International Summer School on Physics at Nanoscale; 30th May- 4th June 2011; Devět Skal, Czech Republic

# CHEMORESISTIVE GAS SENSOR BASED ON THIN POLYANILINE FILM

P. Kunzo, P. Lobotka, E. Kováčová

Institute of Electrical Engineering, Slovak Academy of Sciences, Dúbravská cesta 9, 841 04 Bratislava, Slovak Republic

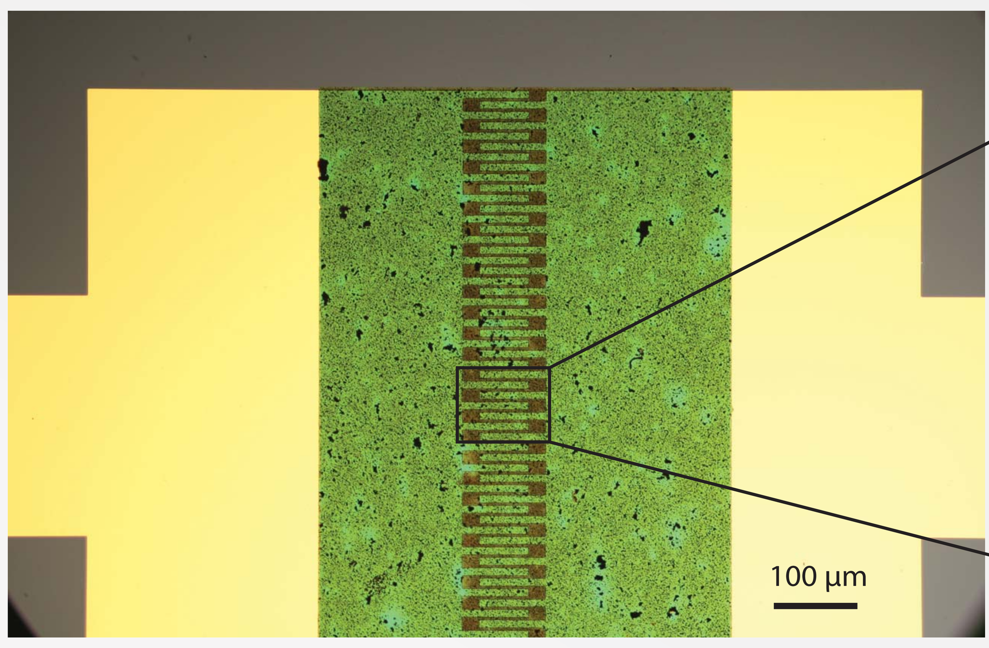
## Motivation:

Sensing of gaseous **ammonia** is critical in many environmental, agricultural, industrial, and medical applications. Concentrations as low as few ppb need to be detected. Sensitive **hydrogen** sensors are requested too, especially for fuel cell safety, facility monitoring, etc.
Organic materials, such as intrinsically conducting polymers have been proposed for low-cost and high-performance gas-sensing devices. Conducting polymer-based chemoresistive gas sensors **can operate at room temperature**, which implies much lower power requirements compared with common metal-oxide sensors working usually at temperature from 200 to 400 °C. **Polyaniline (PANI)** is one of the most important conducting polymers due to its high conductivity, stability and easy preparation.

