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Oxide nanowires for gas sensing applications

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ABSTRACT

Miniaturization is one of the main required characteristics of the present technologyes, and nostructures are becoming fundamental constitutive elements for modern devices. Laser technologies are among the 'cleanest' and 'most accurate' tools for nanostructure fabrication processes, here are presented results on pulsed laser ablation (PLA) based vapour-liquid-solid grown (VLS) ZnO nanowire results, for gas sensing applications. ZnO nanowire are being used as active medium in a surface acoustic waves sensor (SAW) device. In a 'Bottom-Up' approach, a high-repetition rate laser ablation using a plasma reflection plume as a filtering technique is used to grow ZnO nanowires with a controlled morphology and a single crystal structure, based on the PLA / VLS technique. Some detection performances for few gasses were experimentally evaluated and we have made experimental correlations between SAW sensor performances, nanowire morphology and their 'active area' spatial distribution. Few results on Hydrogen isotopes detection, based on these oxide nanowires are presented and briefly discussed together with some analyt discrimination limitations perspectives.

SAW Sensor

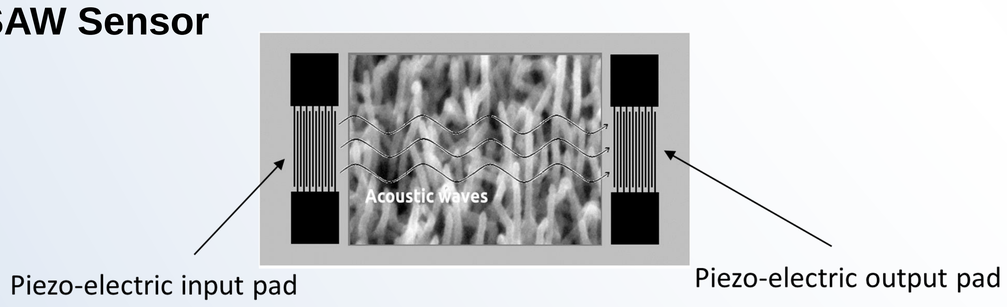


Fig 1. ZnO SAW – Sensor = Surface Acoustic Wave

Nanowire morphology

Few tens of nanometer diemeter and few hundreds of nm long nanowires quasy-vertically aligned on the substrate piesoelectric (quartz) surface

