Carbon-palladium films as gas sensors (hydrogen, ammonia, methane)

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ABSTRACT

In this paper we present the results of the resistances changes of carbon-palladium films under the influences of gas like hydrogen, ammonia and methane. Our research has shown that carbon-palladium films (C-Pd films) according to the form and the structure in which they appear, they can respond to a variety of gases. The C-Pd film obtained by Physical Vapor Deposition (PVD) method is sensitive to hydrogen and do not respond to the ammonia. Thermal modification of the C-Pd film in Chemical Vapor Deposition (CVD) process affects the morphology of the film, increases its resistance and it causes that this film begins to react to the ammonia. This change causes that this film stops responding on hydrogen. Film sensitive to methane was obtained by changing the technology conditions of the PVD process. The reaction of C-Pd film on the hydrogen and the ammonia is increase resistance, while film sensitive to methane reacts by decrease of initial resistance value. In both cases, the changes are reversible after cleaning by air atmosphere. Different varieties of C-Pd films can be used to build selective sensors for hydrogen, ammonia and methane.
Keywords: carbon, palladium, hydrogen, ammonia, methane

1. INTRODUCTION

Gas sensors are used in order to public security, medical diagnosis, environmental pollution, vehicle emissions, food processing, industrial emission, agriculture, aerospace and aeronautics, inter alia. Such devices at the time of the emergence of dangerous gases in the atmosphere are changing one or more of its physical properties, so that they can be measured directly or indirectly [1-2].

Currently, the most popular gas detectors are semiconductor resistive gas sensors. Metal oxides such as SnO_2, ZnO, TiO_2, or WO_3 for example often with various dopants and catalysts are the gas sensitive materials used for manufacturing gas sensors [3-6]. This device besides numerous advantages (high sensitivity of different gases, low power consumption, small size, low production costs and ease of implementation in set-ups) are also characterized by low selectivity, low resistance to temperature changes and environment humidity, lack of a long-term stability.

Hydrogen, ammonia and methane have a number of unusual and useful properties. In addition, these gases have numerous applications. Large quantities of these gases are used in the energy and chemical industries. H_2 is used for the processing of fossil fuels, in the production of ammonia, as a hydrogenating agent and in the production of methanol. Hydrogen is also used as the rotor coolant in electrical generators at power stations, because it has the highest thermal conductivity of from known gases [7-9]. The largest quantities of ammonia are consumed in the production of fertilizers and to receive nitric oxide (II), which is an intermediate product for nitric acid. Ammonia is also used to make compounds like hydrazine, hydrogen cyanide, phenol, hydroxylamine, urea, or amino acids [10-11]. Methane is used as a fuel gas and raw material for the synthesis of many other organic compounds (inks, rubber products, ammonia, petroleum and synthetic oils, solvents).

So many applications these gases create so it is the need to ensure safety and continuous monitoring of the concentration of these gases in the places where they may leak. In order to meet these needs, are still underway studies whose purpose is to obtain and developing reliable sensors. These sensors should be characterized by selectivity for different gases, sensitivity at low concentrations, fast response and low maintenance. A study in this area has been focused on the search for functional sensing materials.

Our C–Pd films containing palladium nanograins incorporated in a carbon matrix, investigated in this paper, seem to be promising materials for gas sensing applications.

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