Significant results, Stage III

Resistive relative humidity sensors were developed, using optimized procedures for the synthesis of the binary composite material used as a sensitive layer (carbon nanochips and PVP). The developed sensors were tested using two experimental setups (Fig. 1). In Fig. 2 shows a typical response of the developed sensors, from which the excellent behavior of the developed sensitive structure can be seen, by comparison with the response of a commercial (capacitive) RH sensor. An optimized version of the reading and conditioning circuit was developed (Fig.3; a. general architecture; b. Optimized wiring of the reading system, a) front of the wiring, b) back; on the back of the wiring, in the middle area you can see the HS SW components). The experimental validation of the reading and conditioning circuit was carried out, at TRL=4. Fig. 4 (a-f) shows the humidity variation curves of the various sensors tested (details in Table 1 below), together with details of the humidity probe (resistive sensor system - reading and conditioning circuit).

No.	Composition	Dilution fraction	IDT substrate	Width IDT trace (μm)*	Abbreviation
1	85% PEDOT: PSS + 15% PVA	1:100	Polyimide	50	**PSS-50**
2	85% CNO + 15% PVA	1:50	Polyimide	50	**CNO-50**
3	85% CNO + 15% PVA	1:50	Polycarbonate	10	**CNO-10**
4	85% CNO + 15% PVA	1:100	Polyimide	25	**CNO-25-1**
5	85% CNO + 15% PVA	1:50	Polyimide	25	**CNO-25-2**
6	85% CNO + 15% PVA	1:50	Polyimide	25	**CNO-25-3**

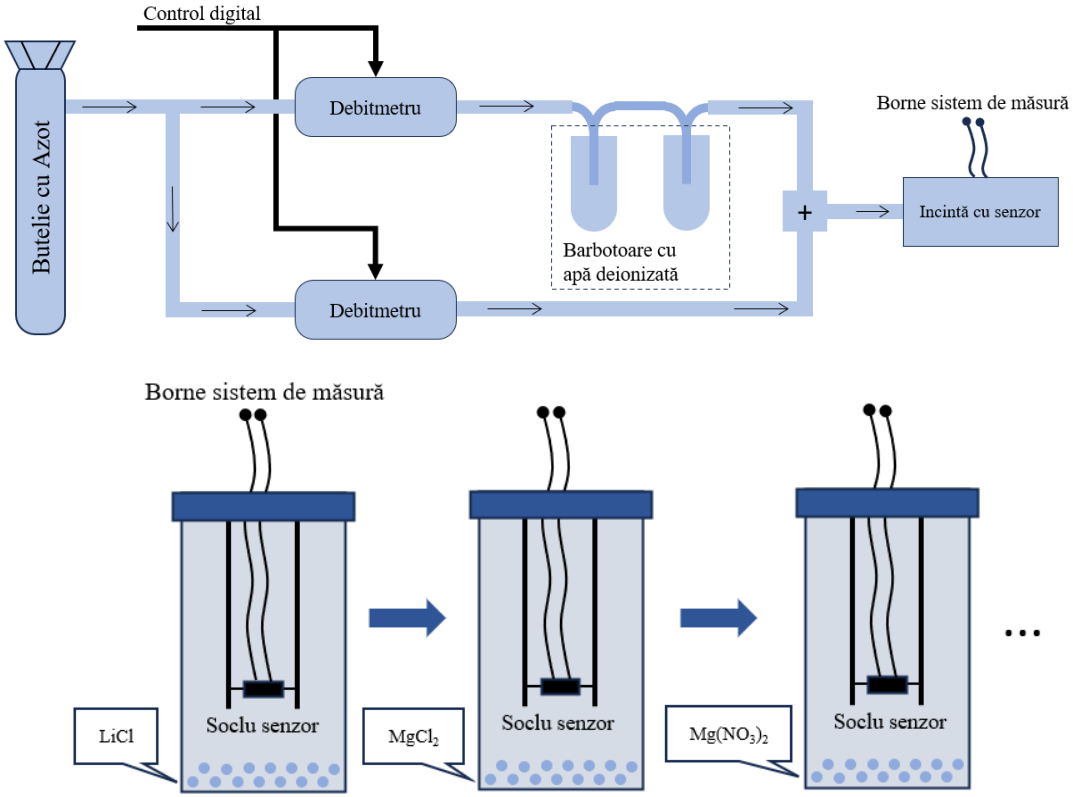


Fig. 1 – Experimental setups used for testing resistive sensors for relative humidity (RH)

