Influence of CVD process duration on morphology, structure and sensing properties of carbonaceous-palladium films

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Abstract. We present the nanocomposite carbonaceous-palladium (C-Pd) thin films prepared by physical vapor deposition (PVD) and chemical vapor deposition (CVD) methods. Scanning electron microscope (SEM) and transmission electron microscope (TEM) methods were used to study the topography, morphology and structure of carbon and palladium nanograins contained in these films. The quantitative analysis of the elemental composition of C-Pd films was determined by energy-dispersive spectroscopy (EDS). The initial PVD films were modified in a CVD quartz reactor using xylene (the mixture of isomers) as a modifying factor at different times (5, 10 and 30 minutes) at a constant temperature of 650°C in atmospheric pressure. It was observed that the average size of palladium nanograins increased with an increasing duration of modification process. The differences in microstructures observed in the CVD films modified at different times, affect their response in measurements of resistance changes in the gas containing H_2 in various concentrations. All samples were measured by cathodoluminescence (CL) method. In CL studies a large amount of objects with high intensity of CL was found. Some of them show the emission bands both at 450 nm and 750 nm. Other reveals emission band only at 450 nm. CL observations show that Pd nanograins coated by graphite shells exhibit optical activity.

1. Introduction

Nanostructured materials containing different allotropic form of carbon such as foam, graphite, fullerene $C_{60,}$ nanotubes, nanofibers doped with transition metals e.g. palladium, platinum, nickel, iron, and cooper can be used in various applications e.g. in catalysis, as hydrogen storage materials [1-4], as hydrogen sensors [5-7] or can provide electrodes in batteries [8], fuel cell [9] or can be used as electrochemical biosensors [10]. These materials are characterized not only by highly developed surface area of carbon but also by presence of metals nanograins which play a special role in catalysis. These metals nanograins cause decomposition of chemical compounds adsorbed on them.

Nanostructures based on nanoporous carbon matrix containing palladium nanograins called as the C-Pd films are promising materials for hydrogen sensing applications. Presently hydrogen technologies awaken of great interest among scientists and entrepreneurs. This interest is related to the potential use of hydrogen as an energy carrier. Recently, the growth of the hydrogen importance in the world economy e.g. in transport, chemical compounds production, cryogenic systems, electronic and metallurgical industry has been noticeable.

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