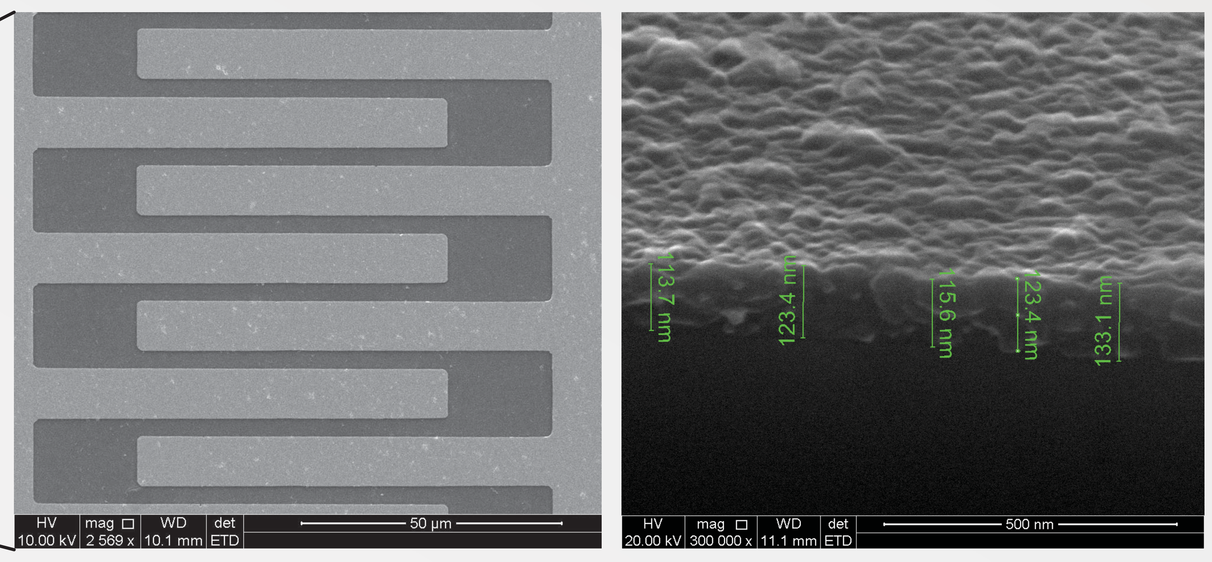
## Experimental details:

PANI was prepared in wet process by in-situ chemical polymerization of aniline hydrochloride in presence of ammonium persulfate oxidant. **Thin PANI film** was deposited on the surface of gold interdigitated electrodes on the oxidized silicon substrate. Commmon **lift-off process** was used to pattern thin PANI layer. Lift-off process is supported by good adhesion of PANI to gold and silica surfaces. Both the substrate and the electrodes are evenly covered by the thin PANI film. To investigate gas sensing properties of PANI film, the sensor was exposed to different concentrations of **ammonia and hydrogen** and corresponding variations of electrical resistance were recorded.

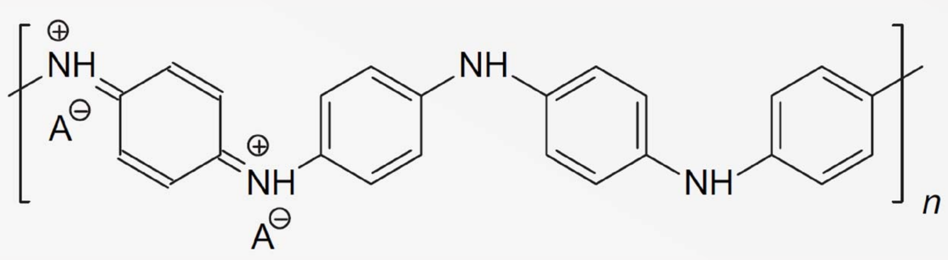
## Results:



