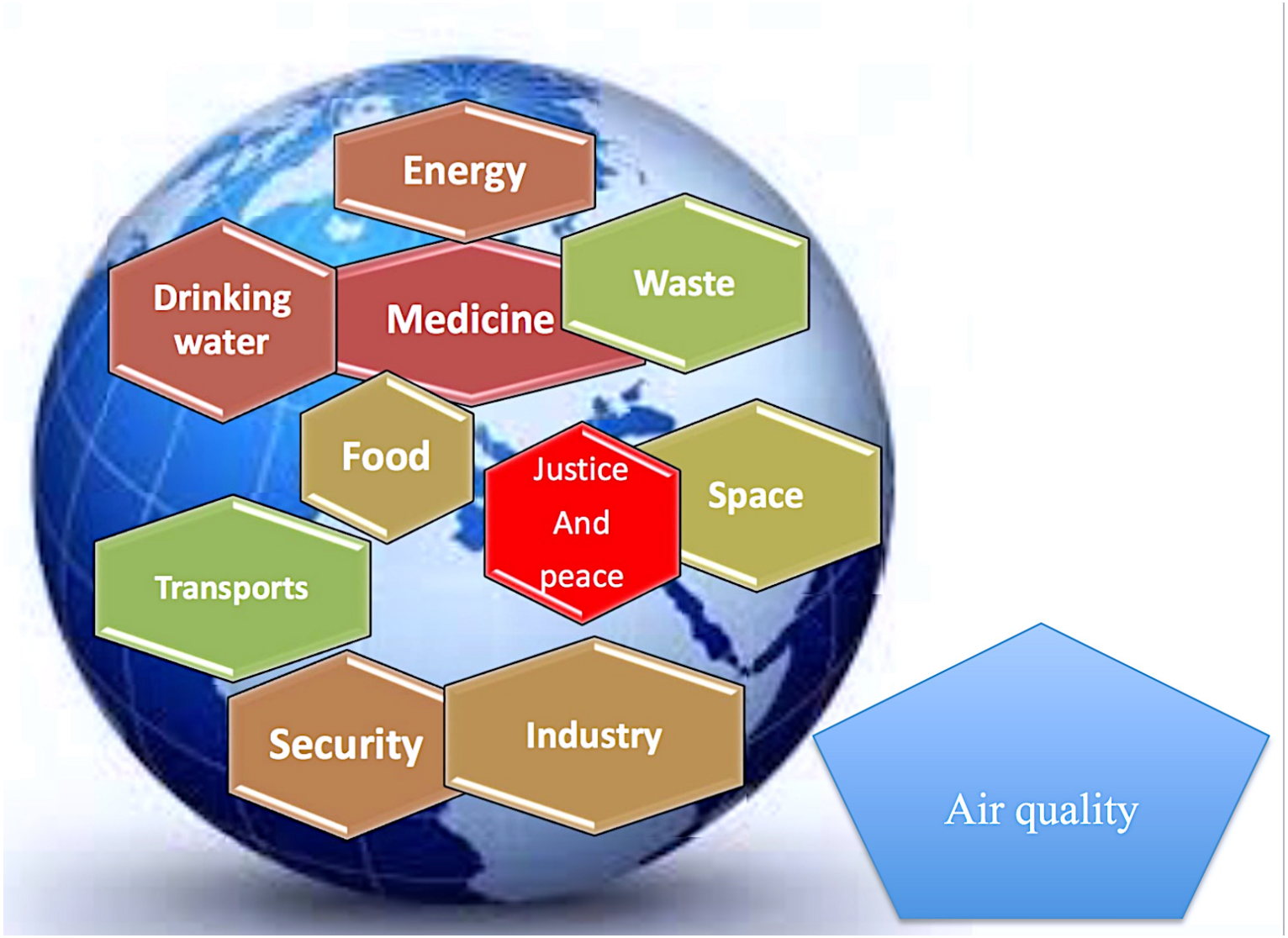
sandrine.bernardini@im2np.fr

Definition

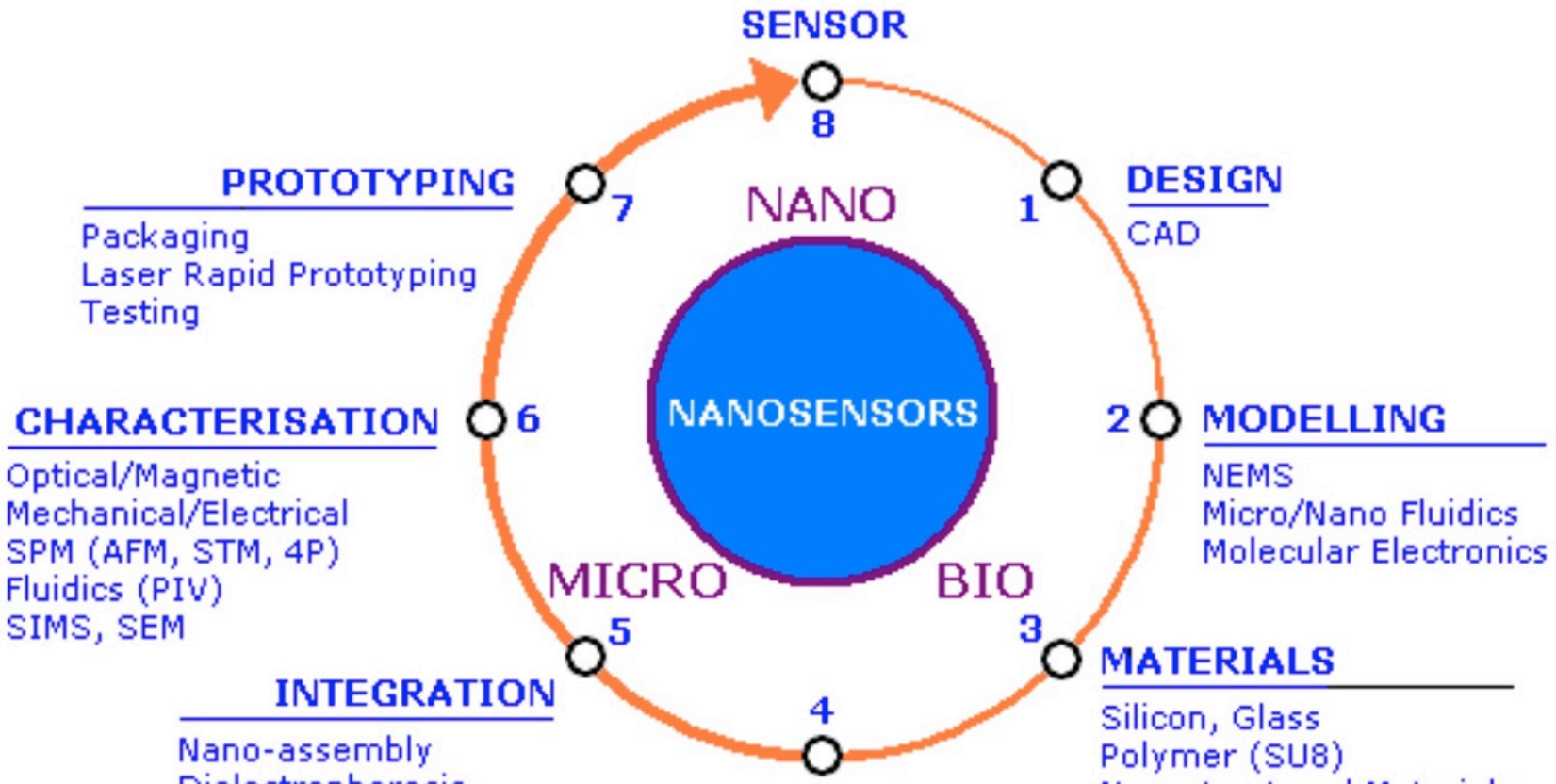
Sensors are solid state devices with the capacity of reading the state of the ambient inside and/or outside of a living body and its variations in time and space domain.

The scope is to dialogue with the state in order to get information, measure, store, process and communicate data

