NO_2 chemiresistive sensor

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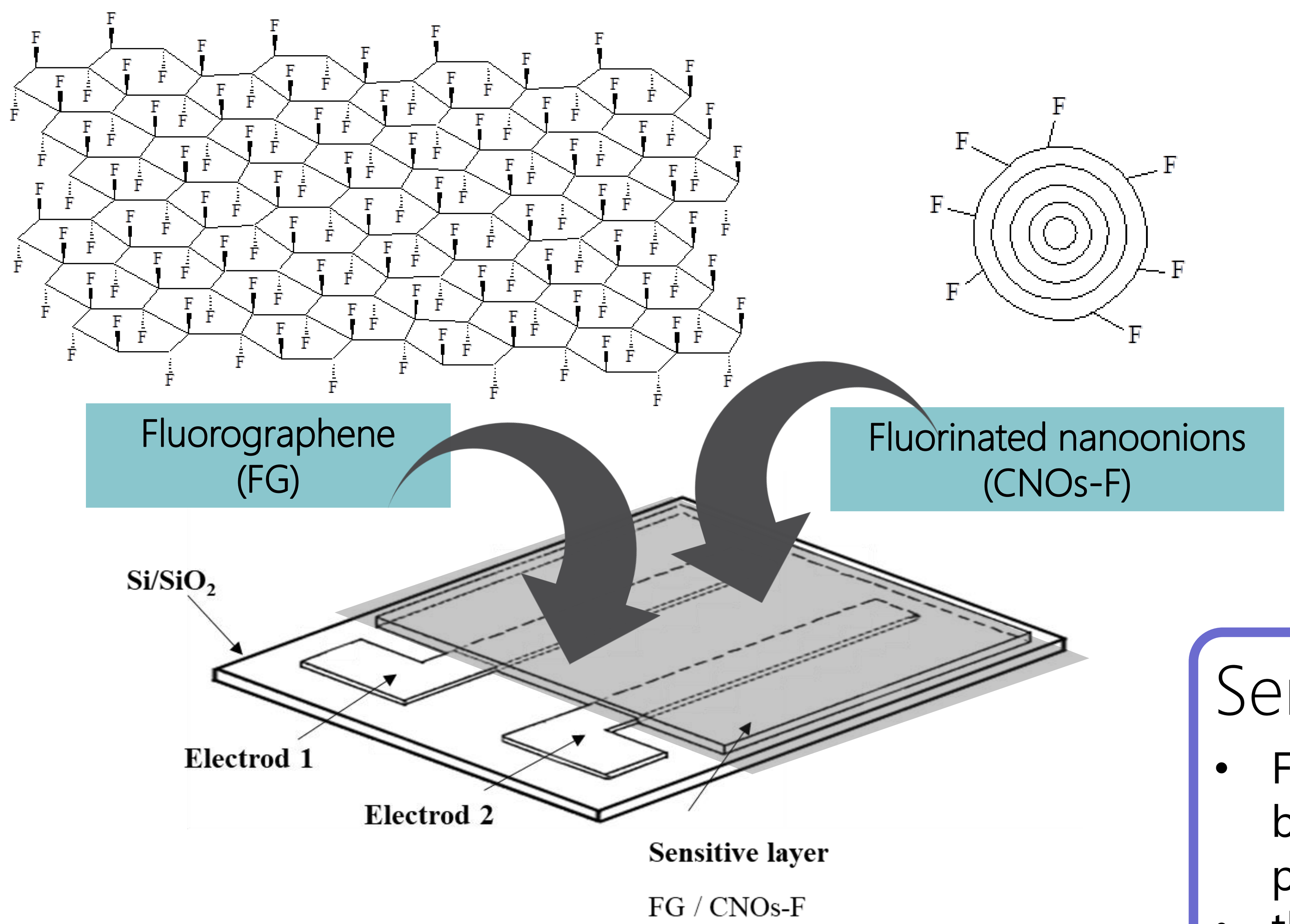
Field of Invention

Nitrogen dioxide (NO_2) is a significant air pollutant with harmful effects on human health and the environment. The increasing awareness of the health and environmental impacts of nitrogen dioxide (NO_2) has led to the development and growth of the NO_2 sensor market. As the need for monitoring and controlling NO_2 emissions has become more significant, several factors have contributed to the remarkable development of this market in recent decades: (a) environmental regulations and air quality standards have been implemented in many regions, which mandate the monitoring of NO_2 levels in all areas, especially in areas with high pollution levels, (c) industries that produce NO_2 emissions, such as automotive, power generation, and manufacturing, require sensors to comply with emission standards and to optimize their processes, (d) the emergence of Internet of Things (IoT) and the concept of smart cities has led to the integration of NO_2 sensors into urban infrastructure for real-time monitoring and data collection. This data can be used to improve public health and reduce pollution.



Original approach

The technical problem that the present invention solves consists in obtaining new layers sensitive to the variation of the NO2 concentration, used in the design of resistive sensors.The sensitive layers described in this invention, which can be used to obtain resistive NO_2 sensors, are fluorographene (FG) nanocomposite matrices - fluorinated onion-type nanocarbon materials (CNOs). From the point of view of the detection principle, the resistance of the sensitive layer varies with the NO_2 concentration level.

Sensing structure

The sensitive layers made of FG / CNOs – F mixture are deposited on the SiO_2 substrate

Sensor manufacturing

- Fluorographene synthesis is carried out from graphene (powder) by plasma treatment of F_2 and Ar (volume mixture 1:8) at a pressure of 0.6 bar, in a nickel reactor, at room temperature.
- the synthesis of onion-type fluorinated nanocarbon materials (CNOs-F) is carried out by plasma treatment of F_2 and N_2 (volume mixture 1:10) at a pressure of 0.5 bar, in a nickel reactor, at room temperature.

Sensor manufacturing

- the fluorographene dispersion is prepared by dissolving FG in ethanol, under magnetic stirring for three hours at room temperature.
- fluorinated onion-type nanocarbon materials are added to the dispersion obtained previously, under magnetic stirring for three hours, at room temperature.
- the obtained dispersion is deposited by the "drop casting" method on the Si/SiO_2 substrate with linear electrodes or with interdigitated electrodes (after masking the contact area beforehand).
- the sensitive layer obtained is subjected to a thermal treatment at 120 ^{0}C, for two hours, in a vacuum.

Advantages of the proposed sensing device

The use of the fluorographene nanocomposite matrix - fluorinated onion-type nanocarbon materials as sensitive layers presents several undeniable advantages:

- fluorographene and onion-type fluorinated nanocarbon materials give a high specific surface / volume ratio, as well as a variation in the resistance of the sensitive layer upon contact with NO_2 molecules;
- the presence of fluorine atoms, through their hydrophobic effect, minimizes the effect of humidity on the resistance variation of the sensitive layer;
- detection at room temperature;
- due to the increased electronegativity, the fluorine atoms increase the polarity of the surface of the nanocarbon material, creating temporary dipoles that facilitate the interaction with NO2 molecules;
- chemical and thermal stability;

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