Nanocomposite matrix for NO_2 sensor with surface acoustic waves

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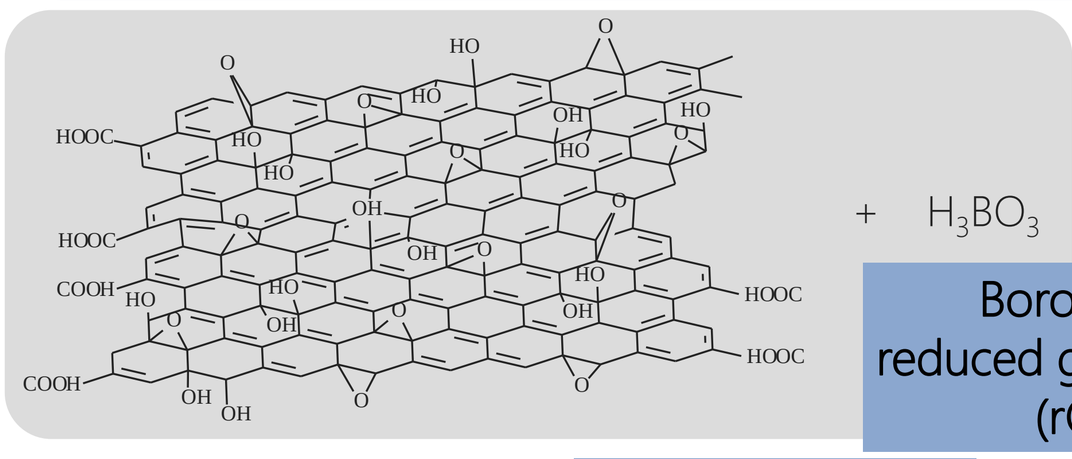
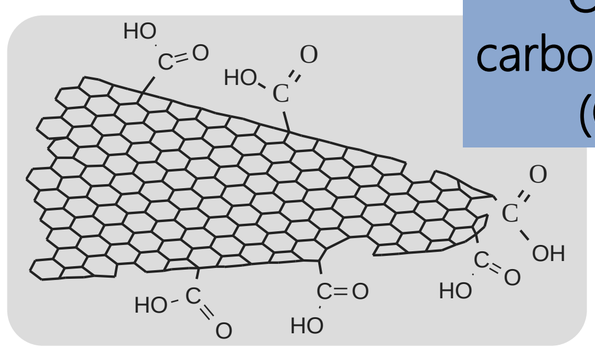
Field of Invention

