# $H_2$ sensor based on Metal Oxide Semiconductor (MOS)

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## Study context

Hydrogen is seen as part of the decarbonized future since it can be produced e.g., by electrolysis powered by renewable energy during off-peak power demand. Once produced, it is aimed to be transported via several ways, among which, a dedicated $H_2$ pipeline (European Hydrogen Backbone) or blended into natural gas (NG) pipelines up to approximately 20% by volume.

**Objective**

Ensure safe operation of the entire H2 value chain infrastructure (electrolyzer, transport, gas turbine) → real-time monitoring of $H_2$ concentration in NG and in air.

**Challenge**

Develop $H_2$ sensors that will work in presence of NG or air (leak detection) with the best possible performance.

## Purpose & method

**Why MOS sensor ?**

Comparative study of different detection technologies such as : acoustic, optical, electrochemical, catharometric, work function, catalytic and **resistive (MOS sensor) [1-4]**

- Advantages: $H_2$ sensitivity and stability in oxidant environment (air), inexpensive technology, easy to produce.
- Disadvantages: tradeoff needed in reductor environment (e.g. diluted in natural gas) among $H_2$ sensitivity AND selectivity AND response/recovery time parameters.

**What performance is needed ?**

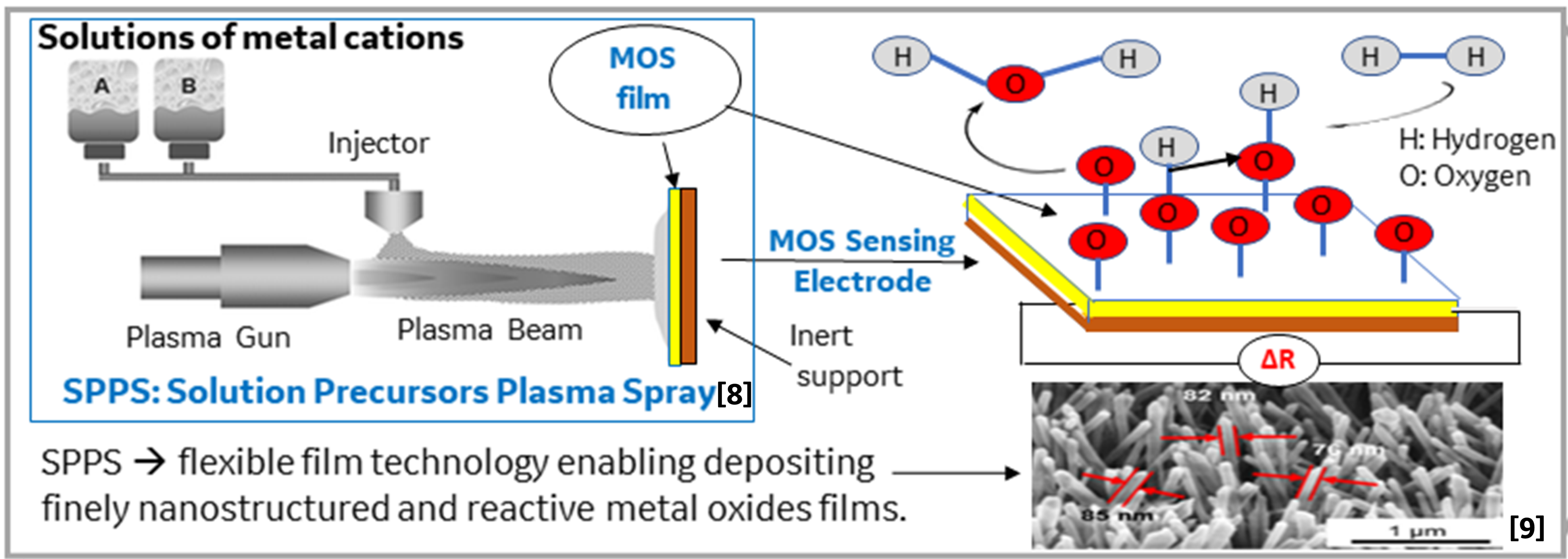
Response and recovery time ~1sec, limit of detection ~200ppm, selectivity.

