Properties of hydrogen sensitive C-Pd films obtained by PVD/CVD method

Ewa Kowalska[1], Mirosław Kozłowski[1], Anna Kamińska[1], Joanna Radomska[1], Halina Wronka[1], Elżbieta Czerwosz[1], Kamil Sobczak[2]

[1] Tele & Radio Research Institute, Ratuszowa 11 Street, 03-450 Warsaw, Poland
[2] Institute of Physics PAS, al.Lotników 32/46, 02-668 Warsaw, Poland

ABSTRACT

Structural, topographical and morphological changes of carbonaceous-palladium (C-Pd) films obtained by physical vapor deposition /chemical vapor deposition (PVD/CVD) method were studied. Effect of changes in these properties under the influence of CVD process temperature on the hydrogen sensitivity of these films is discussed. Scanning electron microscopy (SEM) observations were used to investigate the topography and morphology of an initial (PVD) film and the film modified in CVD process (PVD/CVD film) at different temperatures. The changes of film's morphology after modification performed at various temperatures (500, 550, 600, 650, 700 and 750°C) caused changes in their resistance. The electrical measurements carried out in the presence of gas containing 1vol % of hydrogen showed different sensing characteristics for various films. The highest hydrogen sensitivity and the fastest response were observed for films modified at the temperature of 500°C and 550°C. In SEM images on surface of these films palladium nanograins with different sizes were observed. For films modified at the temperatures higher than 600°C Pd nanograins placed under superficial very thin carbonaceous layer were found.

Keywords: PVD/CVD method, carbonaceous-palladium films**,** hydrogen sensitivity, hydrogen detection, response time

1. INTRODUCTION

Recently, hydrogen has been considered as a potential energy carrier that could replace fossil fuels. In addition, hydrogen can be used in fuel cells to convert chemical energy into electricity where only water is the final product. Thus, hydrogen as the fuel does not pollute the environment. This gas has been also employed as reducing agent for many chemical elements and has a permeability through various materials which requires a special protection in many applications. If the hydrogen technology is developed further, we will need very sensitive H_2 sensors to monitor and control the hydrogen content in an environment to prevent the leakage of this gas. Solid-state H_2 sensors based on metal-oxide [1], optical [2], electrochemical [3], and acoustic wave [4, 5] devices have been already applied. Many of these sensors use bulk Pd or compounds containing Pd (alloys). In order to produce highly sensitive hydrogen gas sensors different palladium nanostructures have been applied such as Pd nanoparticles, nanowires or nanograins [6-8]. Recently much effort is directed to produce hydrogen sensors working at room temperature as thin continuous palladium film resistors (chemiresistor) [9, 10]. This type of sensors can work at room temperature but their response time and sensitivity are not always suitable for many H_2-based applications, such as hydrogen leak detection in hydrogen-powered vehicles [11] or for a typical rafinery system [12]. Therefore the new sensing materials are still being looked for the development of an "ideal" H_2 sensor with parameters such as: fast response, high sensitivity, reversibility, small size, and low power consumption, as well as easy to use and to obtain.

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