6th Research/Expert Conference with International Participations
"QUALITY 2009", Neum, B&H, June 04 – 07, 2009

TiO_2 THIN LAYER AND THEIR BEHAVIOR IN HUMIDITY ENVIRONS

Jana Šišáková, Rudolf Hrehuš, Juraj Slabeycius, Jozef Paliesek
Faculty of Industrial Technologies
Ivana Krasku Street 491/30, 02001 Púchov
Slovakia

ABSRACT

The behavior of TiO2 thin layer is analyzed in this work. For diagnostic of thin layer are used the AC circuit; programmable automatic PM 6306 with accessory BAN 4 wire cable; as well as relative humidity environs.
In paper results will be compared the 1 and 3 layer's of TiO_2 thin layer prepared by sol-gel method.

Keywords: Thin layer, sol-gel, electrical measurement, relative humidity

1. INTRODUCTION

Nowadays the thin layers are the attractive „term", their studying, basic researches are important form material behavior. One of the ways of its preparation is sol-gel method, which is a typical method of special prepared non-metallic materials. There are widely usefully in materials engineering – mainly by preparation of films which modified physical and chemical properties of various substratum. This method is preferred for its simple way of preparation the widely scale thin films with different chemical composition. Describe method allows to prepare types of material, which aren't possibly to prepare another methods e.g. inorganic – organic materials, nanocomposites [1, 2].

One of the „good ways of measurement" of thinmaterials research is Impedance Spectroscopy measurement. This method is like the method of thermal examination in scale of material sensitivity investigation which is one of the chief topics of material diagnostics at Institute of Material and Technonogical Research; Faculty of Industrial Technologies in Púchov [3,4].

2. EXPERIMENT

After the pilot electrical measurements the results weren´t very promissing, but consequently improving of the whole measuring apparatus like earthing, Faraday cage and sample gripping we are able to allege nice behavior of measured data as well as the low statistical discrepancy. Measurement error of impedance and phase angle did not exceed 5% of the values. The average measure value of impedance is shown on figure 1.

Figure 1. Average measuring value of impedance vs. frequency

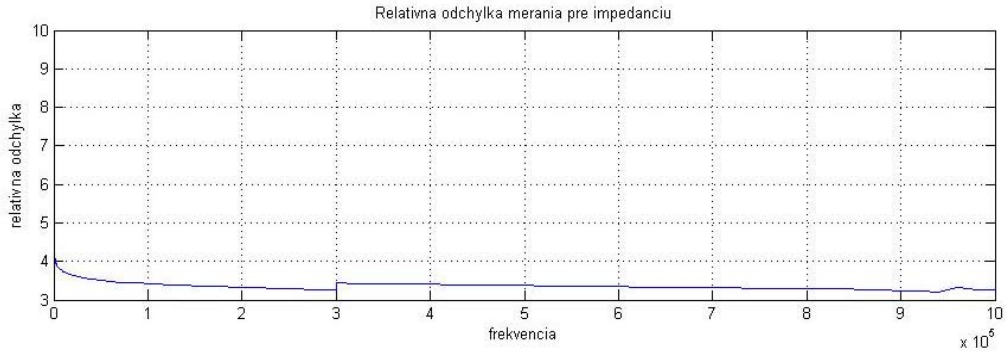

Figure 2. Relative deviation of impedance vs. frequency

Figure 2 illustrated the relative deviation of impedance value. The phase angle and its relative deviations are shown on figures 3 and 4.

