Materials Science Forum
ISSN: 1662-9752, Vol. 1006, pp 239-244
doi:10.4028/www.scientific.net/MSF.1006.239

Submitted: 2020-03-23
Revised: 2020-03-26
Accepted: 2020-03-29
Online: 2020-08-07

Investigation of the Gas Sensitive Properties of Tin Dioxide Films Obtained by Magnetron Sputtering

Igor Chub[1,a*], Oleksandr Pirogov[1,b], Oksana Mirgorod[1,c] and Sergey Rudakov[1,d]

[1]National University of Civil Defence of Ukraine, 94, Chernishevska str., Kharkov, Ukraine, 61023

[a]igorchub1959@gmail.com, [b]pir.s@ukr.net, [c]mir-oksa@ukr.net, [d]serg_266@ukr.net

Keywords: tin dioxide films, gas sensor, magnetron sputtering

Abstract. In an article, studies of tin dioxide films for challenging sensitive elements of gas sensors for monitoring gaseous impurities in air have been described. The technological influence issues parameters of the process producing of tin dioxide films by magnetron sputtering at a fixed magnetron power on their crystal structure and phase composition were considered. The substrate temperature, layer thickness, and oxygen concentration in the atomized gas were considered as parameters. The foundation for improving the constructive and technological solutions of film gas sensors based on the research results was laid.

1 Introduction

The environmental worsening, as well as the tasks of improving the safety of production and housing and communal services, necessitates the widespread use of resistive gas sensors of the adsorption-semiconductor type. These sensors are capable of detecting the presence of various gaseous impurities in the air [1]. In such sensors sintered dioxide powders SnO_2 [2] are traditionally used as sensitive elements. The electrical conductivity of SnO_2 depends on the number of impurity atoms adsorbed from the environment by the surface of crystallites. However, the production of such sensors is material- and energy- intensive. In addition, gas-sensitive properties are manifested at temperatures above 200 °C, which limits the scope of their application and increases the cost and energy consumption. Thin-film performance of gas sensors contributes to the solution of these problems by miniaturization of these devices [3]. Therefore, technologies are currently being developed for sputtering tin oxide films by the following methods: reactive cathodic sputtering, magnetron sputtering of a pure tin target in an oxygen-containing atmosphere, high-frequency magnetron sputtering of a tin dioxide target, pyrolysis of a tin chloride solution and oxidation of a metal film coated by thermal vacuum evaporation [4]. At the same time, significant progress is observed in improving the constructive and technological solutions of film gas sensors, which leads to an increase in gas-sensitivity and selectivity.

2 Unresolved Issues

The substrate temperature, the layer thickness and the oxygen concentration in the atomised gas have a significant effect on the crystal structure and phase composition of SnO_2 films obtained by magnetron sputtering at the fixed magnetron power [5]. These issues have not yet been widely reflected in the scientific literature by despite their considerable practical importance. Therefore, the purpose of the study is to influence these parameters on the gas-sensitive properties of tin dioxide films to optimize the conditions for obtaining the basic layers of SnO_2 gas sensors of the adsorption-semiconductor type.

3 Main Part

The temperature in the range from 150°C to 350°C of the substrate during the deposition of tin dioxide films have been varied by the oxygen concentration in the gas mixture from 20% to 100%. The film thickness has been varied by from 50 nm to 350 nm. All specimens on sitall substrates