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HYDROGEN GAS SENSING USING A POLYANILINE/GOLD INTERDIGITED SENSOR

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INTRODUCTION

- Hydrogen (H_2) measurement is crucial in emerging industries that employ liquid H_2 as an energy source. H_2 gas leak detectors are used to prevent any accident because of the high explosion risks it has in the presence of air, as these can lead to serious injuries and damage.
- Highly sensitive, selective, and simple but yet reliable H_2 sensors are required.
- Polyaniline (PANi) is a convenient material for producing H_2 gas sensing devices, having very good sensitivity and short response times.

AIMS

- To optimize a protocol for PANi film deposition directly on a gold coated substrate. PANi was synthesized via chemical oxidative polymerization method.
- To characterize the prepared sensors by scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS) and to determine their electrical properties.
- To develop a PANi based conductometric H_2 gas sensor, with reasonable sensitivity (~ 1 ppm H_2).

METHODS AND RESULTS

The sensor fabrication steps are presented below:

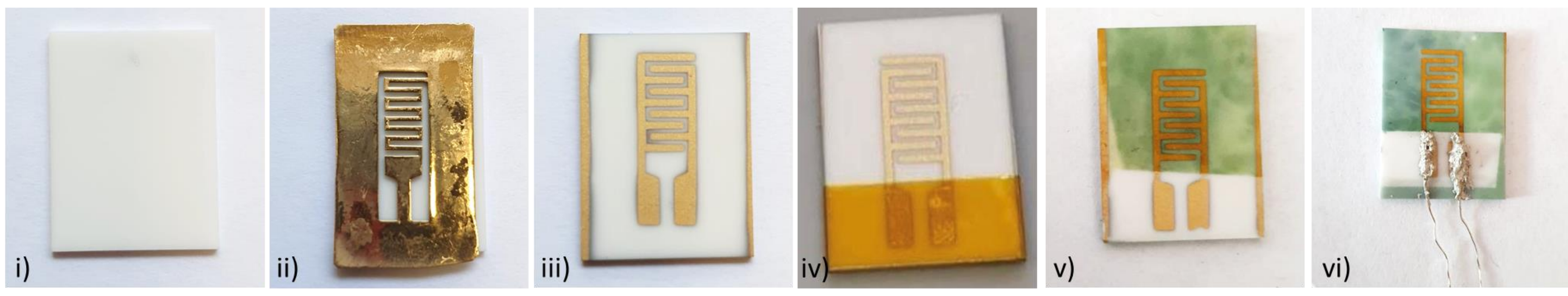


Figure 1: i) Alumina substrate; ii) Laser fabricated deposition glass mask on top of the alumina substrate; iii) Deposited Au thin film interdigits (100 nm thickness), by magnetron sputtering; iv) Substrate with masking tape for controlled polymerization (visible on lower part); v) PANi synthesis via chemical polymerization; vi) Final stage with mounted silver contacts.

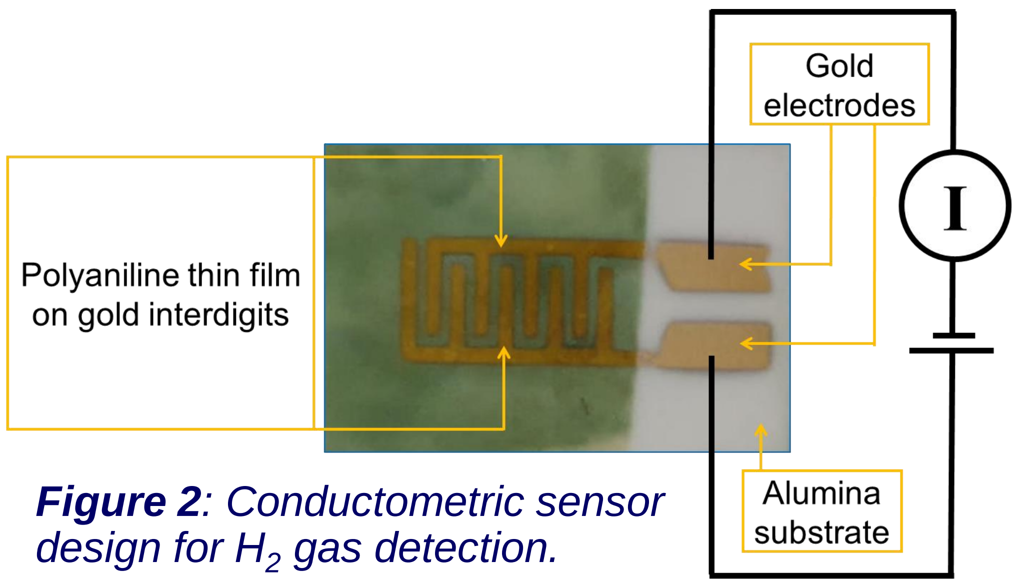


Figure 2: Conductometric sensor design for H_2 gas detection.