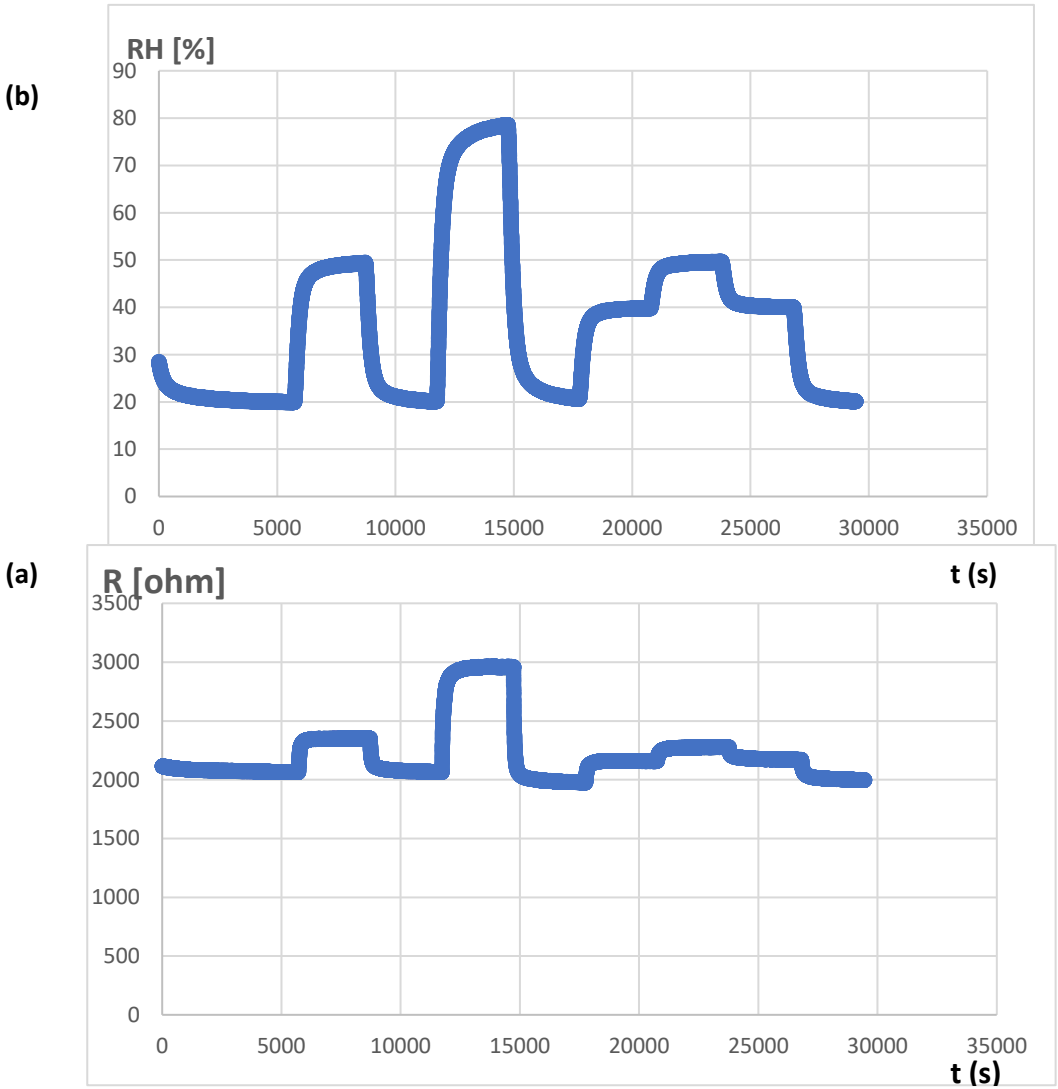
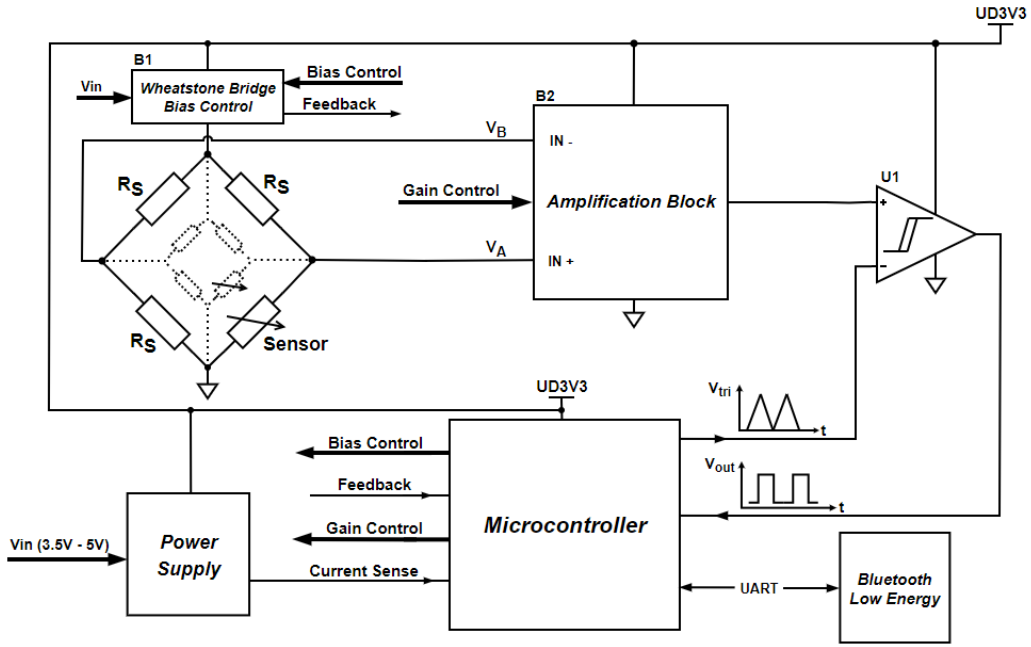