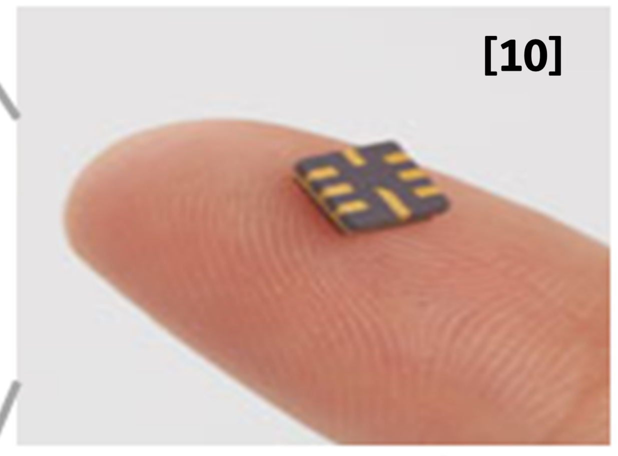
**How ?**

Sensor performance depends on material properties [4-7] …

- Physico-chemical properties: electronic, molecular affinity, electrochemical, etc.
- Microstructure: morphology, thickness, porosity, etc.

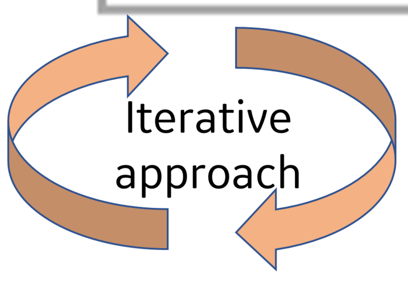
… which depend on manufacturing process




**Performance requirements**

- Response/recovery time
- Stability
- Sensitivity
- Selectivity

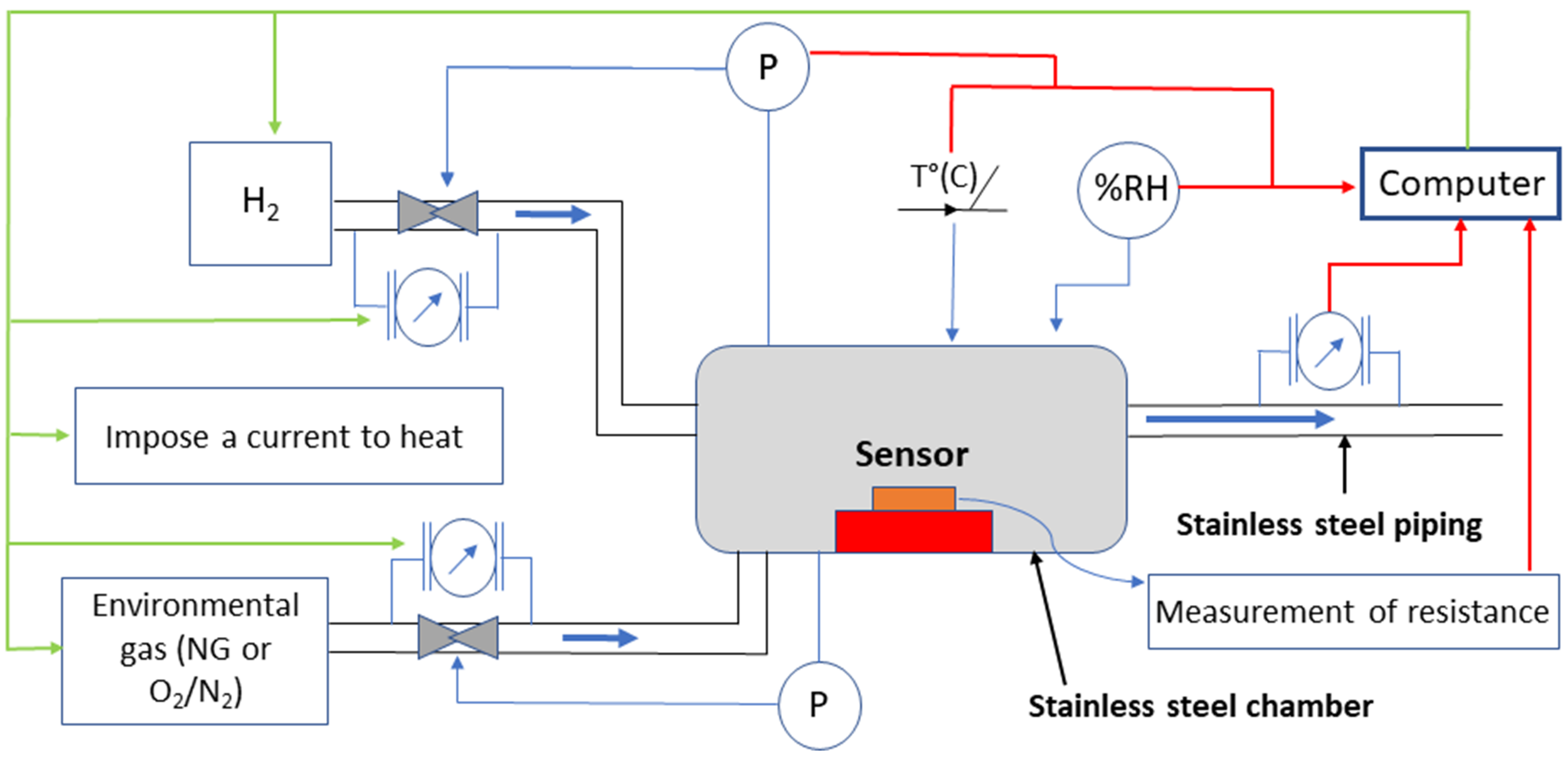



## Sensor performance charaterization

**Development and design of a new tailor-made test bench**

The aim is to characterize sensor performances in different environments (gas, temperature, pressure, humidity)