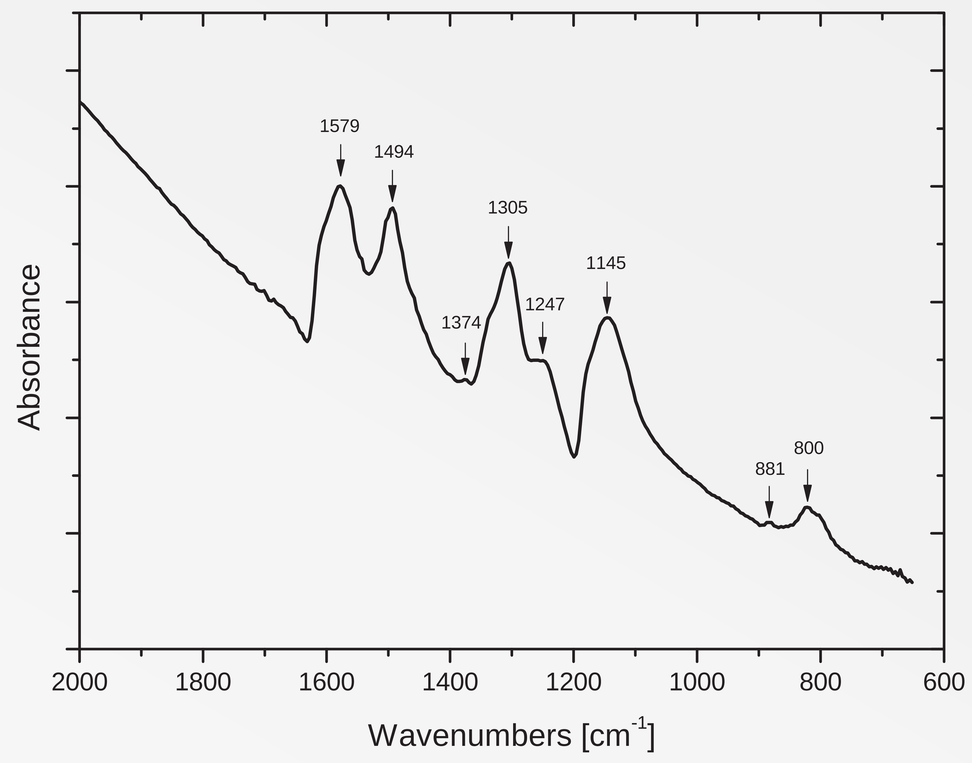

Optical micrograph of lift-off patterned thin PANI film (green color) on the top of gold interdigitated electrodes.



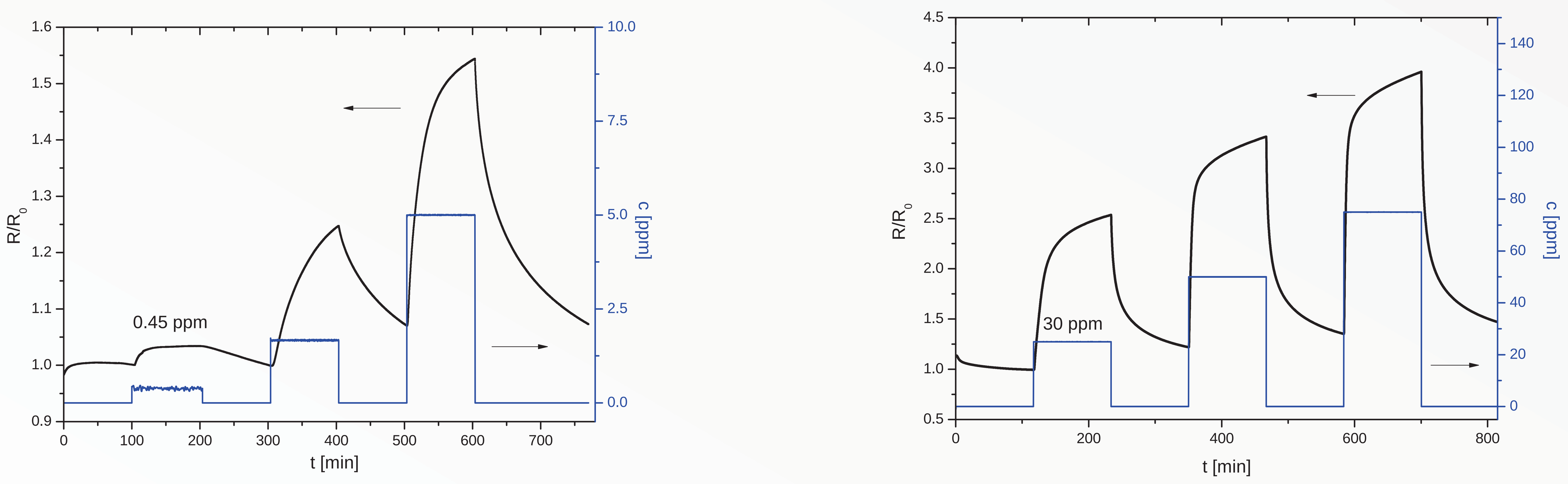
SEM micrographs of smooth thin PANI film with thickness arround 100 nm.