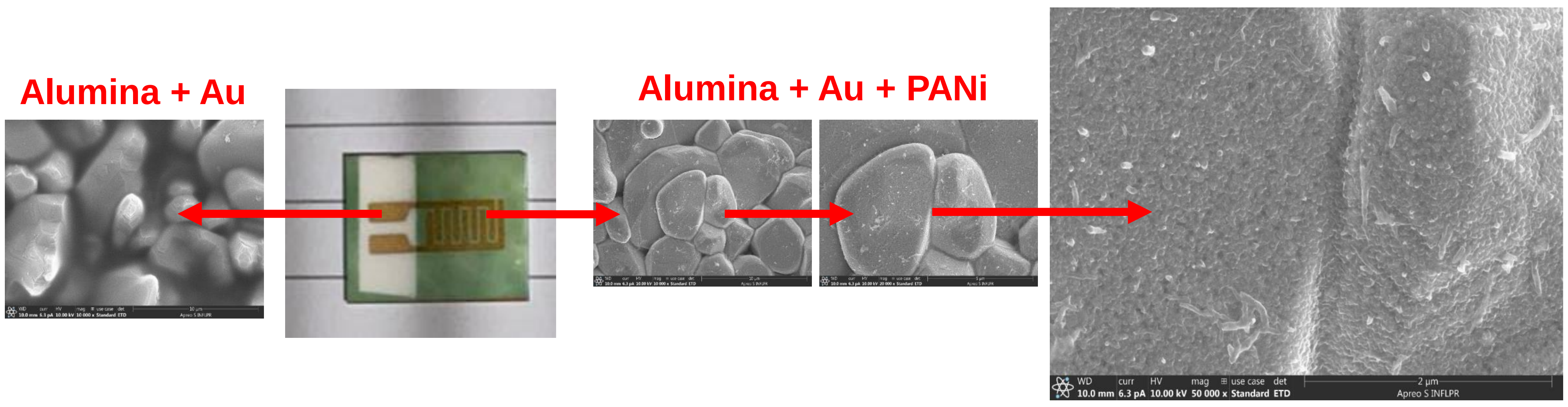


***Figure 3**: Scanning electron microscopy (SEM) investigation of contact area (left arrow) and active area (right arrows). The* PANi films obtained by chemical oxidative polymerization method.