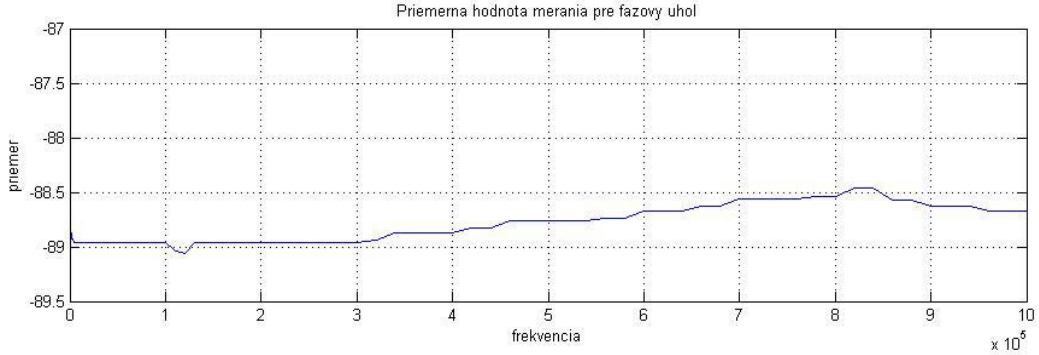

Figure 3. Average measuring value of phase angle vs. frequency

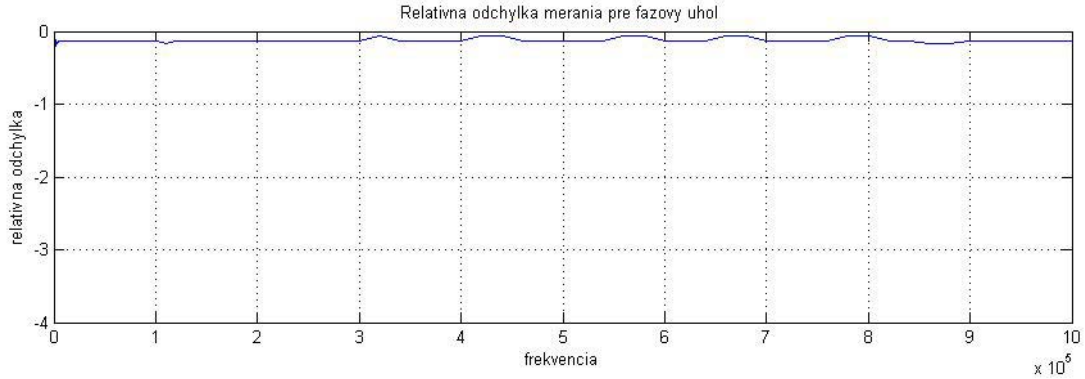

Figure 4. Relative deviation of phase angle vs. frequency

There exist more methods for layer coating on the substrate. The most frequently methods are dip-coating, spin-coating, spray-coating, flow-coating, capillary-coating or roll-coating [5]. In this samples preparation of thin layers was used the technology of dip-coating [1].

The next measurement consist the measured values of impedance versus frequency depencency for one thin layer of TiO_2 which is illustrated on the figure 5. There are used the different humidity environs, via range 0,13% to 97,6% RH.

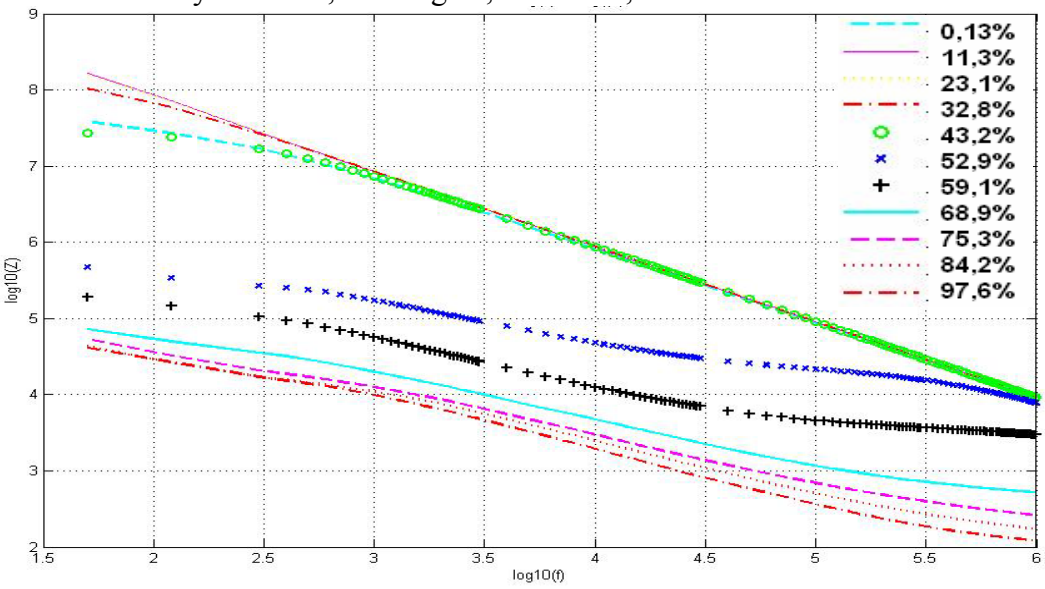

Figure 5. TiO_2 sensor with one layer

The figure 6 illustrated the three layer sensor of TiO_2 where are measured dependencies of impedance value vs. frequency for eleven various RH factors.