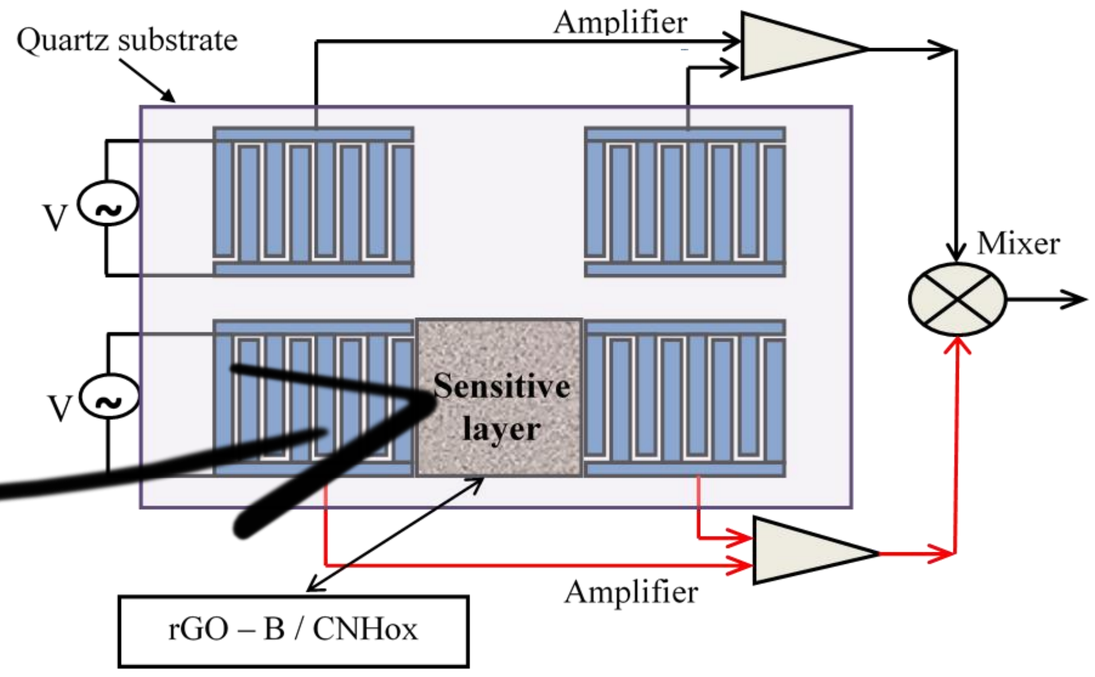
Nitrogen dioxide (NO_2) is a significant air pollutant with harmful effects on human health. Exposure to NO_2 has various adverse effects, especially on the respiratory system. Prolonged or repetitive exposure to NO_2, even at low concentrations, can lead to various health problems that include respiratory issues like bronchitis, decreased lung function, and increased susceptibility to respiratory infections. It can also exacerbate pre-existing respiratory conditions such as asthma. NO_2 is primarily produced by combustion processes, particularly in vehicles, power plants, and industrial facilities. It is a component of air pollution, often associated with urban areas and areas with high traffic. NO_2 is also a contributor to environmental problems. It can lead to the formation of ground-level ozone, which is harmful to both human health and plant life. Additionally, NO_2 is a greenhouse gas, contributing to climate change. Monitoring air quality and implementing measures to reduce NO_2 emissions are essential for public health and the environment.



Boron doped reduced graphen oxide (rGO-B)

Oxidized carbon nanohorns (CNHox)





Sensing structure

The sensitive layers made of rGO-B / CNHox are deposited on the piezoelectric quartz substrate by the drop-casting method or by the spin-coating method.

Original approach

The devices described in this invention consist of new sensitive layers for the detection of nitrogen dioxide. The sensitive films described in this invention are used in the design of a surface acoustic wave (SAW) sensor. A surface acoustic wave device is usually composed of a piezoelectric substrate, a pair of interdigital transducers, as well as a layer sensitive to the analyzed gas. The electrical signal, applied to one of the transducers, generates a surface acoustic wave that propagates to the other transducer, the mechanical wave being converted into an electrical signal. The proposed sensitive layers is made of new binary nanocomposite matrices with reduced graphene oxide, boron-doped (rGO - B) / oxidized carbon nanohorns (CNHox).

Sensor manufacturing

- graphene oxide dispersion in water is subjected to ultrasound for two hours;
- a stoichiometric amount of boric acid (H_3BO_3) is added to the obtained dispersion and subjected to ultrasound for 60 minutes.
- the resulting dispersion is placed in an oven and heated at 100 ^{0}C to evaporate the liquid phase. The solid phase obtained is ground, placed in an alumina crucible, and heated in a tube furnace, in N_2 atmosphere, at 500 ^{0}C. Subsequently, the resulting product is dissolved in water and ultrasonicated. HCl (1 M) is added to the resulting dispersion and stirred magnetically for 24 hours. The obtained dispersion is centrifuged and washed with distilled water. Afterward, oxidized carbon nanohorns is added to the previously prepared dispersion and continue the magnetic stirring at room temperature. Finaly, the obtained dispersion is deposited on the SiO_2 substrate. The sensitive layer obtained is subjected to a thermal treatment at 90 ^{0}C, in a vacuum.

Advantages of the proposed sensing layer

- reduced graphene oxide, doped with boron has a higher affinity for NO_2 molecules compared to reduced graphene oxide; and π-π type interactions between reduced graphene oxide, doped with boron, and oxidized carbon nanohorns ensure mutual homogeneous distribution in the sensitive layer.

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