AGEPI
AGENȚIA DE STAT PENTRU PROPRIETATEA INTELECTUALĂ A REPUBLICII MOLDOVA
Expoziția Internațională Specializată
INFOINVENT
22-24 noiembrie 2023
Ediția a XVIII-a

Resistive sensor for monitoring relative humidity

Romanian Patent Application A100356, RO, OSIM, 23.06.2022

Assignees: National Institute for Research and Development in Microtechnologies - IMT Bucharest
Valahia University of Targoviste
Inventors: Bogdan-Cătălin Șerban, Octavian Buiu, Marius Bumbac, Cristina Mihaela Nicolescu

Field of invention

Relative humidity (RH) sensors are of great importance in a wide variety of residential, industrial, and commercial applications: controlling and sensing humidity in offices and homes, food/beverage processing, electronics (clean rooms and wafer processing), medical field, chemical industry (dehumidifiers, smelting furnaces, dryers), agriculture, automotive industry (engine tests beds etc. Among RH detectors, resistive sensors are attractive due to their simplicity in construction, excellent sensitivity and low price.

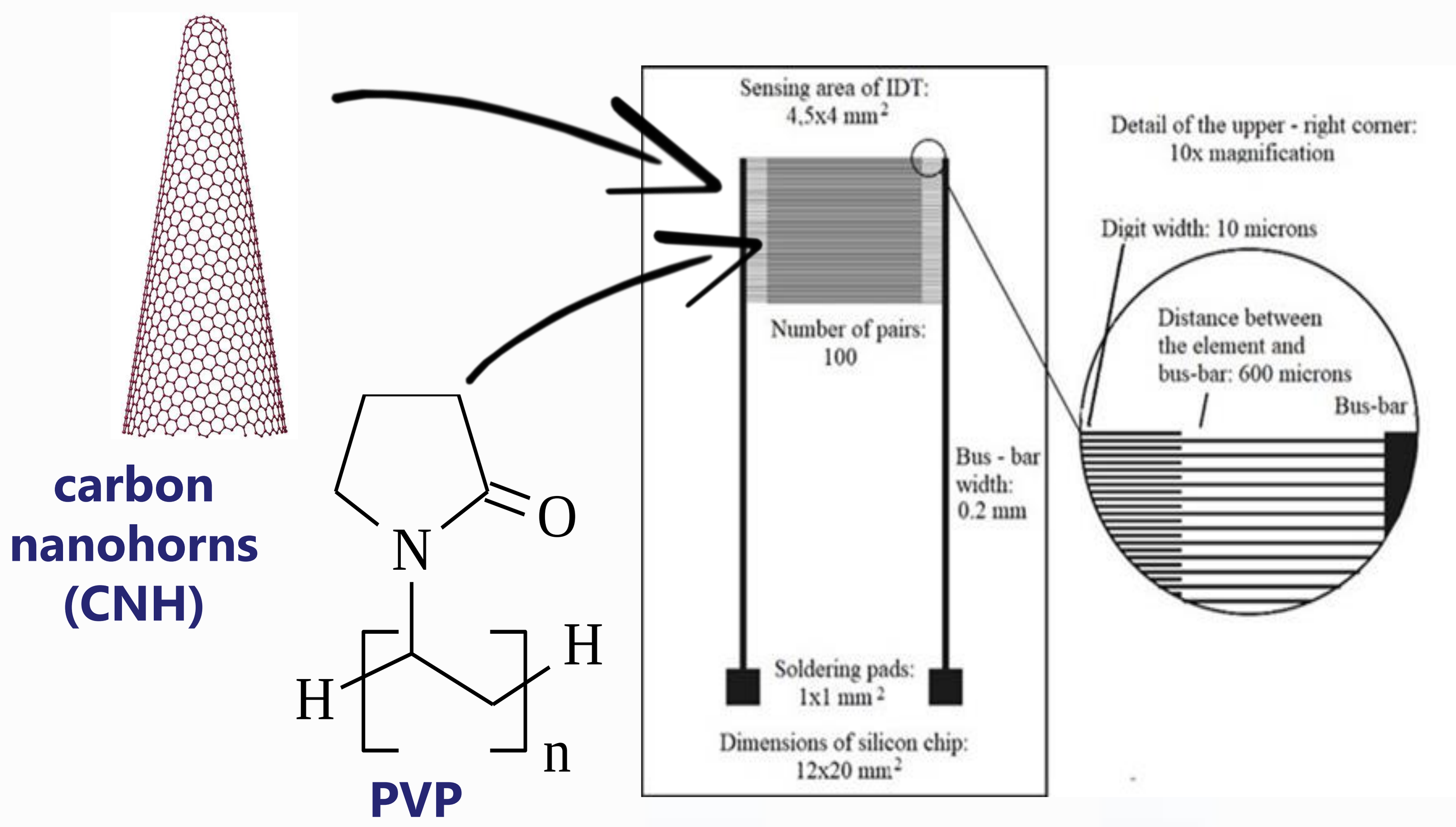

Figure 1 – **The sensing structure**

Original approach

This patent application refers to the development of resistive relative humidity (RH) sensor, employing a sensing layer based on a binary nanocomposite carbon nanohorns (CNHs - Fig.1) - polyvinylpyrrolidone (PVP - Fig.1) in the mass ratio of 1:1.

- The RH sensor includes a silicon (470 microns) substrate coated with SiO_2 (1 micron), interdigitated electrodes and a sensing layer obtained via drop casting method.
- The electrodes were connected by the successive deposition of Cr (10 nm) and Au (100 nm). The width of the electrodes is about 200 microns, with a separation of 6 mm between them.
- They can be linear (Fig.1) or have an interdigitated configuration (IDT).
- The RH 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.

