Changes of electrical properties of C-Pd films due to hydrogen presence. Automation of measurements

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ABSTRACT

Nanocomposite carbonaceous-palladium (C-Pd) films are promising materials for hydrogen and hydrogen compounds sensors. It is connected with highly selective hydrogen absorption by palladium nanocrystallites. Nanostructural C-Pd films were deposited on alundum substrate with silver electrodes. These C-Pd films were prepared in physical vacuum deposition (PVD) process and were characterized by scanning electron microscope (SEM). A special measurement set-up was built to study the changes of C-Pd film resistance in gas presence.

Keywords: C-Pd film, hydrogen sensor, automation of measurements, resistance changes

1. INTRODUCTION

Nanocomposite carbonaceous-palladium (C-Pd) films hold great potential as active devices for gas sensors for automotive and industrial application [1-4]. The electrical properties of these materials, such as their conductivity, is of great interest to researchers. One of the most important parameter for gas sensing is highly-developed surface and high pore volume. This feature of carbonaceous-palladium films promotes efficient adsorption process that allows their use in various types of detectors [5-8].

In this paper we describe method of measurement of film resistance in a wide range from a few ohms to tens of Giga ohms in different gas atmosphere. For these measurements a specially designed measurement set-up was built.

2. PREPARATION OF C-Pd FILMS

The nanocomposite C-Pd films were obtained by physical vapor deposition (PVD) [9-12]. In PVD process fullerene C_{60} (Sigma-Aldrich, 99.9%) and palladium acetate (Sigma-Aldrich, 99.98%) were used as the film precursors. The films were deposited from two separated sources on alundum substrate. Different technological parameters were used to prepare C-Pd films with different structure and properties. The parameters of PVD process (intensity of current through C_{60} source (I_{C60}) and distance between substrate and C_{60} source (d_{C60})) are shown in Table 1. The other parameters of PVD process were the same for all samples. The obtained C-Pd films were characterized using scanning electron microscopy (SEM) and then hydrogen sensing measurements were performed.

Table 1. PVD process parameters

Sample	I_{C60} [A]	d_{C60}[mm]
C-Pd-1	2.10	54.0
C-Pd-2	1.85	54.6
C-Pd-3	1.90	60.0
C-Pd-4	2.10	54.6

3. CHARACTERIZATION OF C-Pd FILMS

The structure and morphology of the obtained films were characterized using scanning electron microscopy (SEM). SEM examination was carried out with the JEOL JSM-7600F field emission scanning electron microscope operating at 2keV and 5keV incident energy. SEM images of C-Pd film surface obtained on Al_2O_3 substrate are showed in Fig. 1. The sample C-Pd-1 is characterized by a very fine crystalline structure. Additionally on the surface

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