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QUATERNARY HYDROPHILIC NANOHYBRID COMPOSITION FOR RESISTIVE HUMIDITY SENSORS

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INTRODUCTION

- Many principles and methods were described in literature for measuring relative humidity (RH) and several types of materials were employed as RH sensing layers. The present invention relates to the RH sensing response of a resistive sensor employing a sensing layer based on a quaternary nanohybrid composition comprising or consisting of CNH_{OX} (**FIG 1**)/GO/SnO_2/PVP at 1/1/1/1 to 0.75/0.75/1/1 w/w ratio. The quaternary hydrophilic nanohybrid compositions exhibit several significant advantages, when employed as RH sensitive layers:
- both oxidized carbon nanohorns (CNH_{OX}) and graphene oxide (GO) are nanocarbonic materials with high specific surface area (SSA)/volume ratio, affinity for water molecules, and exhibit rapid variation of the electrical resistance in contact with water molecules, when varying RH from 0% to 90%;
- nanometric tin (IV) oxide (SnO_2) powder exhibits good RH sensitivity;
- PVP is a hydrophilic polymer with excellent binding properties;
- detection at room temperature;
- low response time;
- low cost, small size, and simplicity in manufacturing

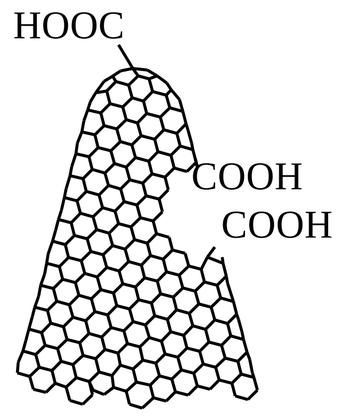

FIG 1 – Structure of oxidized carbon nanohorns (CNH_{OX})

MATERIALS, METHODS, RESULTS

• The interdigitated (IDT) sensing structure (**FIG 2**) was manufactured on a Si substrate (470 µm thickness), covered by a SiO_2 layer (1 µm thickness). The metal stripes of IDT comprised a Cr (10 nm thickness) and Au (100 nm thickness) stack, having 200 µm width. 6 mm was the distance between the electrodes. A dispersion formed in isopropyl alcohol of a quaternary nanohybrid composition described above, at different ratios, was deposited on the IDT structure using the drop casting method (**FIG 3**).

• The RH monitoring capability of the sensitive layers was investigated by applying a current between the two electrodes and measuring the voltage at different RH values

• Measurements were performed in humid nitrogen, at room temperature, and compared with the response of a commercial, industrial grade, capacitive RH Sensirion RH sensor, provided with signal-processing and signal-amplifying electronics (**FIG 4** and **FIG 5**).

• It was demonstrated that the resistance of the sensitive layer this patent proposes varies with RH.

