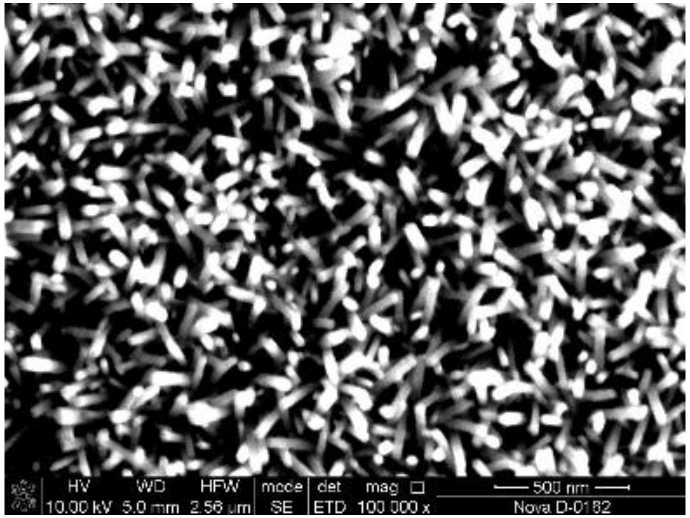
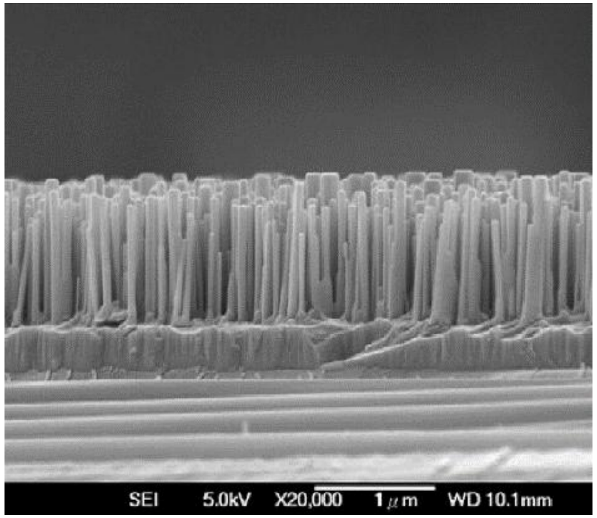
ECSA-6
6th International Electronic Conference on Sensors and Applications
15 – 30 November 2019

THE STUDY OF THE STRUCTURE BASED ON THE ARRAY OF ZNO-NANORODS AS A SENSOR OF THE GAS FLOW RATE

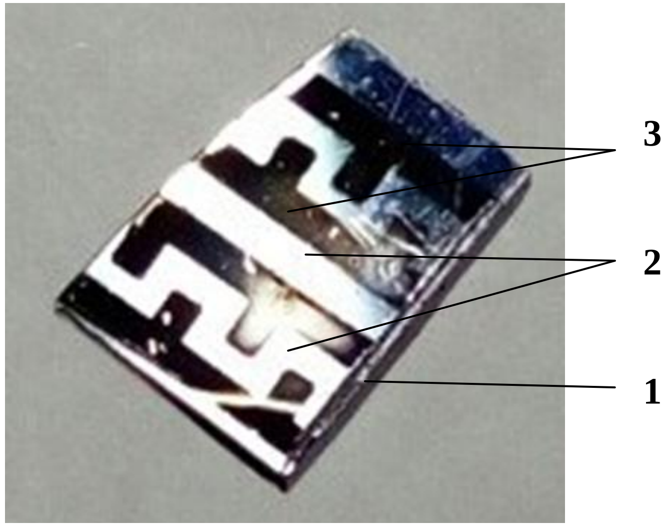
Victor V. Petrov, Alexandra P. Starnikova
Research and Education and Centre “Microsystem technics and multisensor monitoring systems”,
Southern Federal University
Russia, Taganrog, Chekhov Str. 2
vvp2005@inbox.ru