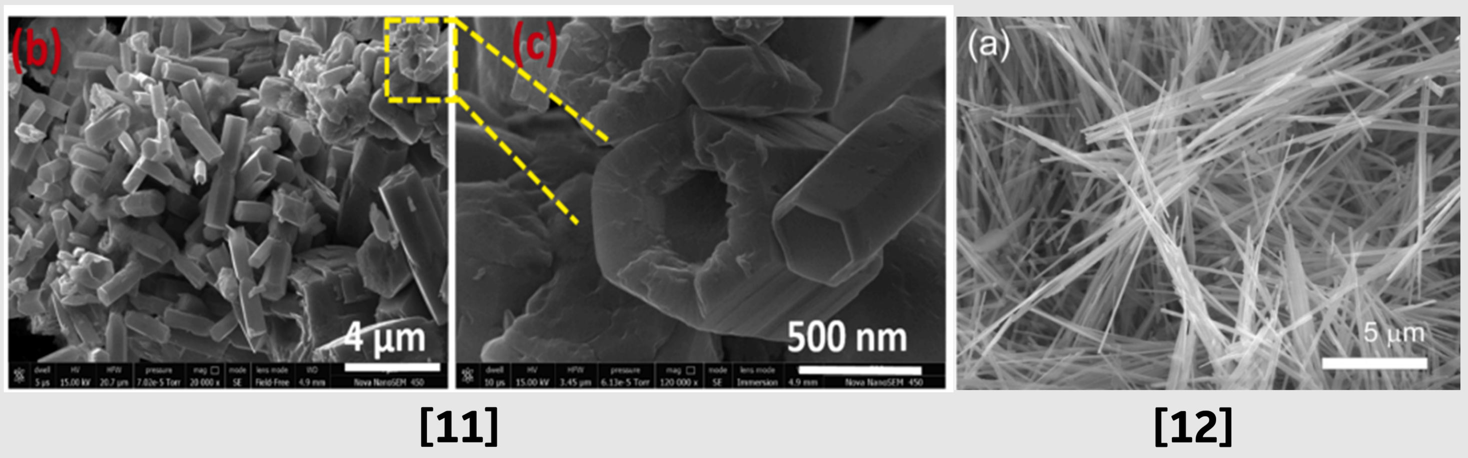
- Design of a specific test bench allowing to:
  - Perform measurements at different gas concentrations in order to evaluate
    - Sensitivity
    - Selectivity
    - Detection limits
  - Determine the optimum and minimum operating temperatures
  - Evaluate the impact of pressure on the measurement
  - Evaluate the impact of humidity on the measurement
  - Evaluate measurement stability, repeatability, response and recovery times
- Develop a multi-parameter control interface.




