Application 2004

The performance testing of the hydrogen sensor based on polyaniline

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The gas sensors based on conducting polymers such as polyaniline (PANI), polypyrrole (PPY) or poly (3,4-ethylenedioxythiophene) (PEDOT) are intensively studied as they can provide remarkable room-temperature sensitivity. On the contrary, sensors based on commonly used inorganic metal oxides have negligible sensitivity at room temperature.

Within our group, we developed a chemiresistive gas sensor based on a thin PANI film (approx. 100 nm thick) shortly treated by oxygen plasma [patent appl. No PCT/SK2011/000022], which showed very high room-temperature sensitivity to hydrogen with excellent lower detection limit. Additionally, the sensor does not contain any palladium, thus its production is very cost-effective and simple. The details are described in our recent publication [1]. We suppose that such a sensor could be used to resolve the safety issues regarding the fuel cell technologies and production and storage of hydrogen.

Based on our preliminary results, the sensor showed very good sensitivity to hydrogen (30% change in resistance after application of 10 ppm of hydrogen in dry air). However, for practical applications it is very important to check its operation in real conditions. We believe that hydrogen sensor testing facility of the JRC could contribute significantly to the examination of the sensor performance and reliability.

Although many sensors of various gases (mainly sensors of ammonia) based on PANI were reported, the data available in the literature offer only limited information on sensor performance at various temperatures, humidity levels or cross sensitivity in presence of a contaminant. It is therefore concluded that the study taking into account these factors would be certainly of great interest for a broad scientific community.

Within this project, I intend to observe the operation of the hydrogen sensor under various conditions. For this purpose, I propose to make a number of tests of 3-5 resistive sensors prepared under different conditions (e.g. the time of plasma treatment). The sensors are prepared on silicon substrates (chips ~2 mm x 2 mm) and can be mounted on standard TO5 packages (with no caps, of course). The base-line resistance is ranging from 1 to 500 kOhm. Testing voltage and current may not exceed ~2 V and ~0.1 mA, respectively.

I suggest to carry out the tests in the following order:

1. CALIBRATION TEST which subjects the sensor to sequential exposures of several ascending concentrations of hydrogen in air (pressure of ~1 bar, room temperature). I would suggest to perform two calibration tests: the first one with humidity of 0% (for the sake of comparison with the same tests performed in Bratislava) and that of 50% of humidity.
2. HUMIDITY TEST
3. AMBIENT PRESSURE TEST
4. AMBIENT TEMPERATURE TEST
5. CROSS SENSITIVITY TEST
6. CALIBRATION TEST to check the stability of the sensor response.

I estimate the time needed to perform all the tests to about one week.

I have an experience with a small gas sensor testing facility (without humidity and pressure control) assembled from Vogtlin flow controllers at our institute.

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[1] P. Kunzo, P. Lobotka, M. Micusik, E. Kovacova, Palladium-free hydrogen sensor based on oxygen-plasma-treated polyaniline thin film, Sensors and Actuators B: Chemical. In Press (2012) doi: 10.1016/j.snb.2012.05.080.