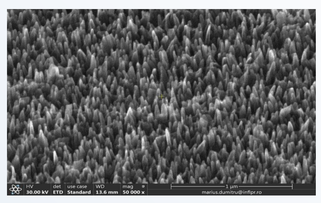


Fig 3 Nanowire morphology

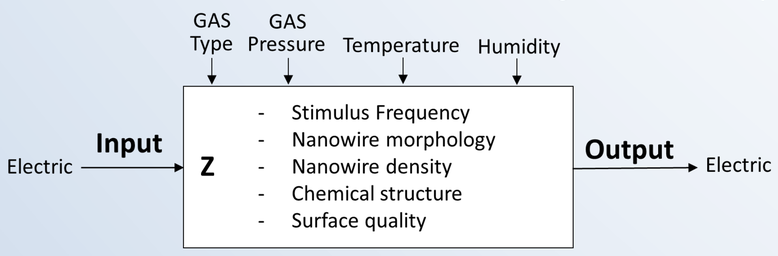


Fig 4 ZnO SAW – Sensor characteristics

Experimental Setup

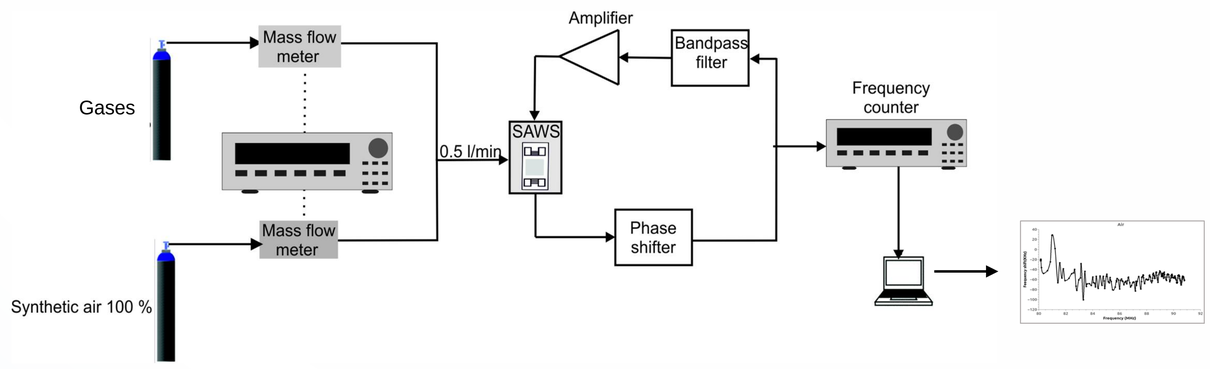
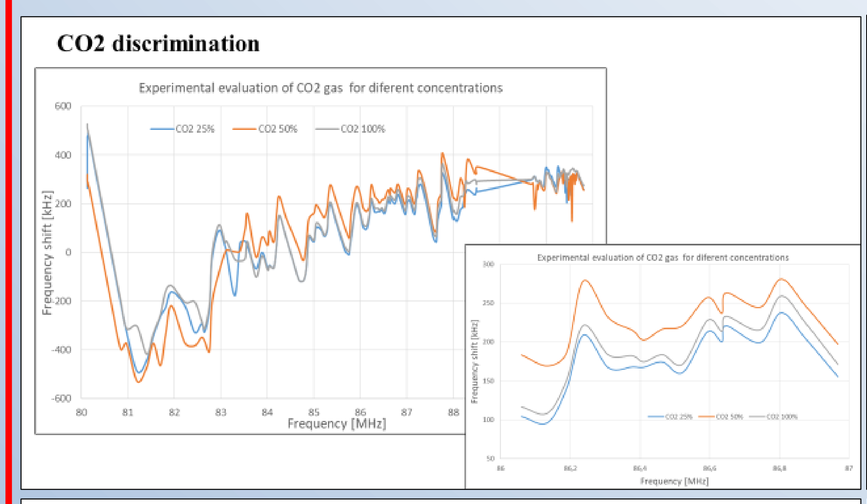


