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DYNAMIC PROPERTIES OF HUMIDITY SENSOR WITH ACTIVE LAYER BASED ON COMPOSITE MATERIAL: PVA + Sn

This paper presents results of the researches upon humidity sensors based on humidity sensitive composite material: PVA + Sn. Construction of the sensor is presented. Influence of electrodes' configuration and arrangement on static characteristics and dynamic properties of the sensors are also included.

1. INTRODUCTION

Idea of operation of microelectronic humidity sensors is based on measurements of the change of the electric parameters of polymers or ceramics as a result of humidity change. Because of good metrological properties, easy fabrication and low production costs, polymer materials are one of the most popular, from the point of view of its application. Operation of humidity sensors belonging to this group is based on change of resistance or capacity as a result of absorption of water. One of the most popular polymer humidity sensitive materials utilised in construction of the sensors is polyvinyl alcohol (PVA)

Modification of the physical structure of the active layer by introduction of various metal dopants in colloidal form and its influence on sensor's properties were reported in our previous papers [1].

This paper presents results of works on influence of electrodes (its shape and configuration) on properties of the sensor.

2. EXPERIMENT

Sensors substrates were made of epoxy-glass with one side copper layer. This kind of substrate presents high elasticity, grease resistivity and it does not absorb humidity. In order to make comb-type electrodes copper layer was etched. In order to examine influence of electrode's arrangement on properties of the sensor three types of substrate, presented on fig. 1, were prepared.

All substrates have the same electrode length and the same ratio of electrode's width to the distance between electrodes. Essential difference between substrate a) and b) is density and electrode's width. Electrodes on a) substrate is made in form of two combs (17 perforations with 0.5 mm wide each). Substrate b) two combs (24 perforations with 0.4 mm wide each). Substrate c) is made in form of two combs (10 perforations with 0.4 mm wide each - similar as in b) substrate).

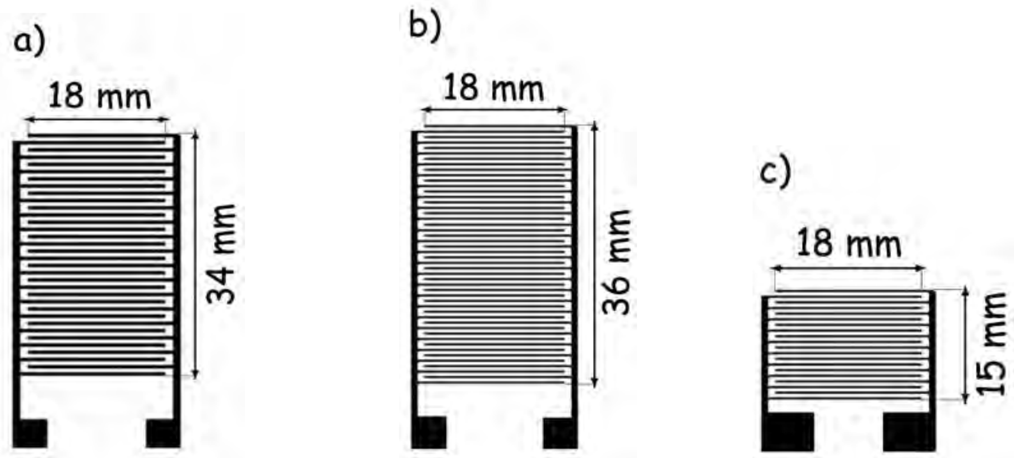


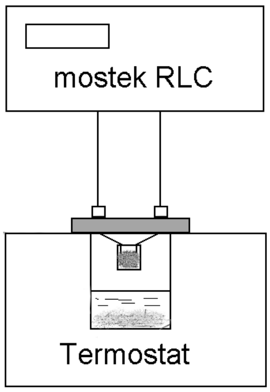
Fig. 1. Substrates for examined sensors

Polyvinyl alcohol admixtured with Sn in colloidal form (diameter of grain 10 μm) was used as active layer of the sensor.

