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Matrix nanocomposite for chemoresistive oxygen sensor

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Field of invention

Oxygen sensors are widely used in Industrial applications, such as the control of air-fuel mixture, combustion engine, domestic and other small-scale boilers emission monitoring in automotive, steel and cement industries. Monitoring O_2 concentration is essential in other fields, such as medicine, food packaging industries, marine biology, soil aeration, limnology and waste management.

Original approach

- This invention includes the design and manufacturing processes for a new resistive, room temperature oxygen sensor, employing perovskite $SrTi_{0.6}Fe_{0.4}O_3$ (STFO40) / oxidized carbon nanohorns (CNHox) nanocomposite as sensing layer.
- The oxygen sensor includes a Si/SiO_2 substrate, interdigitated electrodes and a sensing layer obtained *via* drop casting method.
- The oxygen monitoring capability of the sensing layers was investigated by applying a current between the two electrodes and measuring the voltage, while varying the oxygen concentration in the testing device. The resistance of the sensitive layer varies with the oxygen concentration.

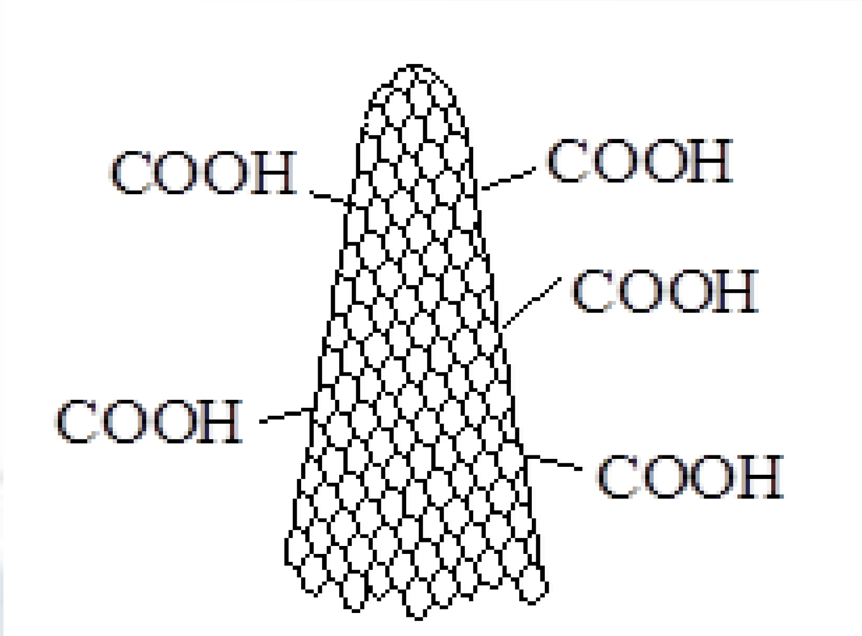

Figure 1 – **Structure of oxidized carbon nanohorns (CNH_{OX})**

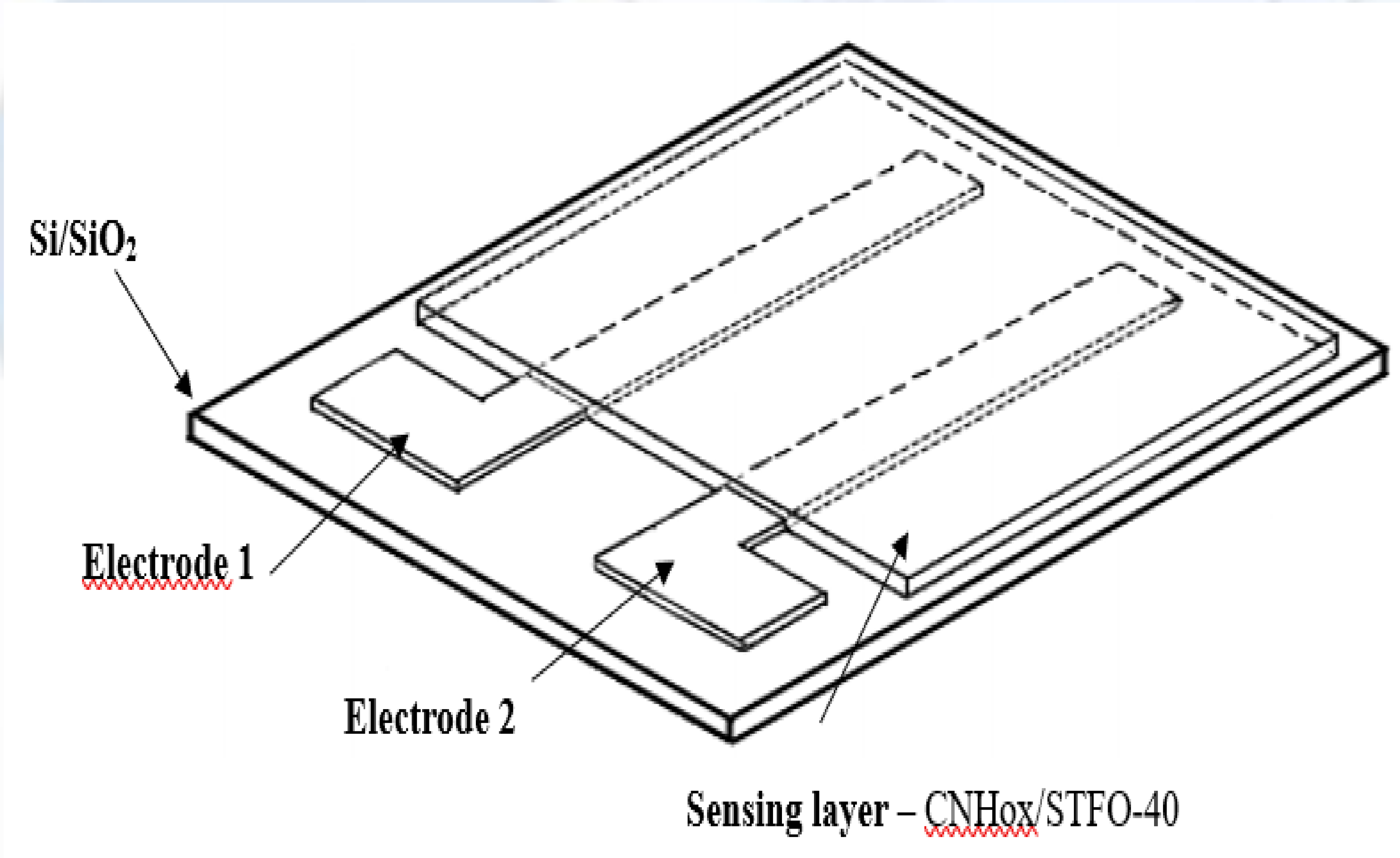

Figure 2 **–The structure of sensor with linear electrodes**

Sensor architecture

a) The suspension obtained is deposited by the drop casting method using a Si/SiO_2 substrate with linear electrodes or with interdigitated electrodes (after masking the contact area).

b) The obtained layer is subjected to a thermal treatment at 500°C, 60 minutes. The thermal treatment ensures the strengthening of the sensitive layer.