Applications



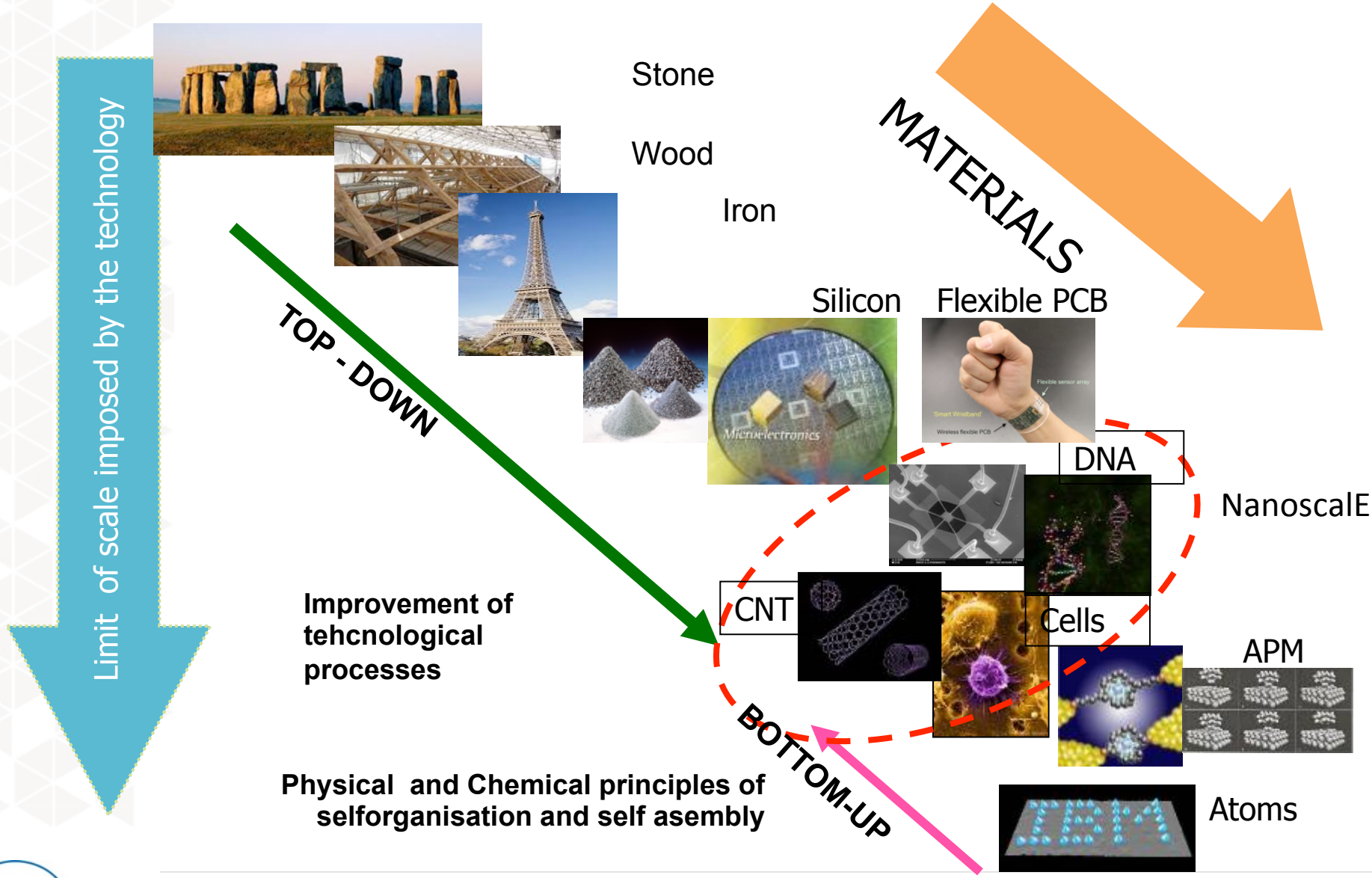
Sensor fabrication steps



Pr. A D'AMICO

Eurosensors school 2017-Paris

The technology evolution



Trends and chalenges in using Micro and Nanotechnologies

Almudena Rivadeneyra-Torres, Institute for Nanoelectronics, Technical University of Munich, Germany

Future aspects and main challenges of printed electronics for sensor technology

Antonio Valente, INESC TEC, Portugal