Preparation of sensing device and validation

Preparation of nanohybrid composite CNH/PVP in 1:1 w/w ratio

- PVP solution prepared by dissolving 1 mg of polymer in 10 mL dimethylformamide and subjected to magnetic stirring for 24 hours at room temperature;
- 1 mg CNHs dispersed in the solution and stirred for 12 hours at room temperature;
- Resulted dispersion deposited by the "drop-casting" method on the Si/SiO_2 ITD sensing structure;
- Obtained sensing layer subjected to heat treatment at 90°C, for 2 hours.

Validation of sensing response with a reference sensor

In Fig. 2, the variation in time of the resistance of the proposed manufactured sensor is compared with the variation in time of the RH as measured by the reference sensor, which was placed in the same humid nitrogen environment. The variation of the measured resistance confirms the suitability of the proposed structure as RH detector.

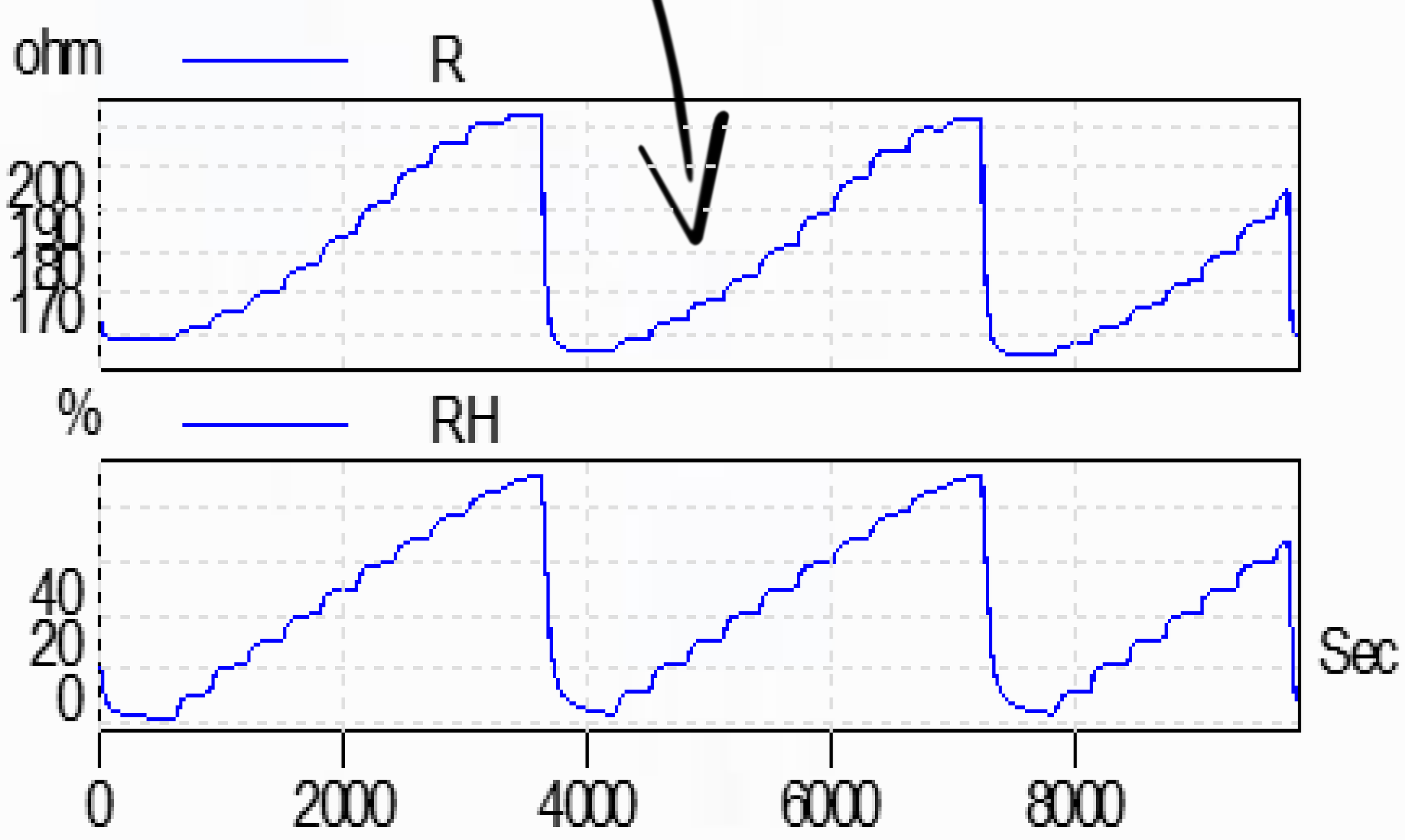

Figure 2 – **Experimentally measured variation in time of resistance for the proposed RH sensors (R Curve) and of the RH, as measured by a reference sensor**

Advantages of the proposed sensing layer

The new synthesized sensing layer used in the manufacturing of resistive oxygen sensor has several significant advantages:

- 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 N_2 environment.
- the sensor response time and stability are comparable to those exhibited by the reference RH sensor.
- the presence of CNHs ensures a high specific surface area / volume ratio as well as a substantial affinity for water molecules;
- detection at room temperature;
- rapid response of the sensor to variations of RH level.

Acknowledgments

IMT authors would like to acknowledge the financial support provided by the Romanian Ministry of Education and Research via the “MICRO-NANO-SIS PLUS” Nucleu program, grant number PN 19 16, and the project 673 PED/2022 (CARESS), financed by The Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI).