Composite material based on oriented nickel oxide networks in a polymer matrix as an active element of a conductometric greenhouse gas sensor

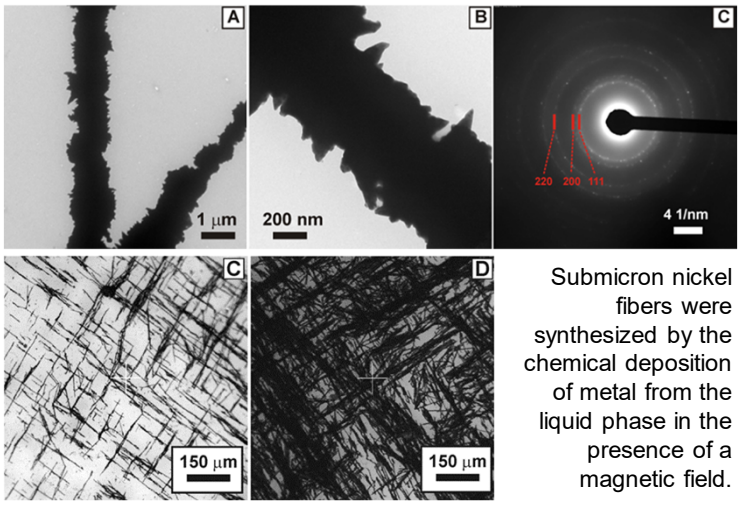
Nizameeva G.R.[1,2], Lebedeva E.M.[1], Gainullin R.R.[1], Nizameev I.R.[1,3], Sinyashin O.G.[1]

[1] Arbuzov Institute of Organic and Physical Chemistry, FRC Kazan Scientific Center of RAS, Kazan, Russia;
[2] Kazan National Research Technological University, Kazan, Russia;
[3] Kazan National Research Technical University named after A.N. Tupolev - KAI

Introduction

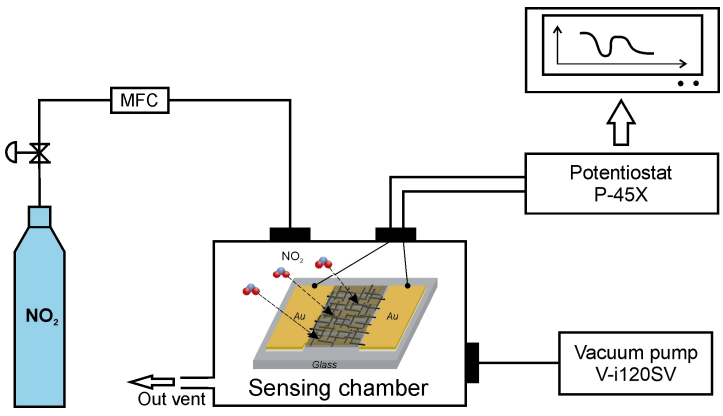
Currently, industrial cities have a problem of greenhouse gases large amount emission into the atmosphere. Nitrogen dioxide is currently considered one of the most toxic and dangerous greenhouse gases. This is a highly toxic compound that has an adverse effect not only on the human body, but also on the environment. In this regard, today there is a high need to create active elements of sensors capable of responding to a low content of nitrogen dioxide in the atmosphere. In the framework of this work, it is proposed to use a composite material based on oriented submicron nickel oxide fibers in a PEDOT-PSS polymer matrix as such an active element of a conductometric nitrogen dioxide sensor.

Characterization of submicron nickel nanowires



Submicron nickel fibers were synthesized by the chemical deposition of metal from the liquid phase in the presence of a magnetic field.

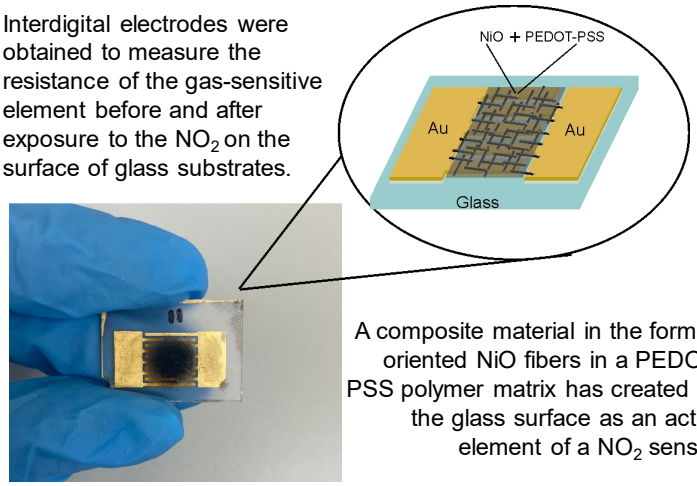
Gas sensing measurements



The sensory properties of the finished samples were studied on specially designed equipment, consisting of a sealed capsule, a detector with an embedded gas-sensitive element, a target gas cylinder, a pressure-reducing valve, a personal computer, and a potentiostat for controlling a given voltage and measuring current. The tests were carried out at room temperature and relative air humidity of 45%. Nitrogen dioxide was used as the target gas.

Composite material

Interdigital electrodes were obtained to measure the resistance of the gas-sensitive element before and after exposure to the NO_2 on the surface of glass substrates.



A composite material in the form of oriented NiO fibers in a PEDOT-PSS polymer matrix has created on the glass surface as an active element of a NO_2 sensor.

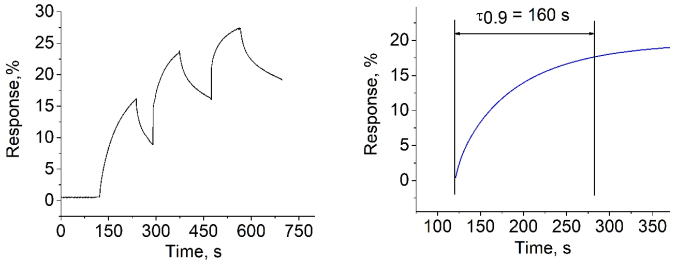
NO_2 sensing properties

The sensor response was calculated by the formula:

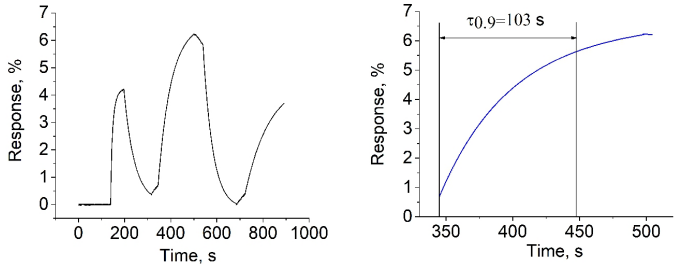
$$R_r=(R_{gas}-R_0)/R_0,$$

where R_{gas} is the sensor resistance in the presence of the test gas, R_0 is the sensor resistance before exposure to the test gas.

Composite material NiO-PEDOT:PSS



PEDOT:PSS



NO_2 sensing properties	Types of gas-sensitive element	
	PEDOT-PSS film	PEDOT-PSS / Oriented nickel oxide fibers composite film
Response R_r	6 %	27 %
Response time $\tau_{0.9}$	103 s	160 s

The reported study was funded by the government assignment for FRC Kazan Scientific Center of RAS