Using Micro Sensors for the Internet of Things in Agriculture

Sandrine Bernardini, Université d'Aix-Marseille, France

MOX Sensor Trends

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MOX Sensor Trends

Sandrine Bernardini, Université d'Aix-Marseille, France
MCI group

sandrine.bernardini@im2np.fr

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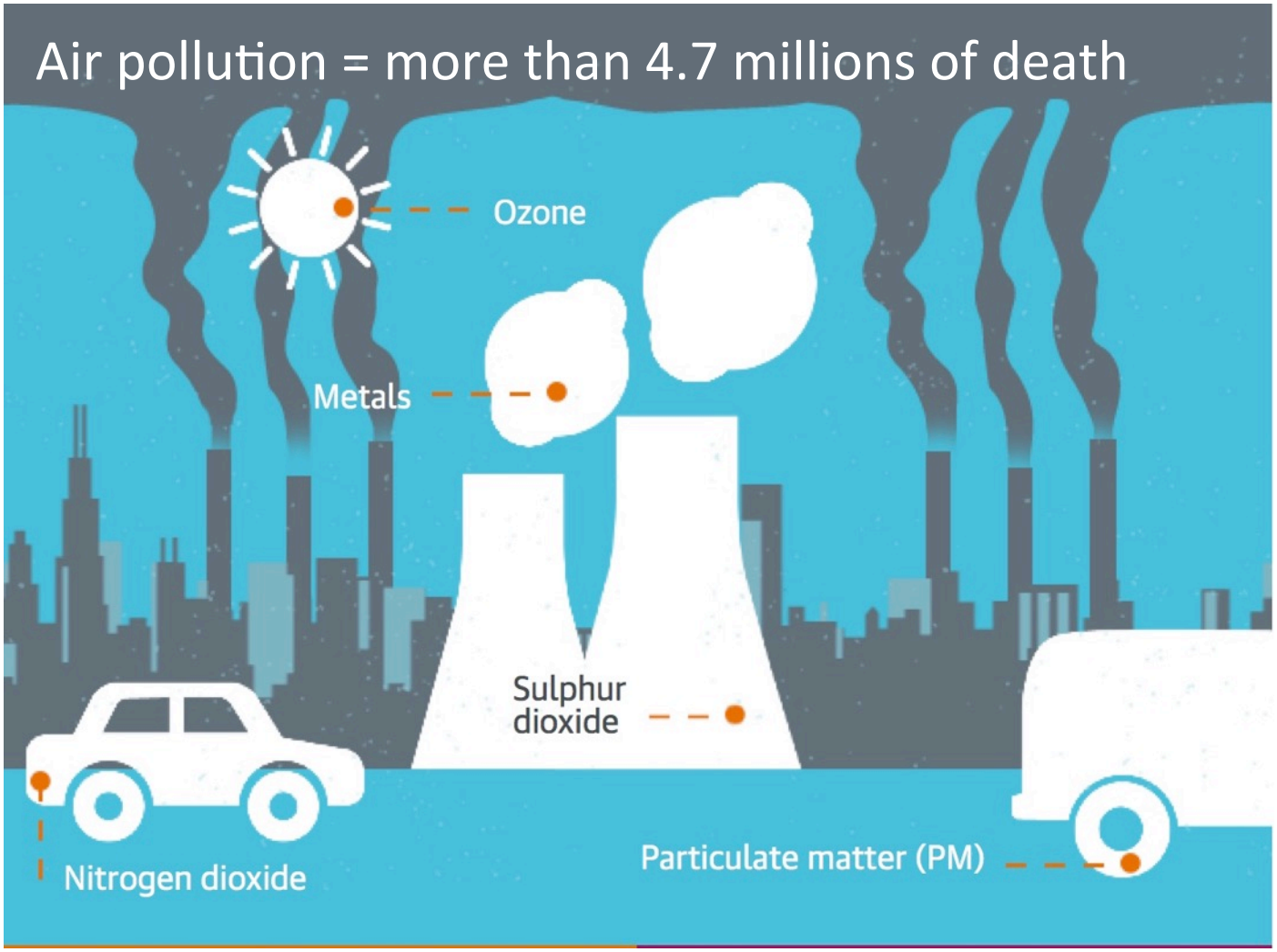
OUTLINE