SEM image of an array of ZnO nanorods on a silicon substrate, the average transverse size of about 30-40 nm



SEM images of lateral cleavage (right) of ZnO nanorod array samples



Silicon substrate (1) with an array of ZnO nanorods (3) and contact metallization (2)

EXPERIMENTAL TECHNIQUE

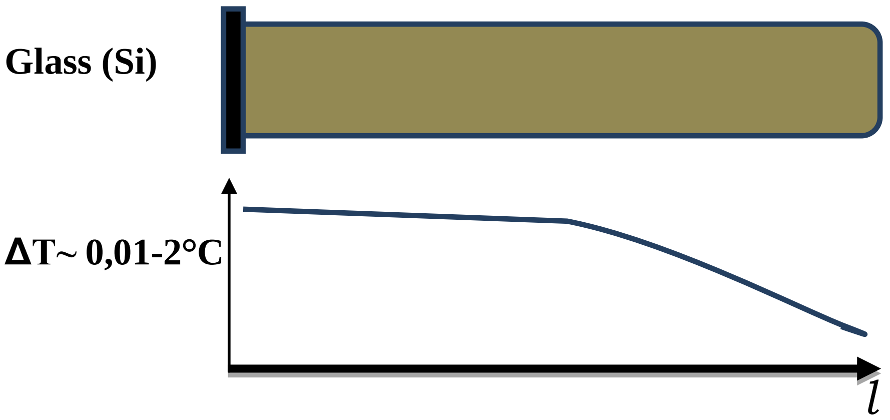
Measurements of electrophysical properties were carried out on an automated bench for determining the parameters of sensors: electronic control unit for the gas distribution system (1), solenoid valves (2), mixing chamber (3). receiver (4). unit for controlling the flow rate of the original gas components (5) unit for controlling the flow of gas mixture (6); measuring chamber (7); cylinders with original gas components (8), personal computer (9), Keithly multimeter 2450 (10) heating control unit (11).

Air was supplied to the sensor at a flow rate of 0 to 12.5 cm / s

The appearance of the stand for the formation of a gas mixture and calibration of gas sensors

Victor V. Petrov, Alexandra P. Starnikova

THEORETICAL INVESTIGATIONS



Investigation of reducing the temperature of the free end of ZnO nanorod.

The theoretical estimate of the decrease in temperature of the free end of ZnO nanorod under isothermal heating / cooling according to the formula:

$$T_2 = T_1 \frac{k \cdot a}{\mu \cdot sh(a \cdot l) + k \cdot a \cdot ch(a \cdot l)},$$

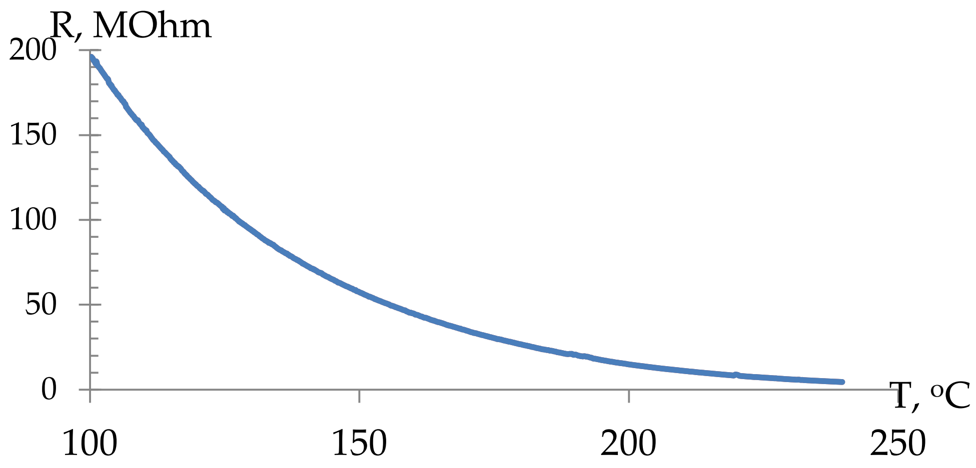
where $a = \sqrt{\frac{\mu \cdot p}{k \cdot \sigma}}$, T_1, T_2 – temperature of the fixed end and temperature of the free end of the ZnO nanorod, respectively; l, σ, p – the length, area and perimeter of the cross section of the ZnO nanorod, respectively; k – the coefficient of thermal conductivity of the rod; μ - coefficient of heat transfer from the rod to the environment.