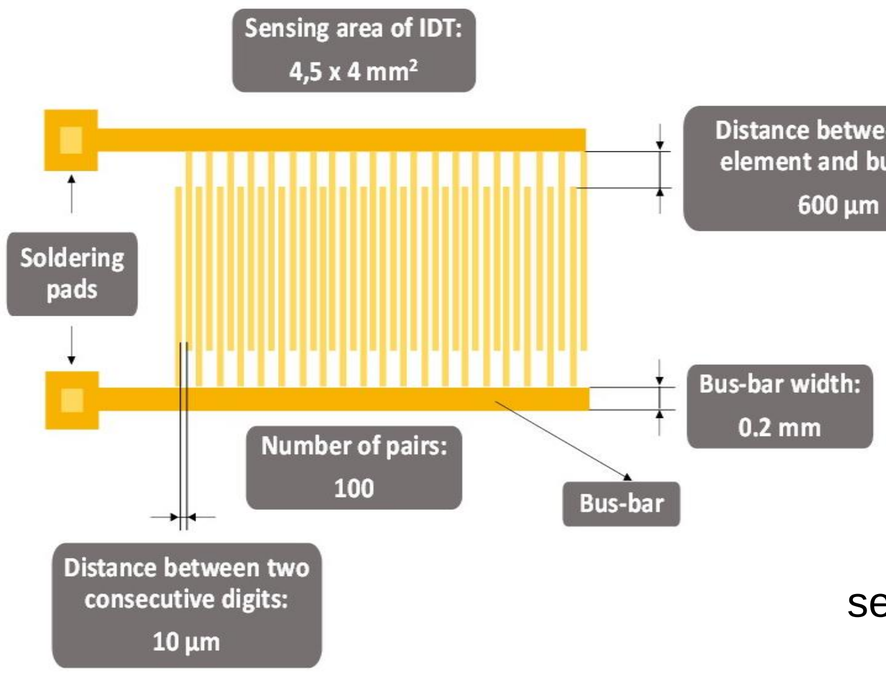

FIG 2 – IDT sensing structure

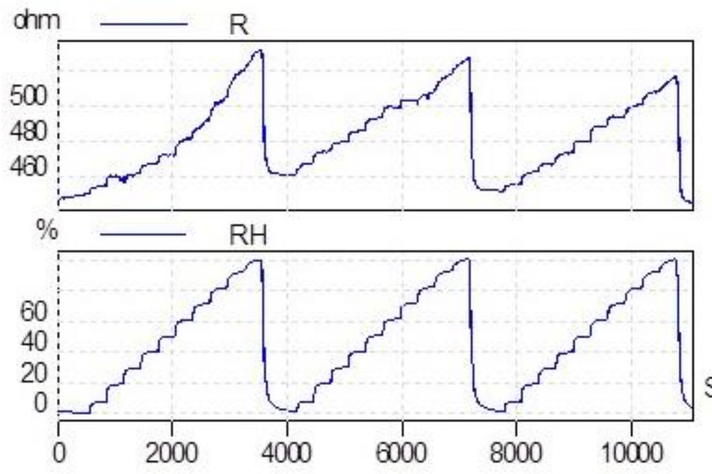

FIG 4 – R Curve: Response of the sensor employing GO/SnO_2/PVP at 0.75/0.75/1/1 as sensing layer, and RH Curve: Response of Sensirion RH sensor

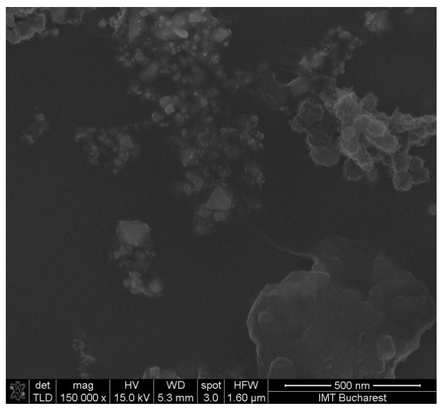

FIG 3 - SEM image for CNH_{OX}/GO/SnO2/PVP (0.75/0.75/1/1) nanohybrid composition

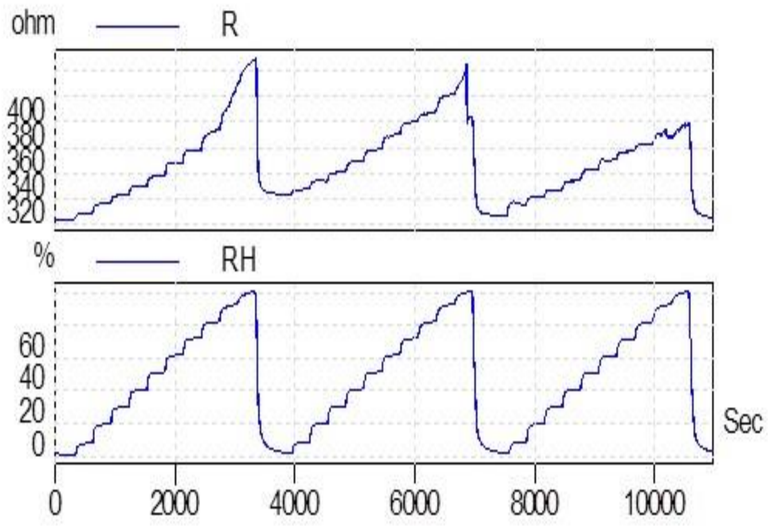

FIG 5 – R Curve: Response of the sensor employing GO/SnO_2/PVP at 1/1/1/1 as sensing layer
RH Curve: Response of Sensirion RH sensor

CONCLUSIONS

- The IDT sensing structure presented in this work exhibits a linear response and good RH sensitivity when varying RH from 0% up to 90% in humid N2 environment.
- The sensor response time and stability are comparable to that exhibited by a commercially available Sensirion RH sensor.

ACKNOWDLEGMENT

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