- Gas sensor Market
- Research trends

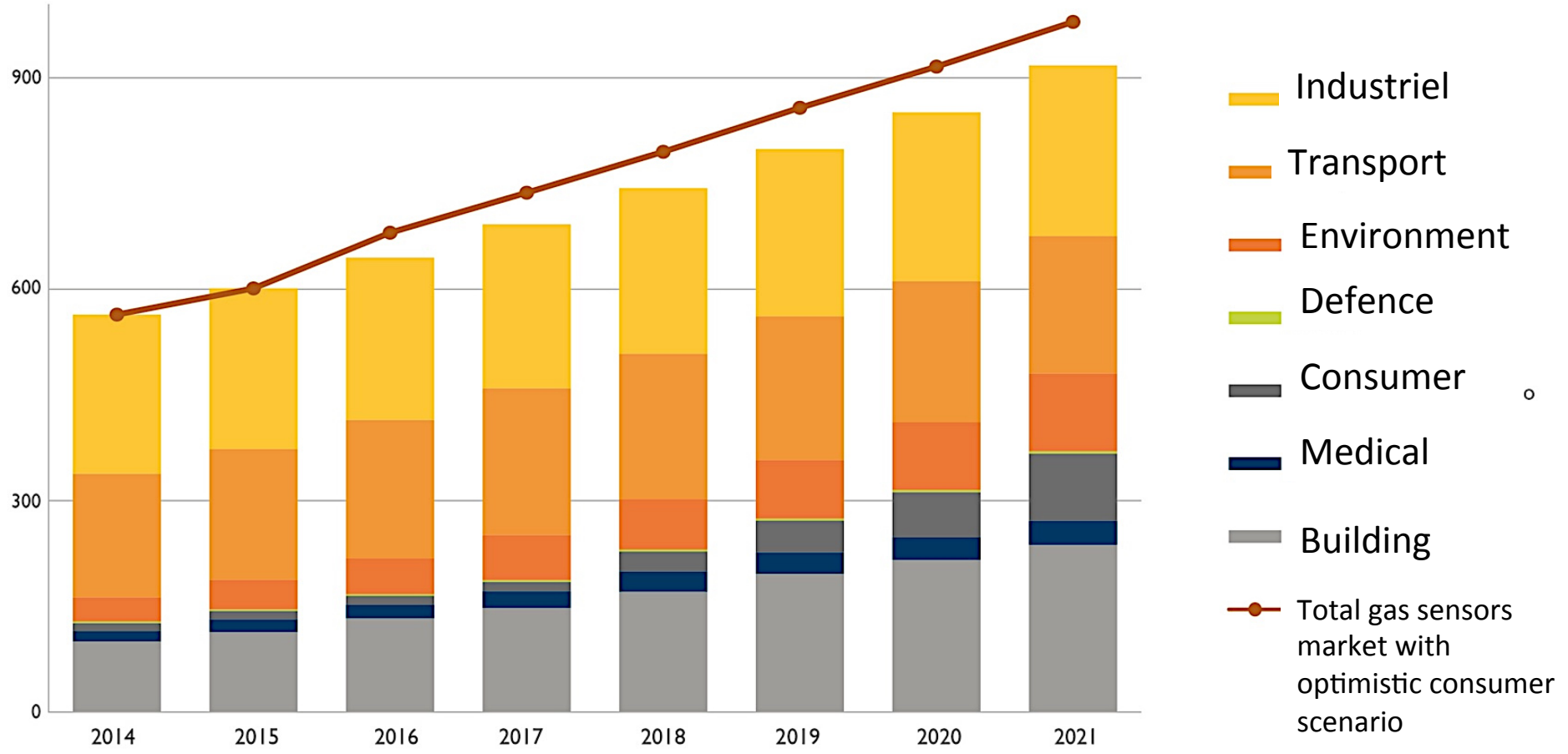
Pollution


Air pollution = more than 4.7 millions of death
Ozone
Metals
Sulphur dioxide
Nitrogen dioxide
Particulate matter (PM)