Structure of the sensor was prepared as follows: 1% water solution of polyvinyl alcohol was mixed with colloidal Sn in 1:1 ratio. So prepared solution was poured on the substrate base. Deposited layer was then left for 24 hours at temperature 293K in order to evaporate water. After vaporisation of water received active layer created porous, enough permanent structure. Thickness of the active layer was 0,5 mm in case of all prepared sensors.

3. MEASUREMENTS

Idea of measurements was based on recording the sensor's capacity in different humidity conditions. Capacity was measured with use of automatic RLC bridge ESCORT 3131D. Block diagram of measuring system is presented on fig. 2.



Rys. 2. Block diagram of the measuring system

Measurement chamber was the glass vessel filled with saturated solutions of various salts, assuring constant expansiveness of the water above the solution and at the same time constant relative humidity [2]

Following salts were used: $CaCl_2 \cdot 6H_20$ (24.6 % RH), $Ca(NO_3)_2 \cdot 2H_20$ (42,8 % RH), $Mg(NO_3)_2 \cdot 6H_20$ (54.9 % RH), $Mg(C_2H_3O_2) \cdot 4H_20$ (64% RH), $(NH_4)_2SO_4$ (77.2 % RH), $ZnSO_4 \cdot 7H_20$ (90% RH), K2HPO4 (99 % RH). All measurements were made in temperature 295±2K.

Static and dynamic characteristics were measured for three types of sensors. Results are presented in fig. 3 –9.

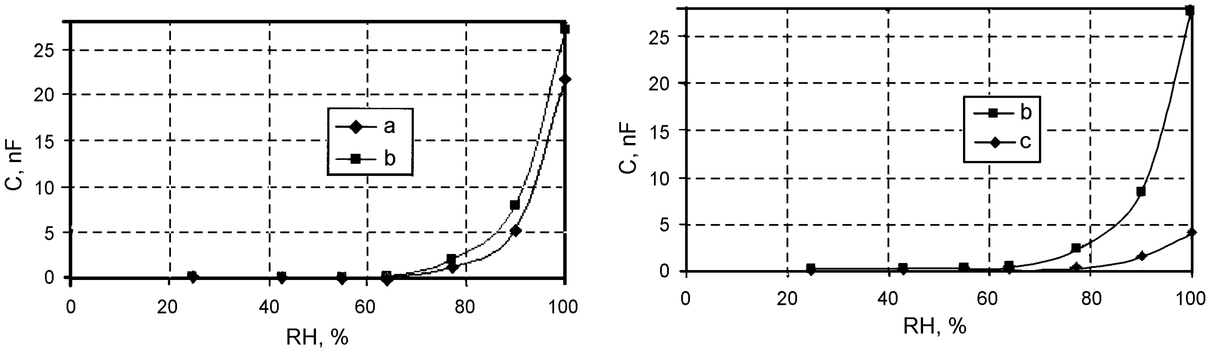


Fig. 3. Comparison of static characteristics based on substrates a), b), c)

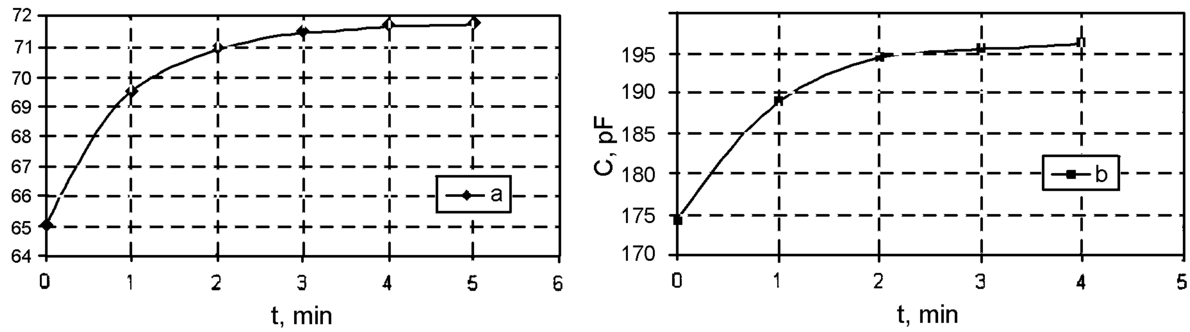


Fig. 4. Response of (a) i (b) sensors on humidity jump (24,6% RH to 42,8% RH)

