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Resistive oxygen sensor and its manufacturing method

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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 consisting of perovskite (STFO60) / oxidized carbon nano-onions (ox-CNOs) 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 at different values of the oxygen concentration at which the sensing layer was exposed. The resistance of the sensitive layer varies with the oxygen concentration.

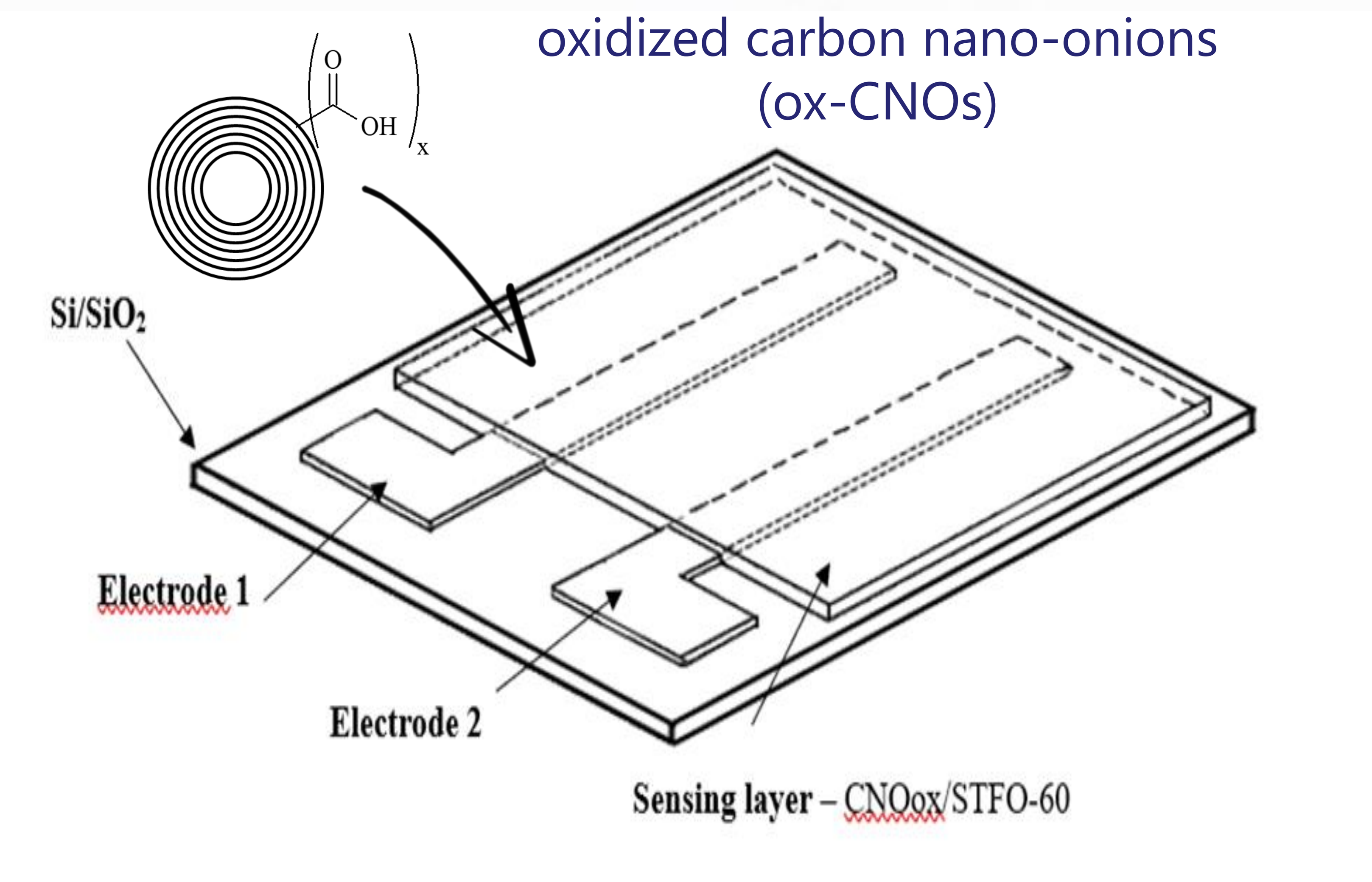

Figure 1 **– The structure of sensor with linear electrodes**

Preparation of sensing device

Sensitive layer preparing steps

1. Onion-type nanocarbon materials (CNOs) are synthesized from nanodiamond, by thermal treatment at 1650 °C, in a helium atmosphere.
2. The oxidation of CNOs is carried out by treatment in oxygen plasma, in a quartz tube, at a pressure of 7 torr, at room temperature. The injection time is 2 minutes, the exposure time varying between 5 and 10 minutes.
3. The dispersion of ox-CNOs is prepared by dissolving 4 mg of ox-CNOs in 10 mL of deionized water, under magnetic stirring for 60 minutes, at room temperature.
4. A suspension of STFO-60, glycerol (solvent), hydroxypropyl cellulose (binder) and caprylic acid (surfactant) is prepared. Suspension components are added in a mass ratio of 60/30/5/5.
5. The solution prepared in step 3 is added under continuous magnetic stirring to the suspension obtained in step 4, so that the mass ratio of ox-CNOs-STFO 60 varies between 1 and 5.

Sensor manufacturing

1. The obtained suspension is deposited by the "drop casting" method on a Si/SiO_2 substrate with linear electrodes or with interdigitated electrodes (after masking the contact area beforehand).
2. The obtained layer is subjected to a heat treatment at 500 °C, 60 minutes.

Oxygen measurements

The oxygen monitoring capability (O_2/N_2 mixtures in different proportions) was investigated by applying a current between the two electrodes and measuring the voltage at different values of the oxygen concentration to which the sensitive layer was exposed.

Advantages of the proposed solution

The sensitive layers described in this invention, used to obtain resistive sensors for monitoring the oxygen concentration, are nanocomposites consisting of perovskite $SrTi_{0.4}Fe_{0.6}O_{2.8}$ (STFO60) / oxidized onion-type nanocarbon materials.

The use of perovskite nanocomposite (STFO60) / onion-type oxidized nanocarbon materials gives some important advantages:

- Ox-CNOs give a high specific surface / volume ratio, affinity for oxygen molecules, as well as a variation in the resistance of the sensitive layer upon contact with oxygen;
- detection over a wide temperature range, the nanocomposite matrix used being sensitive to the variation of oxygen concentration both at ambient temperature and at high temperature;
- quick response of the sensor to variations in the oxygen concentration value, reversibility, chemical, mechanical, thermal stability, reduced drift.

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