Forecast

2014-2021 gas sensors forecast - In US$ million value

(Source: Gas Sensor Technology and Market Report, February 2016, Yole Développement)



Most important markets : China, US, Germany

Advantages of MicroSensors

Traditional environmental monitoring methods:

- Are expensive (>$15,000-50,000 per unit)
- Require trained personnel to interpret data
- Require regular maintenance
- Analyse a very limited sample of air
- Are often poorly positioned: on top of buildings/ away from people
- Have low spatial coverage

Spectroscopy, Chromatography

Micro - sensors are:

- ✓ Low cost (< $10 per unit)
- ✓ Low power (< 30 mW)
- ✓ Small (< 10 mm^3)
- ✓ Easily integrated into a wide range of products

Manufacturers:

markets gas sensor solutions

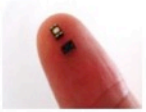
- Figaro (Japon)

  - Leader mondial
  - Plateforme suspendue
  - Consommation MEMS 15mW
  - Chauffage Platine (stabilité long terme)
- SGX / Amphenol (Europe)

  - Micro plateforme silicium
  - Principal fabricant Européen
  - Consommation MEMS 80mW, nouveau design PT 60mW
  - Chauffage Poly silicium (PT en 2017)
- New manufacturers
  - Bosh Sensortec *

  - Sensirion*

  - Cambridge Sensors Ltd (tungsten heater)

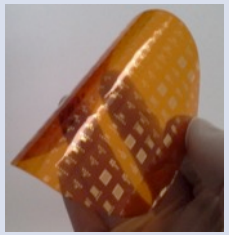
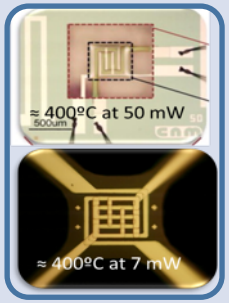
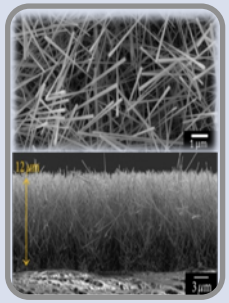
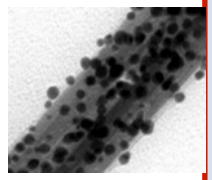


  - AMS AG (34mW)

Austria

Trends in MOX gas sensing

MOX

Low cost	Low power consumption	Ambiant T	High sensitivity	Low working T, High stability	Improve selectivity
Flexible substrates Upilex (up to 400ºC)	Bulk µ-machining of Si substrates	Light	N-structured MOX (High S/V ratio)	Use of metal N-particles	Use of sensor arrays
					

