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Influence of palladium chemical structure on hydrogen sensing properties of carbonaceous–palladium thin films

ANNA KAMIŃSKA*, SŁAWOMIR KRAWCZYK, MIROSŁAW KOZŁOWSKI

Tele and Radio Research Institute, Ratuszowa 11, 03-450 Warsaw, Poland

*Corresponding author: anna.kaminska@itr.org.pl

In this work we investigate nanocomposite carbonaceous–palladium (C–Pd) films prepared by physical vapor deposition. Such films are promising materials for hydrogen sensor applications. This is related to the highly selective hydrogen absorption by palladium nanocrystallites. The C–Pd films obtained in various technological conditions differ in structure and electrical properties. These films were characterized by SEM, EDS and FTIR spectroscopy. FTIR spectroscopy was used to determine the amount of palladium acetate and fullerene, incompletely decomposed during the deposition process. FTIR spectra enabled us to explain the differences in C–Pd films resistance based on palladium chemical structure. The possibility of the application of C–Pd films as active layers in hydrogen sensors was also studied. The results showed that synthesized C–Pd films containing palladium nanograins could be used for hydrogen sensing.

Keywords: C–Pd thin films, hydrogen sensor, FTIR spectroscopy.

1. Introduction

The development and more widespread use of hydrogen gas as an energy carrier has led to the increasing demand for fast and reliable hydrogen sensors. Palladium-based hydrogen sensors have been thoroughly explored because of their highly selective interaction with hydrogen [1]. The interaction between hydrogen and palladium begins with H_2 adsorption on the palladium surface following the homolytic dissociation of H_2 molecules to H atoms. These hydrogen atoms diffuse into the Pd lattice and occupy its interstitial sites, forming solid solution [2]. At higher hydrogen pressure, further incorporation of hydrogen atoms induces phase transition from the α- to β-phase and formation of palladium hydride [3]. The Pd–H system is characterized by larger volume, different optical properties, lower work function and higher resistance compared to pure Pd [4]. Hydrogen sensing is based on changes in these properties. The palladium-based sensors include palladium thin films [5, 6], Pd nanowires [2, 7], Pd nanoparticle layers [8, 9] and C–Pd composites [10, 11].