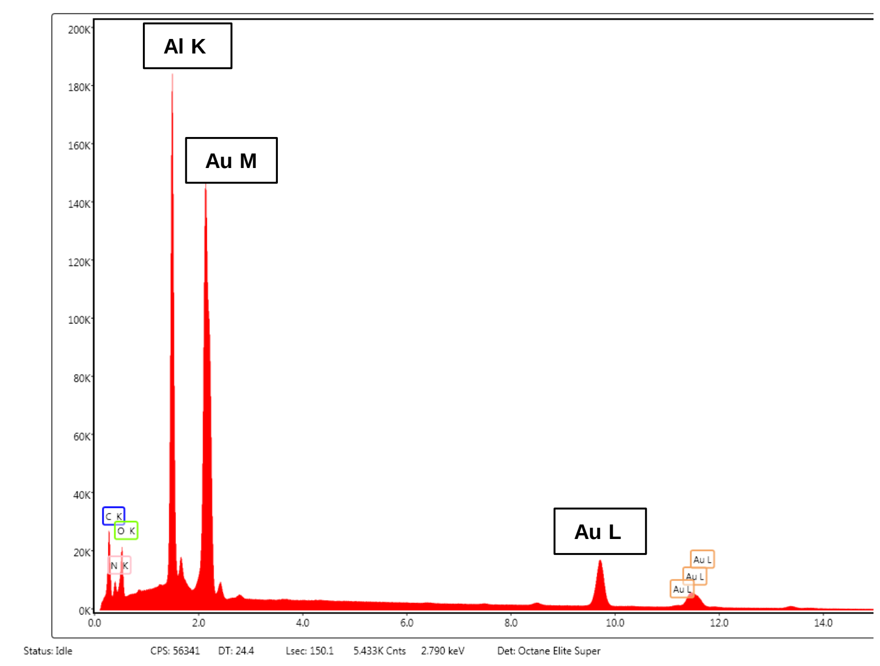


***Figure 4**: Energy-dispersive X-ray spectroscopy (EDX) of active area.*

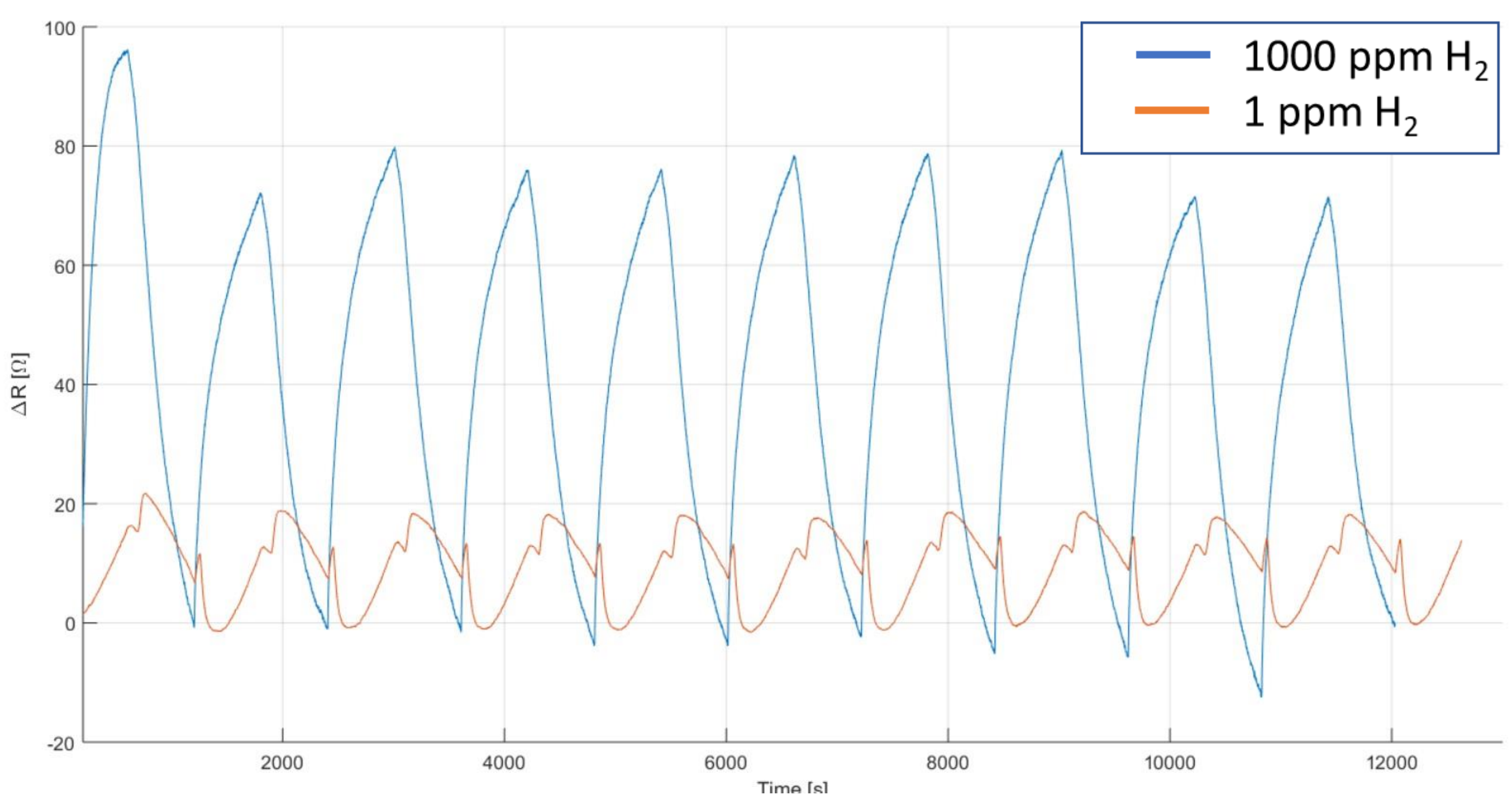
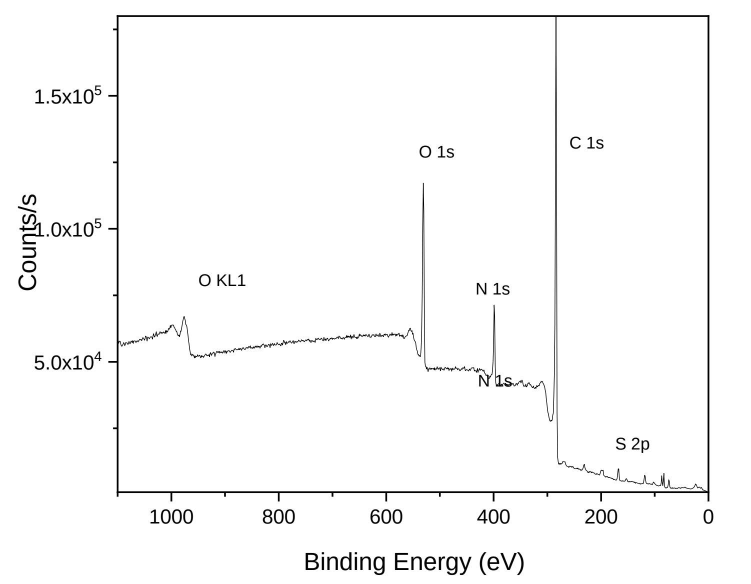