RENATECH : French Network for nanofabrication

https://www.renatech.org/en/

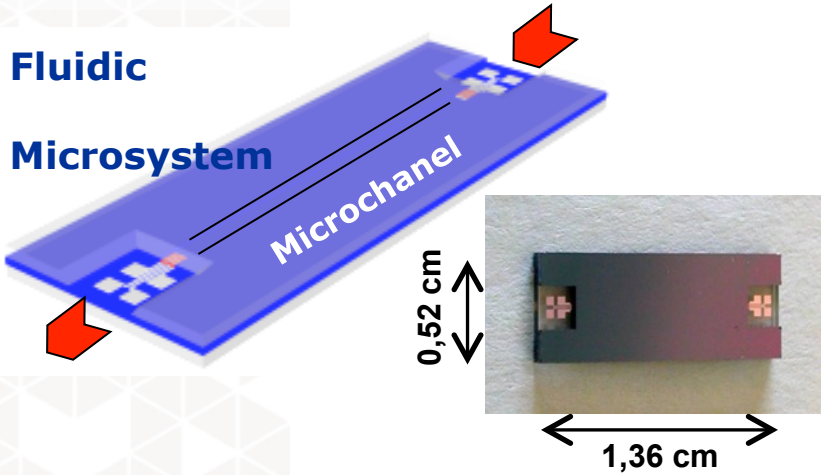
7300 m²
of clean rooms

150
clean room
engineers et technicians

130 M€
of equipement

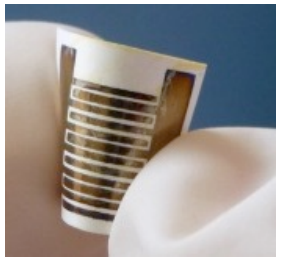
Trends in MOX gas sensing at IM2NP

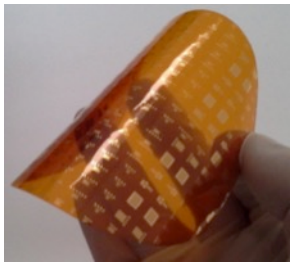
Fluidic Microsystem



V Martini, et al.
Sensors and Actuators B: Chemical 170, 2012, 45-50

Flexible sensors

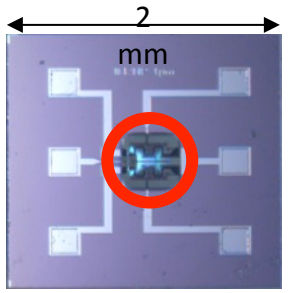




T Fiorido, Sensors and Actuators B: Chemical 151 (1), 2010, 77-82

Miniaturisation

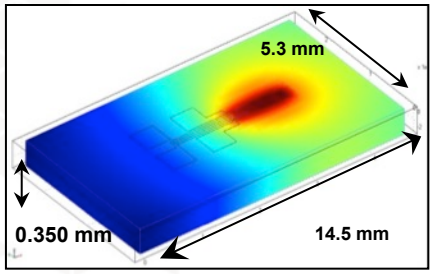
Transducer: 2x2 mm



Active part: 400x400 µm

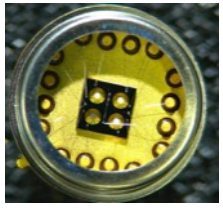
K. Aguir et al., patent N° FR 13 59494,
2013, international extension 2016

MODELISATION THERMOELECTRIC

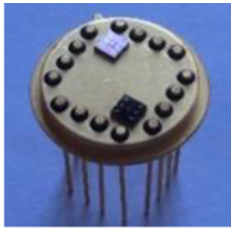


M Acuautla, et al.
Sensors and Actuators B: Chemical 203, 2014, 602-611

Gas Multi-sensors



IM2NP-LAAS



IM2NP

P. Menini et al.,
EurosensorsXXII, 2007

Future

- Gas sensors are/will be met everywhere in the future
- Many technologies have been developed in the last 30 years
- Not big advancements in the market
- Low cost (1 - 10 €), but high repetitivity and life time are necessary
- Ultra low power for portable systems. Microtechnologies
- Nano features are necessary to increase S/V ratio.
- Improvement of sensitivity, selectivity, time response, working temperature
- If low power devices are developd, then:

  - flexilbe sustrates
  - microenergy sources: harvesting ?...

Future aspects and main challenges of printed electronics for sensor technology

Almudena Rivadeneyra

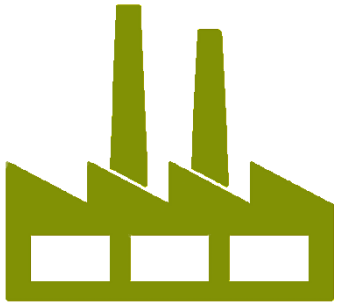
Institute for Nanoelectronics
Technical University of Munich
(Germany)

Internet of Things

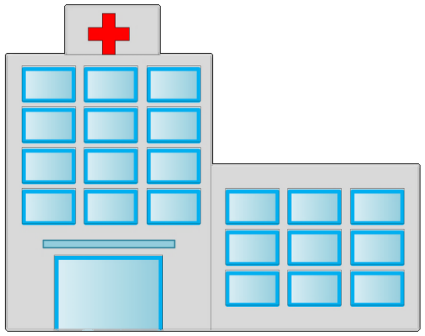
Things connected to Things → possible to access data from a distance and to remotely monitor and control our physical world