The oxygen monitoring capability was investigated O_2/N_2 mixtures in different proportions.

Sensor manufacturing

Sensitive layer preparation comprises the following stages:

a) Stoichiometric quantities of $Sr(NO_3)_2$ and $Fe(NO_3)_3$ are dissolved in 10 mL of deionized water;

b) TiO_2 nanopowder is added to the solution obtained in the previous step;

c) Separately, a 4M NaOH solution is prepared;

d) Solutions obtained in steps a) + b) is pipetted into the NaoH solution prepared in step c), under continuous magnetic stirring;

e) The obtained reaction mixture was ultrasonicated for 2 hours, using a Hielscher UP200St ultrasonic generator (200 W, 26 kHz). The temperature in the reaction vessel was maintained at $T < 350K$ using an ice bath.

f) The pH of the solution is adjusted to a value of approximately 7.

g) The solution is filtered, dried in air at a temperature of 100 °C.

h) Anhydrous synthesized STFO- 40 is then subjected to a thermal treatment at 500 °C for one hour.

i) Prepare a suspension of STFO-40, terpineol (solvent), carboxymethylcellulose (binder), caprylic acid (surfactant) and oxidized carbon nanohorns (Fig.1). The components of the suspension are added in a mass ratio of 30/30/5/5/30.

Advantages of the proposed sensing layer

The new synthesized sensing layer used in the manufacturing of resistive oxygen sensor has several significant advantages:

- the presence of CNHs-ox ensures a high specific surface area / volume ratio as well as a substantial affinity for oxygen molecules;
- detection at room temperature;
- rapid response of the sensor to variations of oxygen concentration.

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