Tem and CL investigations of Pd nanograins included in carbonaceous film

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Abstract. In this paper we presented results of investigation of carbonaceous-palladium materials obtained in the CVD (Chemical Vapor Deposition) process. This investigations were carried out with transmission electron microscopy (TEM) and scanning electron microscopy (SEM), equipped with spectrum imaging for cathodoluminescence (CL). The composites will be applied as a active layers in hydrogen and also hydrocarbons detectors. Our measurements showed that some of Pd nanoparticles have a graphite shell and also are optically active. This particle in CL spectrum reveal the peak wavelength around 520 nm (2.38 eV).

Introduction

Since many years, palladium is well known for its ability to absorb hydrogen [1]. The absorption of hydrogen produces two different phases α and β, both of which contain palladium metal atoms in a face centred cubic (fcc) lattice [2]. In phase α, adsorbed hydrogen occupies the octahedral gap. In phase β, associated with an increase in the concentration of H_2 up to $PdH_{0.02}$ [3] the hydrogen occupies more space in the crystal lattice and both phases coexist until a composition is reached to $PdH_{0.58}$ when the phase α disappears. The change in lattice parameter due to this processes are observed, in phase α from 3.889 Å to 3.895 Å, $\alpha+\beta$ from 3.895 Å to 4.025 Å and β more than 4.025 Å. The volume of the palladium nanocrystal increases, becomes fragile and cracked, and also, what is important - is observed a change in electrical conductivity, both in the phase α and β [4]. This makes the palladium an ideal detector of hydrogen. Placing the palladium particles in the matrix of carbonaceous film, which is characterized by high porosity, significantly enhances the detection of hydrogen and also hydrocarbons.

Production of hydrogen is expensive, but still are being developed economical and effective method of obtaining pure H_2 [5]. Everything indicates that hydrogen will be one of the most important energy sources after the exhaustion of oil reserves. Hydrogen and its compounds are already widely used in many areas of technology, for example: Haber–Bosch process - the nitrogen fixation [6], in food industry - hydrogenation [7], hydrogen and hydrocarbons can be found practically everywhere, not only in industry, also science need a capacity to monitor the concentrations of hydrogen and hydrocarbons. It becomes really important to control and monitor these gases, as there is a huge risk of damage to property and human lives if a leak occurs. Certain gases can be toxic for humans, or corrosive gases or else explosive like CH_4 in the ionization chamber [8] or rocket propellant [9], more about the use of hydrogen can be found in [10]. Therefore, the rapid development of technology and a highly selective hydrogen sensors is very important. The project, aimed at developing next generation technology of hydrogen and hydrocarbons sensor based on nanoparticles Pd contained in carbonaceous film is being realized by the Institute Tele & Radio Research. Performing the standard structural, morphological and optical studies this films, we noted that some particles are optically active. The purpose of this study was to answer the following questions: why some particles are optically active, and some do not show this feature.