Fig. 2– (a) Time response of the resistive RH sensor developed within the project (sensitive layer made of carbon nanochips and PVP); (b) time variation of RH, measured with a commercial sensor.

Fig. 3a).


UD3V3
B1
Vin
Wheatstone Bridge Bias Control
Bias Control
Feedback
B2
V_B
IN -
Amplification Block
IN +
V_A
Gain Control
U1
R_S
R_S
R_S
Sensor
UD3V3
V_{tri}
t
Bias Control
Feedback
Gain Control
Current Sense
Microcontroller
V_{out}
t
Vin (3.5V - 5V)
Power Supply
UART
Bluetooth Low Energy

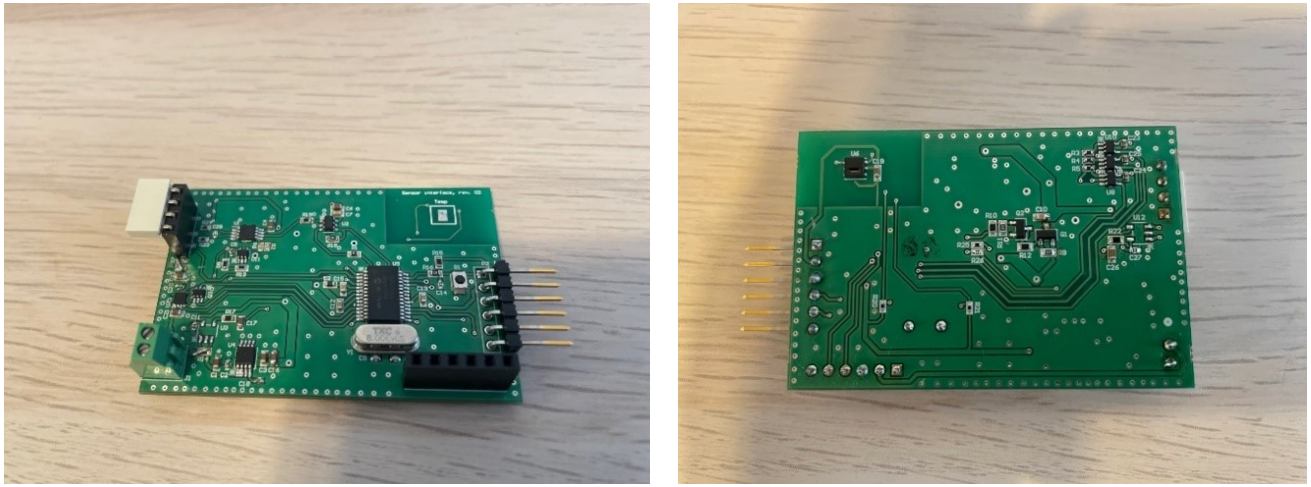
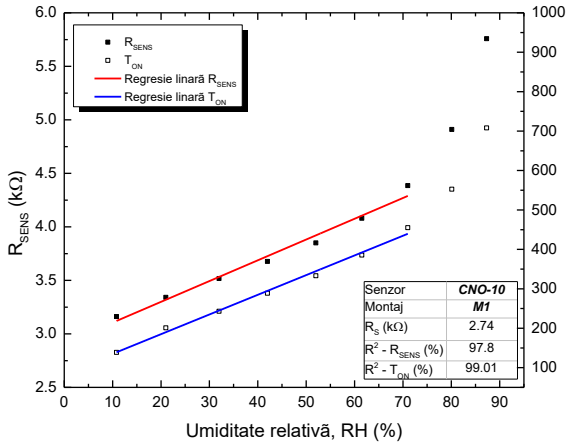
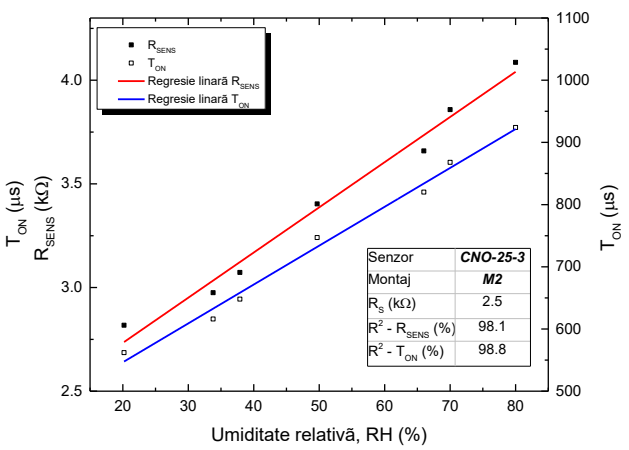


Fig. 3b.

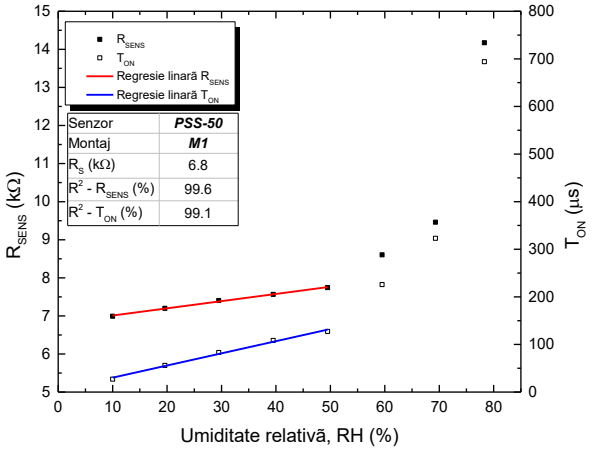
Fig. 4


R_SENS
T_ON
Regresie liniară R_SENS
Regresie liniară T_ON
Senzor | CNO-10
Montaj | M1
R_S (kΩ) | 2.74
R² - R_SENS (%) | 97.8
R² - T_ON (%) | 99.01
R_SENS (kΩ)
T_ON (µs)
Umiditate relativă, RH (%)

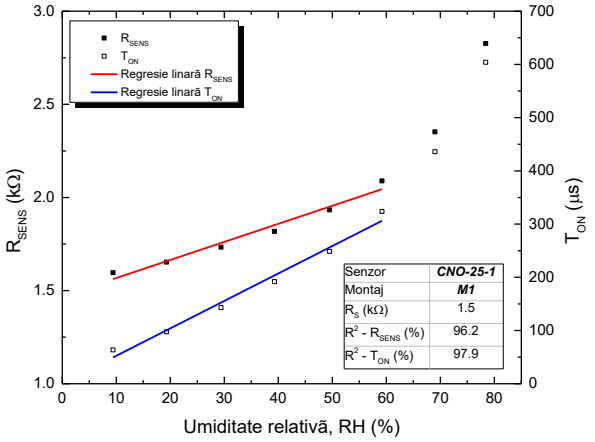
a.