Theoretical calculations carried out using the expression (1) showed that the temperature of the free end of the nanorod when it is blown with air can decrease from hundredths to several degrees, depending on the values *k* and μ.

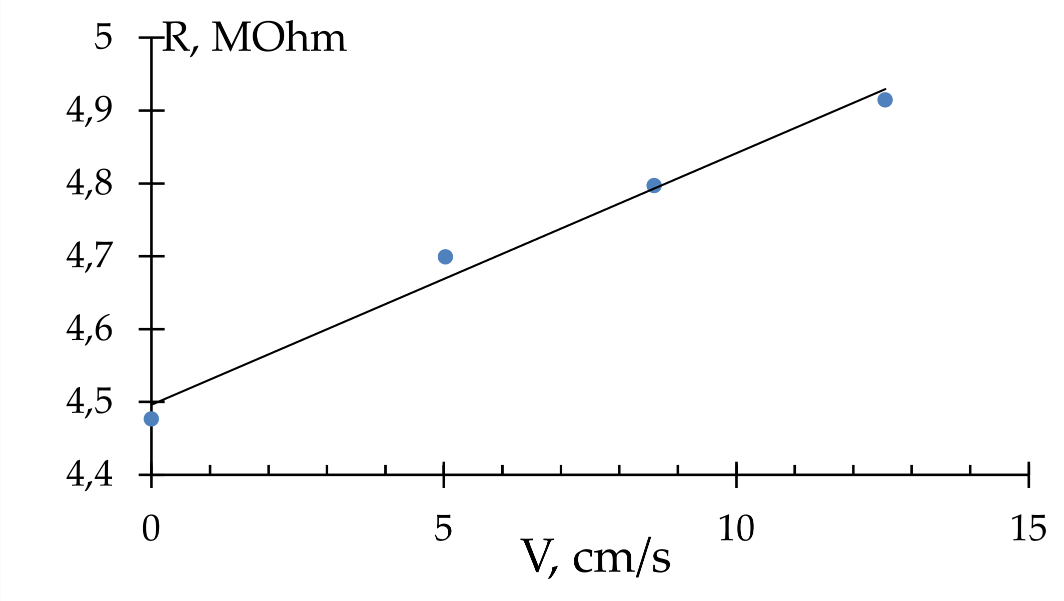
Victor V. Petrov, Alexandra P. Starnikova

THE STUDY OF THE STRUCTURE BASED ON THE ARRAY OF ZNO-NANORODS AS A SENSOR OF THE GAS FLOW RATE

RESULTS OF EXPERIMENTS



Temperature dependence of the resistance of a sample of a sensor structure based on an array of ZnO nanorods



The dependence of the resistance of the sensor structure on the speed of air flow (points - experiment; line - approximation)

In the temperature range of 100 - 250 ° C, it is well approximated by a power-law dependence with a correlation coefficient of 0.95:

$$R = 2{,}19 \cdot 10^{10} \cdot T^{-4{,}21}$$

The dependence shown in Figure 2 is well approximated by an expression with a correlation coefficient of 0.986:

$$R = 0{,}0346 \cdot V + R_0$$

where V is the air flow rate (cm / s); R_0 is the resistance of the sensor structure at zero air flow rate.

Results. Studies have shown that sensor elements based on ZnO nanorods can be used as a sensitive element for measuring low air velocities. The parameter sensitive to the flow velocity is the resistance of the sensor element, which linearly increases in the range of flow velocities 0 - 12.5 cm / s.

Thank you for your attention