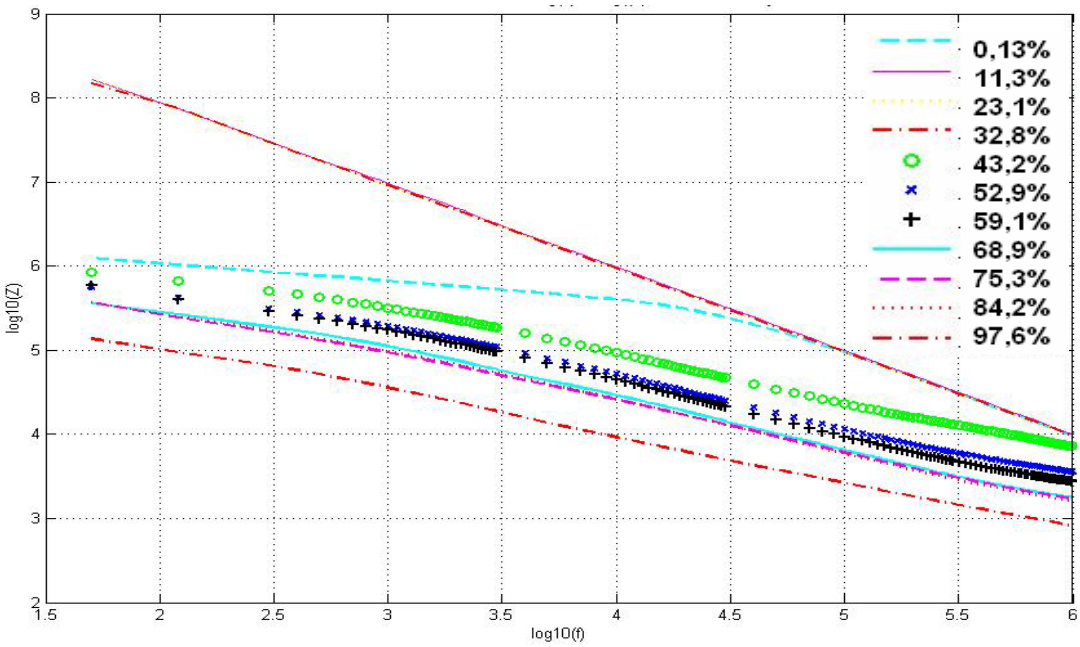

Figure 6. TiO2 sensor with three layers

We suppose to allege that the curves on figures 5 and 6 have similarity relations characters of increasing RH sequence. We can see that one and three TiO_2 layers have like linearity area in

measurement with relative low RH of 6,9% to 32,8%. The areas of increasing RH range of 43,2% to 97,6% are changing of rising layer dependency. The lower humidity and frequency values subject to high value of impedance during this time the dependencies allocate the downtrend. One interesting fact occurs by the low 0,13% RH factor - both figures has another characters and the said theorem appears false. But this fact could be explain by the memory effect of sensor, because the low, 0,13% RH was measured after the higher 97,6% RH.
We can allege that one thin TiO_2 layer has another properties than the three layer in comparison of relative humidity study.
The perfectly linearity have values 6,9% and 11,3% of RH factor for the one layer TiO_2. In case of three layers of TiO_2 there are the values of 6,9% to 23,1% RH factor.
Sensor already reacts to the lower value of RH by three layers of TiO_2 system; besides the one layer system.
System starts tu react at humidity of 43,2 % RH, along with impedance decreasing by 2 grades. It follows the high sensitivity of three layer system of TiO_2 sensor.

Acknowledgements
This work is supported by the Ministry of education of the Slovak Republic – research grant Vega 1/0209/08.

3. REFERENCES

[1] Šišáková J., Šišák F.: Efficiency of impedance spectroscopy in sensor technics, The 13th International Conference on Problems of Material Engineering, Mechanics and Design, Rajecké Teplice, Slovakia, 2008.,
[2] Koštial P., Berezina S., Slabeycius J.: Využitie ultrazvukových vĺn pri štúdiu povrchov a rozhraní, ISBN 80-7100-388-3,1998.,
[3] Kopal I.: Termovízna inšpekcia materiálov, objektov a štruktúr, In: Bezpečnost a spolehlivost materiálů za extrémních podmínek provozování, ISBN 80-248-1098-0. - s.16-18, 2006.,
[4] Koštial P., Hutyra J., Kopal I., Mokryšová M., Švecová Z., Ružiak I., Kučerová J.: Quick, Contactless thermal Analysis of Blends,
In: Rubber World. - ISSN 0035-9572. Vol.234, No.2, pp.21-23, 2006,
[5] Klein, L.C.: Sol-Gel Technology for Thin Films, Fibers, Preforms, Electronics and Specialty Shapes, William Andrew Publishing/Noyes, 1988.