***Figure 5**: Typical real-time sensorgram of the proposed conductometric sensor showing the response for two consecutive measurements at different H_2 concentrations (1 and 1000 ppm), at room temperature (RT).*



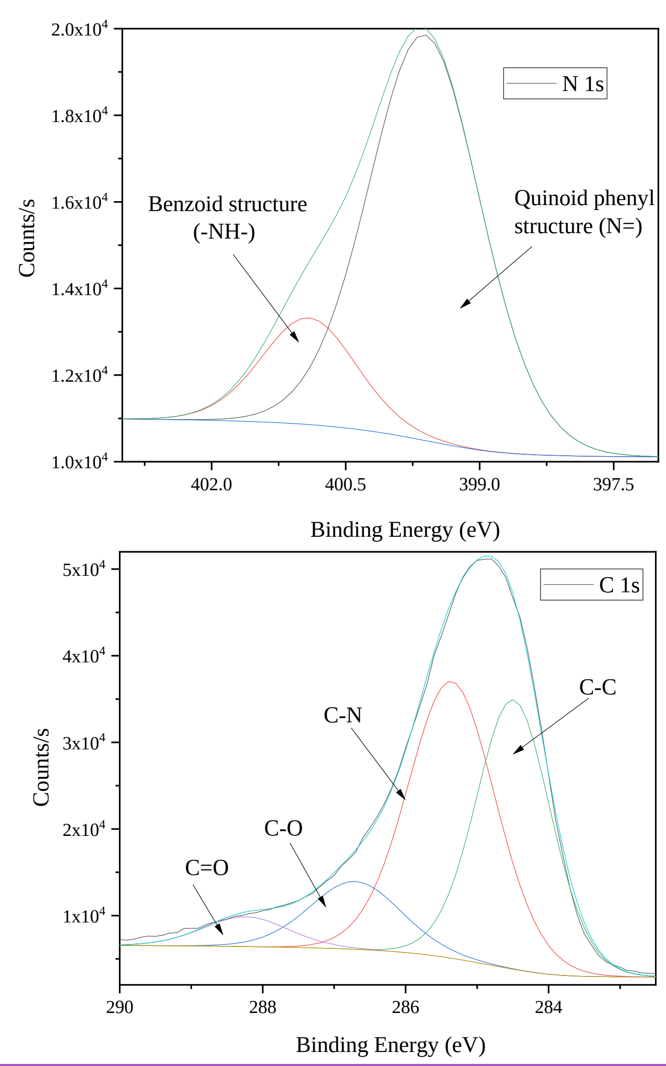


***Figure 6**: X-ray photoelectron spectroscopy (XPS) analysis of active area: survey spectrum (top left), N 1s (top right), C 1s (bottom right)*
- N 1s HR-spectrum: two nitrogen chemical species in the BEs region (397–403) eV, the peak at 399.8eV - the quinoid phenyl structure (-N=), 400.6 eV - benzenoid structure (–NH−).
- C 1s HR-spectrum: specific transition of PANi, such as: C-C (284.8 eV), C-N (285.8 eV), C-O (286.7 eV) and C=O (289 eV).

CONCLUSIONS

- A performant chemiresistive H2 gas sensor has been designed, fabricated and characterized using PANi as sensing element.
- The conductive PANi layer was synthetized using a fast, easy and low-cost chemical oxidative polymerization method.
- The resulting sensor showed a stable and sensitive response for 1 to 1000 ppm H2 gas concertation, at room temperature (RT).

ACKNOWLEDGEMENTS

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