Smart environment

Smart cities

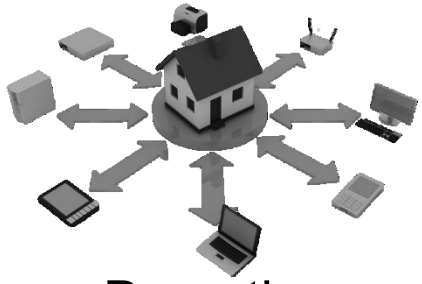


Industrial control



eHealth

Logistics

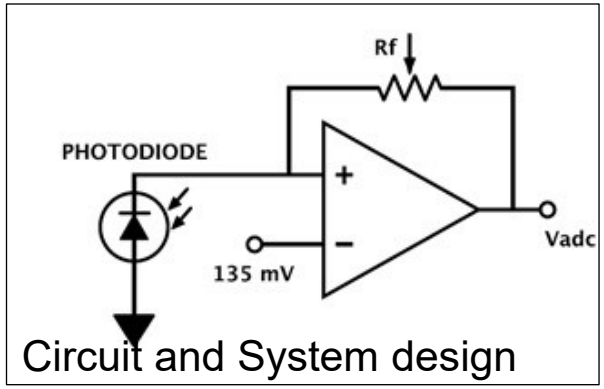


Domotics

from $655.8 billion in 2014 to $1.7 trillion in 2020

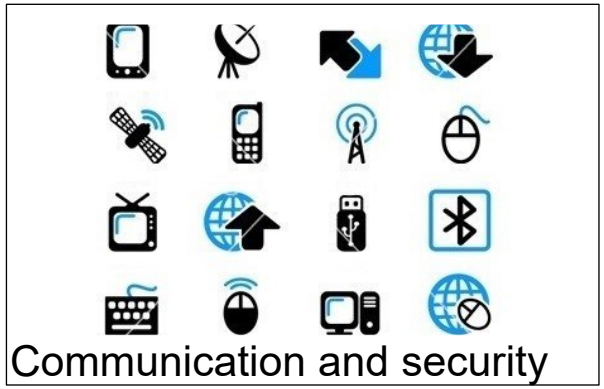
IoT Dimensions

Sensors



Circuit and System design


Big data processing


Communication and security

Sensors in the IoT

- Wide spectrum of parameters to be covered — light, radiation, pressure, acceleration, temperature, gases, humidity, blood pressure, heart rate...
- Rapid increase in the number of sensors: In 2020, **25 Billion** connected "Things" will be in use

- Desirable features: Low-cost, green electronics, low power consumption

Sensors Technology

Silicon technology

Conventional IC-CMOS technology

- ✓ Miniaturization
- ✓ IC integration
- ✓ Well-established

- x Technology cost
- x Fabrication conditions
- x Sustainability

Printed Electronics

Traditional printing techniques

- ✓ Environmental friendly
- ✓ Large scale: Low-cost and ease of redesign
- ✓ Flexible substrates

- x Size
- x Low performance

Sensors Technology

Silicon technology

Conventional IC-CMOS technology

- ✓ Miniaturization
- ✓ IC integration
- ✓ Well-established

- x Technology cost
- x Fabrication conditions
- x Sustainability

Hybrid electronics

Printed Electronics

Traditional printing techniques

- ✓ Environmental friendly
- ✓ Large scale: Low-cost and ease of redesign
- ✓ Flexible substrates

- x Size
- x Low performance

Open Discussion

Future aspects and main challenges of printed electronics for sensor technology

utad UNIVERSIDADE DE TRÁS-OS-MONTES E ALTO DOURO

Using Micro Sensors for the Internet of Things in Agriculture

Panel on Trends and Challenges in using Micro and Nano-technologies for (all)Sensors

António Valente

University of Trás-os-Montes and Alto Douro :: Science and Technology School :: Engineering Department
and
Institute for Systems and Computer Engineering, Technology and Science – INESC TEC

ALLSENSORS 2018
March 25, 2018 to March 29, 2018 - Rome, Italy

Outline / Sumário

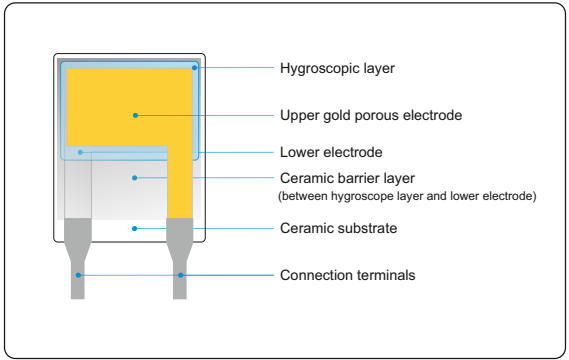
MEMS Applications in Agriculture

Main Parameters in Agriculture

Type	Classes	Parameters
Agricultural Conditions	Environment	Air Temperature Air Humidity Wind Direction Wind Velocity Solar Radiation
	Soil	Soil Moisture Content Water Flux Electrical Conductivity Soil pH Soil Temperature and Thermal Properties
Agricultural Products	Agricultural Crops	Sap Flow Leaf Wetness Fruit Width Stem Width