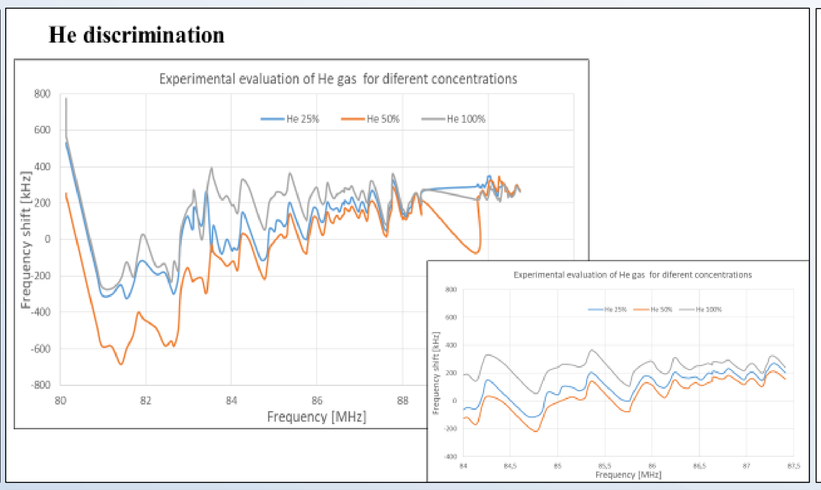
Fig. 2 Experimental setup

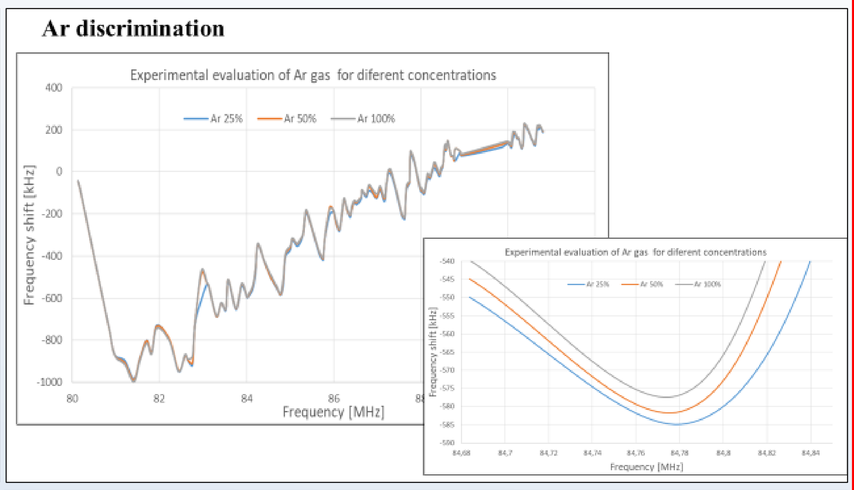
Measurements

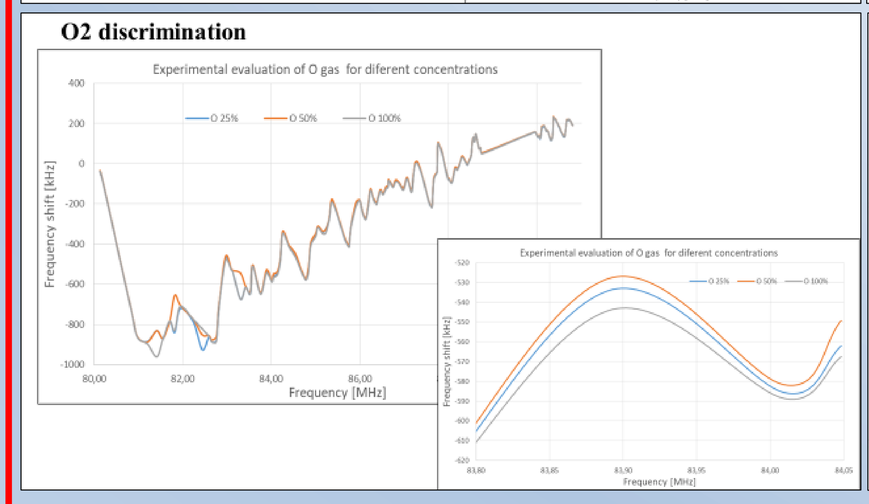
- The experiments was performed for usual gases such as CO_2, Helium, Argon, and Oxygen and Hydrogen isotopes.
- The measurements conditions
  - standard ambient conditions - 1000 mb, 23 C, no humidity
  - different gas concentrations (usual for 25%, 50% and 100%).
  - different working frequency determine the specific response pattern.

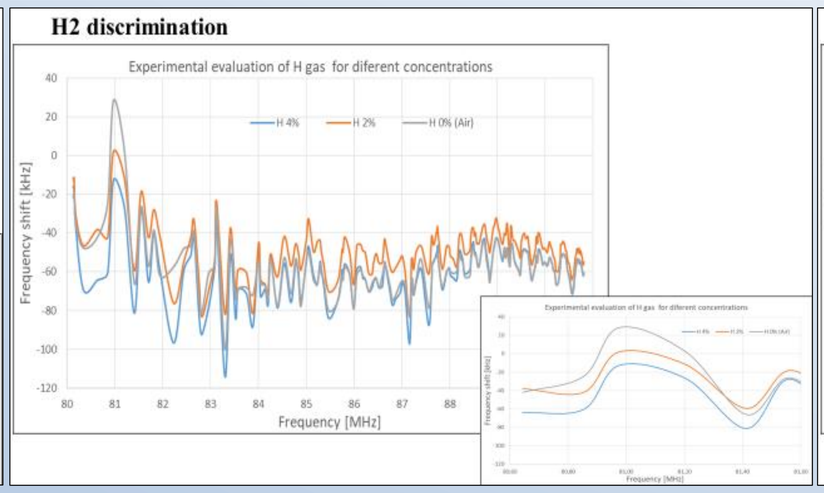
Results











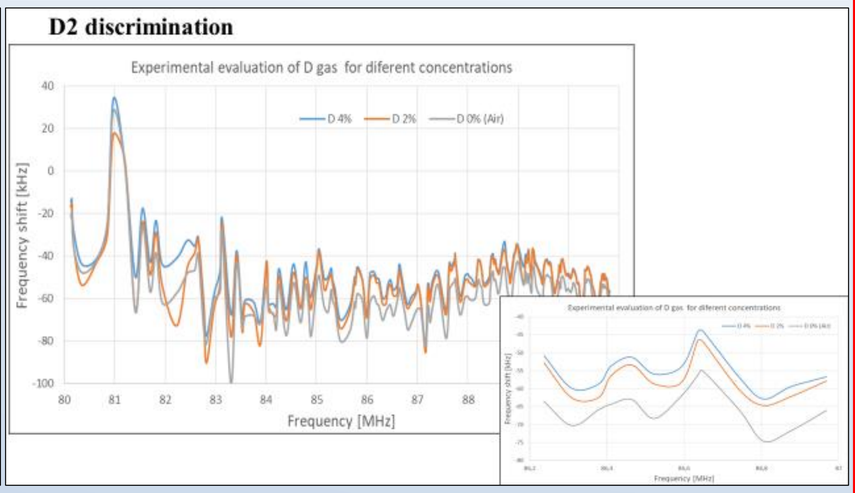


Fig 6 . ZnO SAW Sensor response for gases as CO2, Helium, Argon, Oxygen, Hydrogen and Deuterium.

Acknowledgment

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Conclusions

- ZnO nanowire based SAW sensors are sensitive sensors for monitoring different concentrations of gases.
- SAW sensor response is dependent on gas chemical composition
- Based on sensor response "finger prints" gas discrimination is potentially possible using artificial intelligence