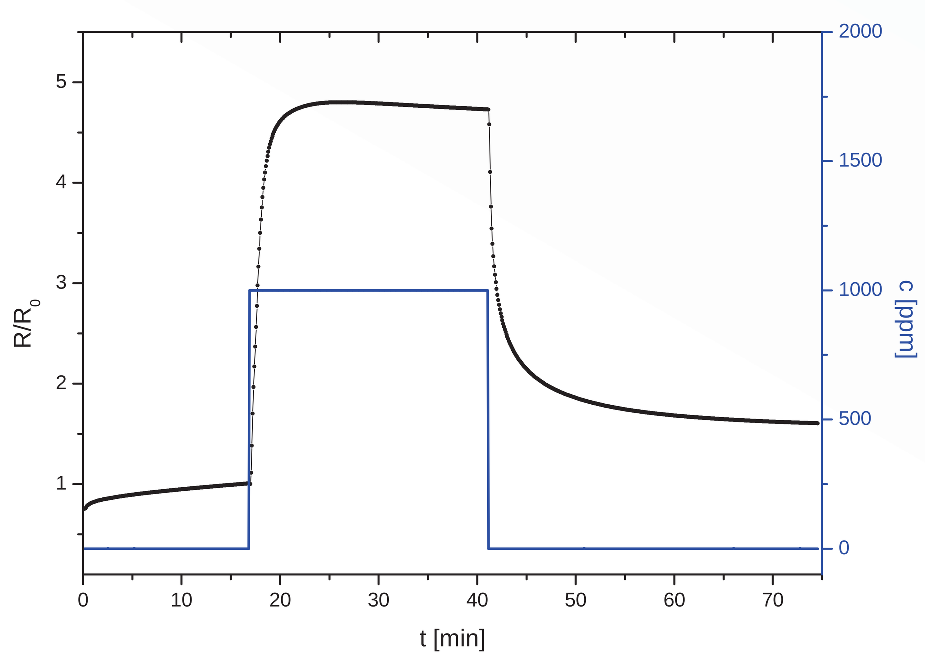

Chcemical structure of protonated polyaniline (emeraldine salt).



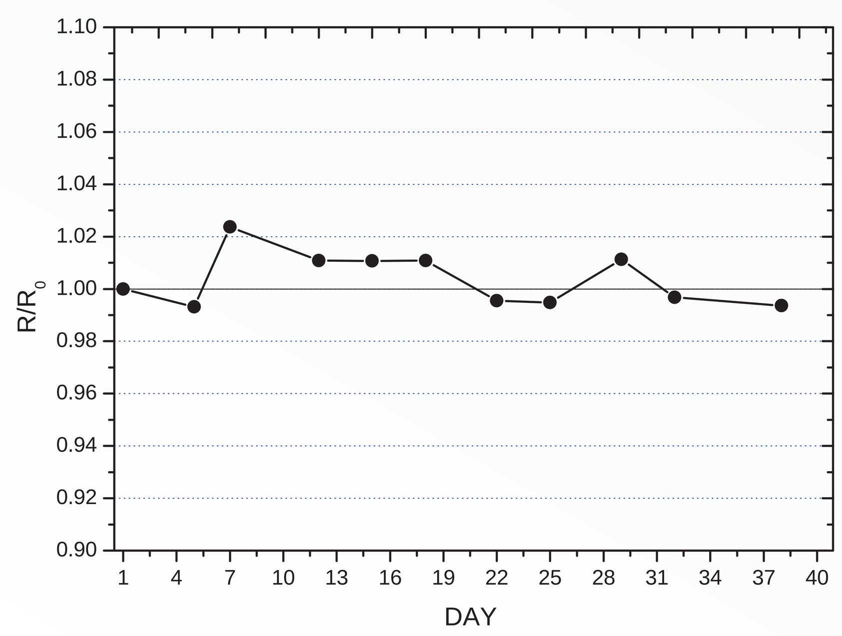

Infrared spectrum of thin PANI film obtained by reflection FTIR microscope. The spectrum indicates well-protonated conducting form of PANI film.




Resistance changes of thin PANI film when exposed to various concentrations of gaseous **ammonia**. Detection limit of the sensor is in the ppb range.




Resistance changes of PANI film decorated by Pd particles upon the exposure to 1000 ppm of **hydrogen** gas.




**Long-term stability** of baseline resistance of thin PANI film. Data were collected at 310 K and pressure of 10-3 Pa.

## Conclusion:

We found very good sensitivity of the gas sensor based on thin PANI film. The detection limits for ammonia and hydrogen were in the range of hundreds of ppb and tens of ppm respectively. Additionaly, common lift-off process can be used to successfully pattern thin and homogenous PANI film prepared in-situ.

## References:


- P. Lobotka et al.: Thin Solid Films 519 (2011) 4123
- I. Šeděnková et al.: Polymer Degradation and Stability 93 (2008) 428


**Acknowledgement:**

The authors acknowledge A. Kleinová (Polymer Institute, SAS Bratislava) for assistance with FTIR spectra measurements. This work was supported by The Slovak Research and Development Agency under the contract no. APVV 0478-07.