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BORON DOPED REDUCED GRAPHEN OXIDE - OXIDIZED CARBON NANOHORNS MIXTURE FOR SURFACE ACOUSTIC WAVE SENSOR

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Introduction

In a Surface Acoustic Wave (SAW) device, the piezoelectric quartz substrate plays a crucial role in generating and transmitting acoustic waves. Interdigital Transducers (IDTs) are electrodes patterned on the piezoelectric quartz surface. When an alternating voltage is applied to these transducers, it generates an oscillating electric field. Due to the piezoelectric effect, the oscillating electric field interacts with the quartz substrate, causing mechanical deformations. These deformations generate acoustic waves that travel along the surface of the quartz substrate. The surface acoustic waves propagate across the surface of the piezoelectric substrate from the transmitting IDT towards the receiving IDT. If the piezoelectric surface is modified it can change how the surface acoustic waves propagate. This might affect the wave velocity, amplitude, or attenuation, which can be useful for sensing specific properties like temperature, pressure, or the presence of certain chemical species.
The interaction of NO_2 molecules with oxidized carbon nanotubes and reduced boron-doped graphene oxide can be interpreted from the perspective of HSAB theory. Thus, a "soft acid - soft base" interaction between the NO_2 molecules and the sensitive layer consisting of a nanocomposite matrix, oxidized carbon nanohorns - reduced graphene oxide doped with boron, is to be anticipated.

Materials and methods

The sensitive layer of the type of oxidized carbon nanohorns/reduced graphene oxide, doped with boron is obtained by following the procedure bellow:
- 10 mL graphene oxide dispersion in water - 4mg/mL (purchased from Sigma Aldrich) 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 °C for 3 hours to evaporate the liquid phase.
- the solid phase obtained is ground, placed in an alumina crucible and heated in a tube furnace, in an N2 atmosphere, at 500 °C for 60 minutes at a growth rate of 20 °C/min. Subsequently, the resulting product is dissolved in distilled water and sonicated, and 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.

For the preparation of mixture 1 mg of reduced graphene oxide, doped with boron, is dispersed in ethyl alcohol at room temperature and ultrasonicated for 3 hours. Oxidized carbon nanohorns (10 mg) is added to the previously prepared dispersion and continue the magnetic stirring for 60 minutes at room temperature. The obtained dispersion is deposited by the drop casting method on the substrate (Figure 1). The sensitive layer obtained is subjected to a thermal treatment at 90 °C, for three hours, in a vacuum.

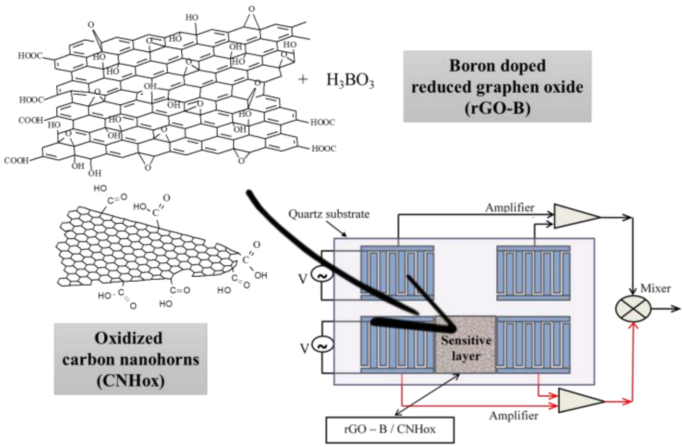

Figure 1. NO_2 SAW sensing device

Results and conclusions

The proposed sensitive layers is made of new binary nanocomposite matrices with reduced graphene oxide, boron-doped (rGO - B) / oxidized carbon nanohorns (CNHox).

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.