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Zink selenide nanofilms application in carbon monoxide detection

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Abstract

The article is aimed at developing innovative primary transducer nanoscale material for semi-conductor sensors and investigating their surface physicochemical properties. Zink selenide nanofilms were obtained by discrete thermal evaporation in vacuum. Adsorption properties of the given material for carbon oxide (II) and oxygen were studied by the piezoquartz microweighing. Zink selenide nanofilms applicability in gas analysis was investigated. Based on the obtained experimental data, CO micro-impurities sensor was developed, the laboratory tests passed successfully.

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Keywords: nanofilms; ZnSe; adsorption; carbon monoxide; sensor

1. Introduction

Currently, carbon oxide (II) is widely used in organic synthesis industry. However, carbon monoxide acute toxicity, together with smell and colour absence, often results in severe poisoning with fatal outcome. All this calls for timely monitoring of industrial enterprises process media composition.

CO content rapid detection with sensor systems is one of the ways to solve the above-mentioned problem.

Special attention is to be given to the sensors with sensitive element represented by A^2B^6 type diamond-like semiconductors polycrystal films. This allows for toxic gases micro-impurities to be detected at low, even room, temperatures [1].

Significant improvement of such sensor characteristics can be achieved by using nanomaterials [2], such as ZnSe nanofilms investigated in the present work.

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2. Research technique

To obtain ZnSe nanofilms (d=30…100 nm), the method of discrete thermal evaporation in vacuum was used (vacuum universal post VUP-5). The evaluation of ZnSe nanofilms applicability in carbon monoxide diagnostics was carried out on the basis of adsorption research results, the research having been performed with the piezoquartz microweighing in temperature and pressure ranges of 243...393 K and 3...26 Pa, correspondingly. Adsorbates (CO and O_2) were obtained according to the procedures described in [3]. Adsorption values were determined by the investigation findings, and thermodynamic characteristics of adsorption (differential heat and adsorption entropy changes) were calculated [4].

3. Results and discussion

The research of ZnSe nanofilms (d=30 nm) adsorption properties has demonstrated high selective sensitivity of the material to the chosen adsorbates. Thus, CO and O_2 adsorption values equal 10^{-2} mmol./m^2 (Fig. 1,2).

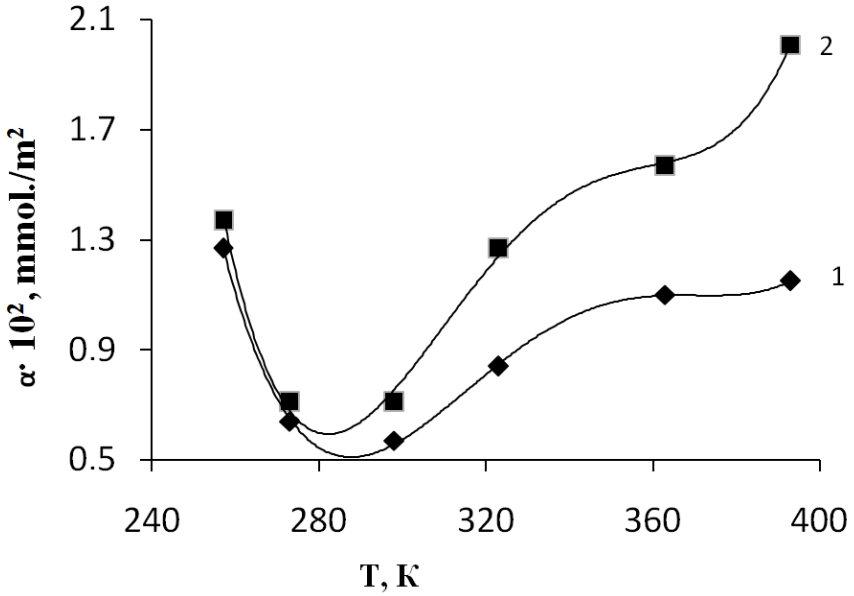

Fig. 1. Temperature dependencies of CO (1) and O_2 (2) adsorption values on ZnSe nanofilm at P_n=15 Pa

Moreover, the given values are 2-3 times higher than those obtained by the authors [5] in investigating adsorption properties of ZnSe films with 0.25-0.3 μm thickness, indicating the advanced adsorptive sensitivity of the nanoscale materials.

ZnSe nanofilms surface selective sensitivity is due to chemical adsorption of oxygen and carbon monoxide starting with 298 K. This is also indicated by the typical experimental dependences - isobars of adsorption**,** as well as by the calculation of thermodynamic adsorption characteristics: differential heat and adsorption entropy *(q_a, ΔS_a)*. Moreover, q_a values for CO and O_2 amount to 15 and 21 kJ/mol., respectively; ΔS_a values equal (-81.8)…(-66.9) J/(mol.·K) for the entire temperature range.

The analysis of ZnSe nanofilms adsorption properties leads to the conclusion that this adsorbent surface is highly sensitive to O_2 in contrast to CO in all investigated temperature and pressure ranges (Fig. 1,2).