R_SENS
T_ON
Regresie liniară R_SENS
Regresie liniară T_ON
Senzor | CNO-25-3
Montaj | M2
R_S (kΩ) | 2.5
R² - R_SENS (%) | 98.1
R² - T_ON (%) | 98.8
R_SENS (kΩ)
T_ON (µs)
Umiditate relativă, RH (%)

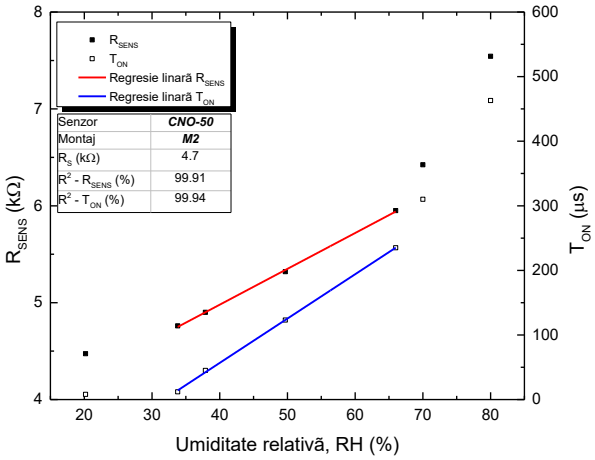
b.


R_SENS
T_ON
Regresie liniară R_SENS
Regresie liniară T_ON
Senzor | PSS-50
Montaj | M1
R_S (kΩ) | 6.8
R² - R_SENS (%) | 99.6
R² - T_ON (%) | 99.1
R_SENS (kΩ)
T_ON (µs)
Umiditate relativă, RH (%)

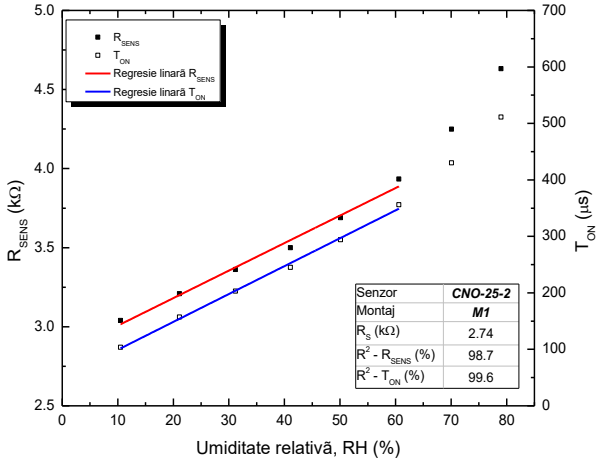
(c)


R_SENS
T_ON
Regresie liniară R_SENS
Regresie liniară T_ON
Senzor | CNO-25-1
Montaj | M1
R_S (kΩ) | 1.5
R² - R_SENS (%) | 96.2
R² - T_ON (%) | 97.9
R_SENS (kΩ)
T_ON (µs)
Umiditate relativă, RH (%)

(d)


R_SENS
T_ON
Regresie liniară R_SENS
Regresie liniară T_ON
Senzor | CNO-50
Montaj | M2
R_S (kΩ) | 4.7
R² - R_SENS (%) | 99.91
R² - T_ON (%) | 99.94
R_SENS (kΩ)
T_ON (µs)
Umiditate relativă, RH (%)

(e)


R_SENS
T_ON
Regresie liniară R_SENS
Regresie liniară T_ON
Senzor | CNO-25-2
Montaj | M1
R_S (kΩ) | 2.74
R² - R_SENS (%) | 98.7
R² - T_ON (%) | 99.6
R_SENS (kΩ)
T_ON (µs)
Umiditate relativă, RH (%)

(f)