### Materials deep dive

Difference of microstructure

→ **difference of active area**

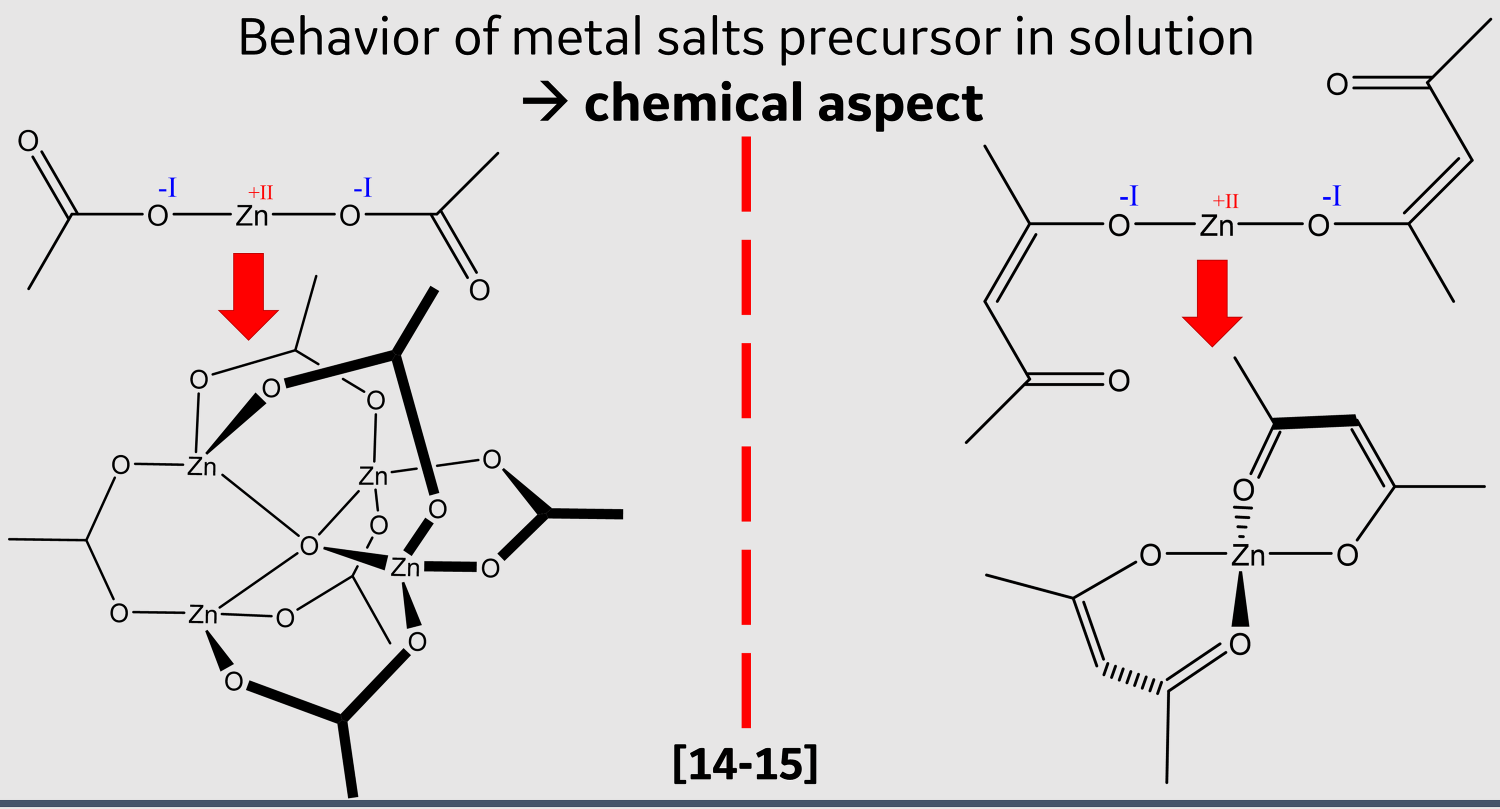



Depend on **[13]**:

- Spraying parameters: power, spraying distance…
- Solution parameters: concentration, pH, metal cation behavior

Behavior of metal salts precursor in solution

→ **chemical aspect**

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