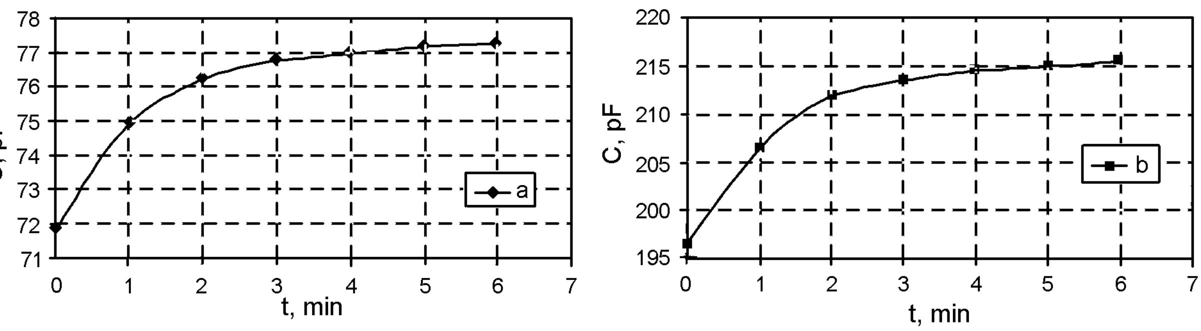


Fig. 5. Response of (a) i (b) sensors on humidity jump (42,8% RH to 54,9% RH)

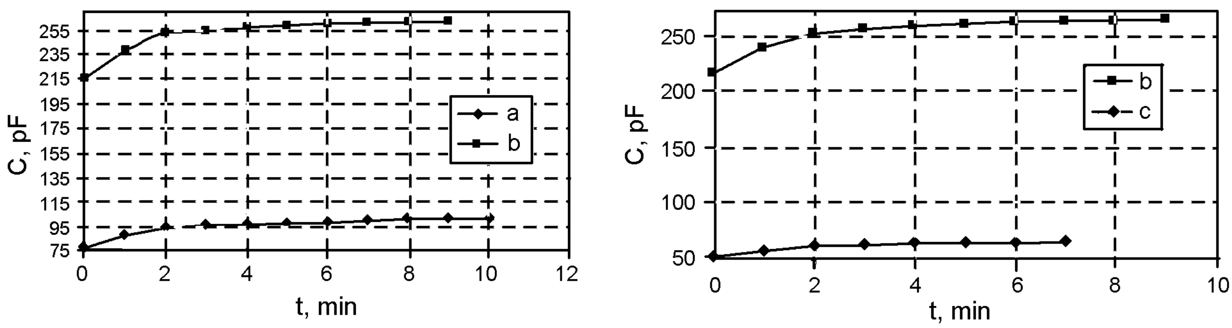


Fig. 6. Response of (a), (b) and (c) sensors on humidity jump (54,9% RH to 64% RH)

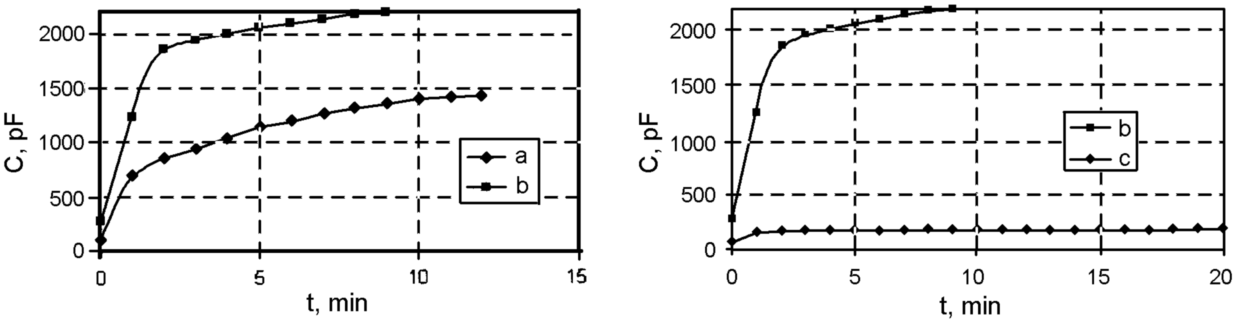


Fig. 7. Response of (a), (b) and (c) sensors on humidity jump (64% RH to 77,2% RH)

