Novel type of gas sensor based on the effect of surface photovoltage

Description for the general public

The aim of this project is an elaboration of novel type gas sensor based on surface photovoltage for the fast detection of toxic gases already at room temperature. The proposed solution is an own original modification of the well known method of measurements of the variation of contact potential difference (CPD) at the semiconductor surfaces (Kelvin probe) and consists in additional illumination by light of well determined photon energy related to band gap of semiconductor. After that a strong variation of the electronic properties of the surface space charge layer of semiconductor material appears resulting in the strong variation of surface potential (surface band bending), what can be easily measured as the so called surface photovoltage. This is why the SPV effect can be effectively applied for the detection in potential application in the development of new generation of gas sensors because after any interaction of sensor materials like semiconductive oxides (playing a role of an active electrode in Kelvin probe) with active or toxic gases a strong additional variation of surface photovoltage (SPV), what can be treated as the gas sensor response.

The results of preliminary studies in our centre on the elaboration of novel type gas sensor based on surface photovoltage (SPV) effect, using the thin, porous ZnO layers as the sensor material, are very promising. We were successful in elaboration of its test version, which allowed us the fast detection of nitrogen dioxide (NO_2) up to its minimal concentration of 2 ppm in synthetic air.

Within the realization of this Project we will focus on the optimization of the test version of our gas sensor based on SPV effect, with a special emphasis on its geometrical and electronic construction in order to allow the optimal process of regeneration of sensor material after detection process, and then on the selection of conductive oxide of different dimensionality for reaching the best gas sensor characteristics including the selectivity threshold, and its dynamic parameters (response and recovery times) in NO_2 atmosphere.

In contrary to the human olfaction system, which is extremely sensitive and selective, the most popular conductometric sensor of toxic gases on the base of conductive oxides have quite good sensitivity, but still rather poor selectivity for the selected oxidizing and reducing gases. However, their main limitation is high working temperature (what cause the high power consumption) and their relative long response and recovery times. Mostly, this second limitation is extremely important in aspect for their potential using as gas sensor material in the development of novel generation of gas sensor devices, including the so called electronic nose (EN).

Therefore was it been proper to undertake test to find another physical (chemical) effects, which could be applied for the elaboration of gas sensor system not exhibiting the above mentioned limitations. One of the possible novel and promising solution would be an application for the gas detection the above mentioned surface photovoltage (SPV) effect, which is very sensitive on the even small variation of surface electronic properties of sensor materials after their exposure to toxic gases.