ABSTRACT

Outdoor air pollution is one of the main environmental problems today. Its monitoring is, among other things, given by the European Union directive (2008/50/EC) on air quality and places high demands on the quantity and reliability of sensors deployed in our immediate surroundings. In order to continuously monitor large number of habitats, it is necessary to develop simple and inexpensive types of sensors. **Figure 1** shows an example of such a sensor.

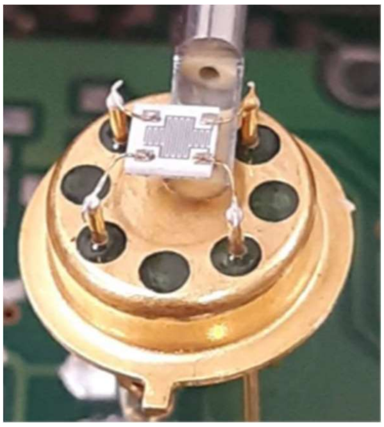

Figure 1 The final realization of the sensor

The topic of the dissertation is the preparation by physical methods and the study of the surfaces of thin oxide layers as an active medium for the above-mentioned applications. The thesis investigates the possibility of materials preparation by pulsed laser deposition, discharge in a hollow cathode and magnetron sputtering thin film materials for chemiresistor sensors based on copper and tungsten oxides, luminescent Eu doped ZnO layers and resonant so-called QCM, where a quartz resonator was covered with a layer of black aluminium showing a large specific surface in order to increase the sensitivity of these types of sensors.

Since the state and properties of the surface are crucial for the function of these types of sensors, an integral and important part of the work is the characterization of the structural properties of the prepared layers, especially by electron microscopy (SEM, TEM) and their influence on the resulting electrical, optical and transport properties in terms of use for chemical sensors.

The processes involved in gas detection are interactions that take place primarily on the surface of the sensing medium. For the process of gas absorption and desorption itself, the state of the surface plays a very important role; that is, its morphology, but also the porosity, crystallinity and grain size of the structure, where critical processes take place within the structure and at the grain boundaries of the sensitive layer. In a semiconducting medium, this significantly affects the electron exchange between the gas molecules and the medium, with oxidizing gases acting as electron acceptors (p-type dopants), while reducing gases act as electron donors (n-type dopants). The porosity of the structure is

particularly important for the type of sensors working on the principle of gas absorption inside the medium and the subsequent detection of the change in the resonance frequency of the quartz crystal.

Chemical sensors are usually made up of small analytical devices, which enable us to qualitatively and quantitatively analyse gas ambient. Such information is derived from specific chemical changes or chemical reactions of certain chemicals with the sensor. The active layer (**Figure 2**) can react either selectively to only one specific molecule or to a group of substances with the same chemical functional group. Nowadays, signals are processed almost exclusively through electrical devices. This conversion of a non-electrical quantity into an electrical quantity is done by changing voltage, current or resistance.

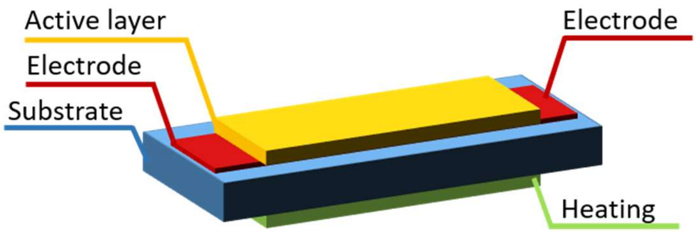

Figure 2 Illustration of the chemiresitor sensor

This is a comprehensive study of the influence of deposition technologies and preparation conditions on the resulting structure of the prepared thin films, which will be subsequently used for chemical sensors: (i) heteroepitaxial Cu_2O-type p-layers, (ii) WO_3 and phosphorus-doped WO_3 layers, (iii) ZnO-doped Eu^{2+}/Eu^{3+} ions and thin films of the binary Ga_2O_3-Gd_2O_3 system, (iv) magnetron sputtering for black aluminium porous thin films.

Keywords: metal oxides, chemical sensors, thin films and surface, SEM, TEM, Cu_2O, WO_3, black metals