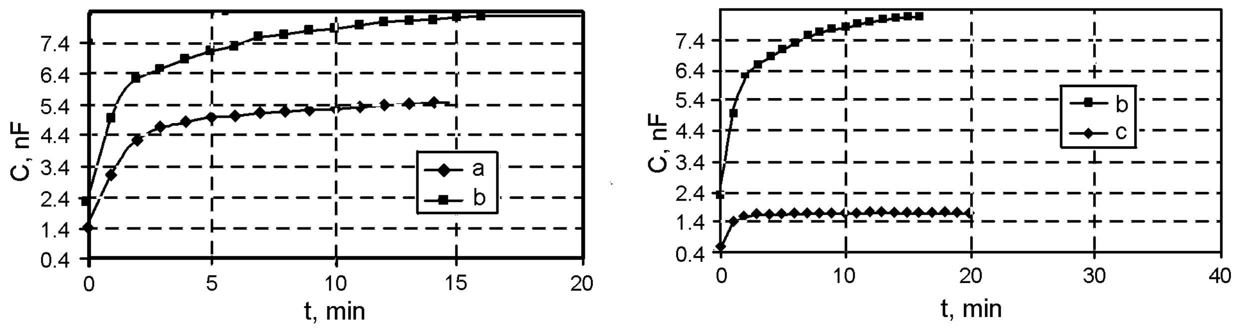


Fig. 8. Response of (a), (b) and (c) sensors on humidity jump (77,2% RH to 90% RH)

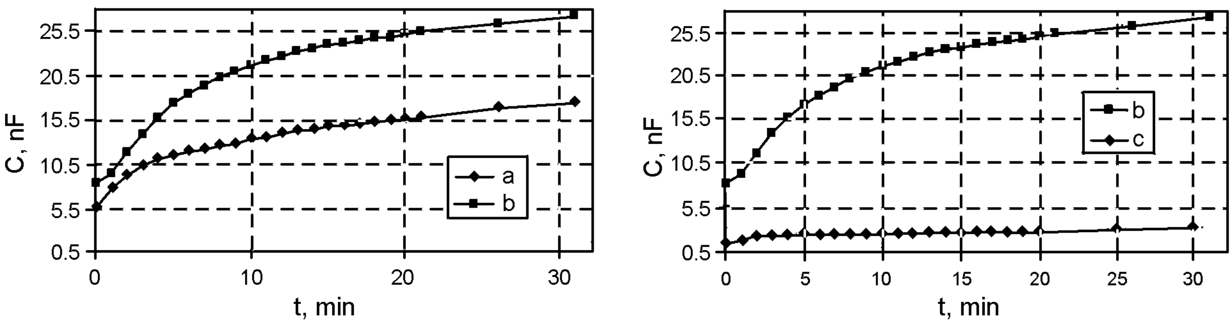


Fig. 9. Response of (a), (b) and (c) sensors on humidity jump (90% RH to 99.9% RH)

4. CONCLUSION

Capacitive humidity sensors based on PVA doped with Sn still require further researches. It will be necessary to determine characteristics of long term stability. From the point of view of current researches it can be said that there is a promising perspective in application of this sensors in humidity measurements.

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1. *Zenon Gotra, Danuta Proszak, Bogdan Woś - Humidity Sensor Using Polyvinyl Alcohol Doped With Metals In Colloidal Phase, 5th International Symposium On Microelectronics Technologies and Microsystems, 7-9 June 2001, Piteşti, Romania*
2. *A. Carotenuto, M. Dell'Isola - Experimental verification of Saturated Salt Solution-Based Humidity Fixed Points, International Journal of Thermophysics Vol.17 No.6 November 1996.*