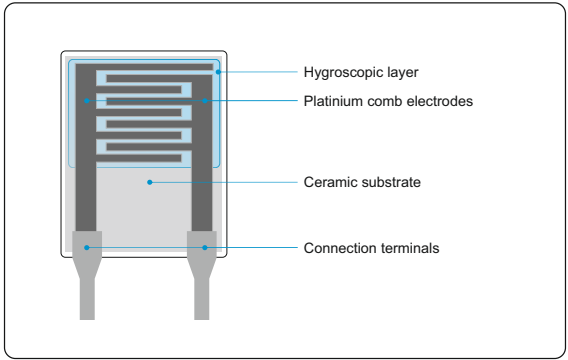
Air temperature and humidity

Capacity type humidity sensor



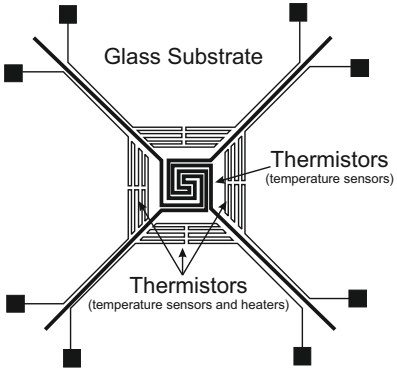
Air temperature and humidity

Resistive type humidity sensor



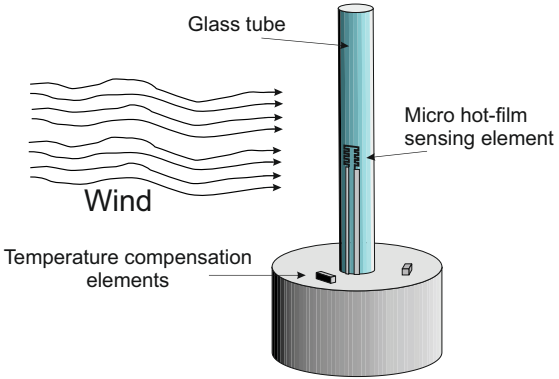
MEMS Wind Sensor

- In-plane thermal wind sensor



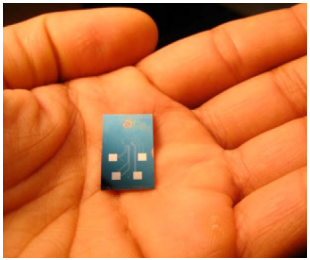
MEMS Wind Sensor

- Out-of-plane thermal wind sensor



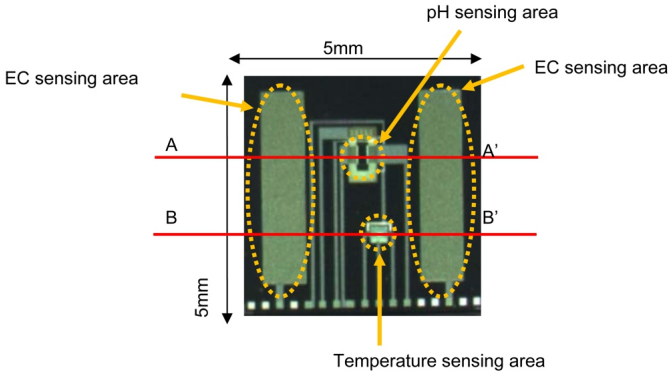
MEMS Water Sensor (leaves)

- Sensor for measuring water potential



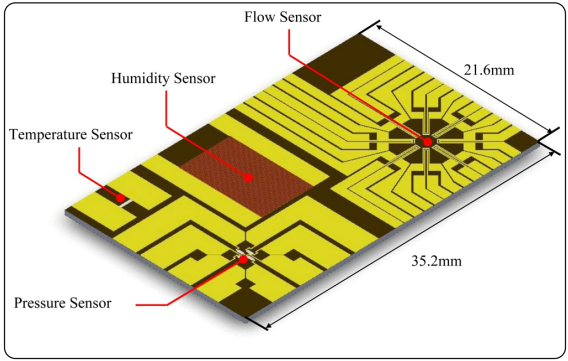
Health Control of Cows

- Sensor chip integrated with EC and temperature sensors



MEMS Weather Monitoring System

- Wireless remote weather monitoring system



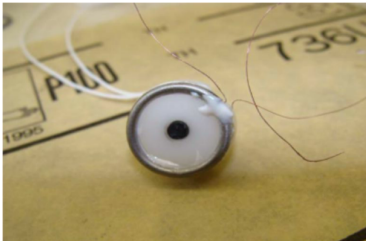
Other sensors

- Steam width sensor

Dimensional problem

Other sensors

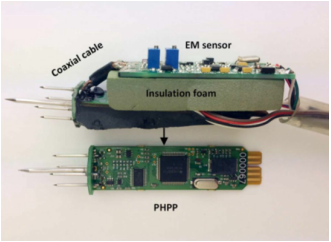
- Soil moisture sensor (Heat-pulse)



Dimensional problem
Power consumption problem

Other sensors

- Soil moisture sensor (Heat-pulse)



Dimensional problem

Other sensors

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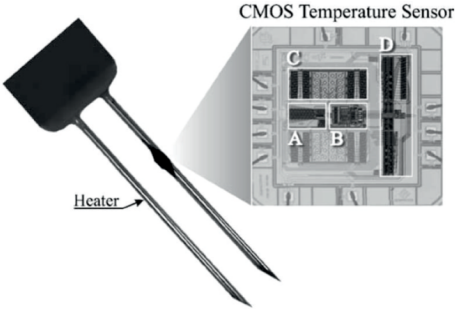

Trying to use micro-electronics

Power consumption considerations

Power consumption considerations

- Sensors for IoT in agriculture must have low power consumption
- Usually MEMS sensor are low power ...
- ... but there are not too many MEMS sensors for agriculture;
- Excluding those that are also used in other areas (eg temperature, humidity, atmospheric pressure ...)

What's the best wireless technology to use?

What's the best wireless technology to use?

- ... of course Low-Power Wide-Area Network (LPWAN)
- Sigfox?
- LoRaWAN?
- NB-IoT?
- Sigfox and LoRa are advantageous in terms of battery lifetime, capacity, and cost...
- ... NB-IoT offers benefits in terms of latency and quality of service.
- and the best, in my opinion, is ...
- LoRaWAN!