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HYSTERESIS EFFECT IN LANGMUIR FILMS BASED ON BARIUM STEARATE WITH PHTHALOCYANINE ADDITIVES FOR UV SENSING APPLICATIONS

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In this paper are reported the results obtained from the investigation of Langmuir films based on barium stearate with nanocarbon additions and phthalocyanines, which could be potential candidates for UV sensing applications. The multilayers were deposited on a special ceramic body provided with two interpenetrating platinum electrodes. During the first 2 cycles of compression-extension the Langmuir layer was stabilized. Further cycles do not show any modification. The area covered by every cycle becomes constant for all cycles. Our prepared multilayers composed on five layers, revealed the presence of a hysteresis effect in the compression-extension tests. Based on this behavior we proceeded further to prepare and characterize high sensitivity sensor for ultraviolet light.

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1. Introduction

In this paper we report the results obtained in the study of Langmuir films subjected to several cycles of compression-expansion and their properties related to the effect of ultraviolet rays on multilayer films based on barium stearate with carbon nanotubes and different types of phthalocyanines. The ordered lattice of long chain alkylic molecules is ideal host for various chemical molecules. On the other hand the embedded molecules can change dramatically the surface tension and alter significantly the physical and chemical properties of the layer as e.g. the electrical resistivity. Studies have been performed in order to reveal the properties of nanotubes and fullerenes in order to be mixed with fatty acids and thus point out the fine chemistry of these materials [1]. The LB films of various compositions are prospective materials to be used as substrates for active species appropriate for chemical and biochemical sensors [2] and for drug delivery [3]. Thin sensitive films for different substances have been prepared and intensively investigated [4-7]. Langmuir Blodgett films proved to be efficient material for sensing.

In this paper we report a hysteresis effect during compression-extension cycles of the Langmuir film formed at the surface of water by ordered packing of the fatty acid (Ba-stearate) molecules. Moreover thus stabilized layers of Ag-stearate with additives (Magnesium phthalocyanine) shows a strong sensitivity to ultraviolet light of a sensor prepared on a ceramic body that has been successfully operated.

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2. Experimental

The basic solutions in benzene of Barium stearate and carbon nanotubes with phthalocyanine have been prepared followed by ultrasonication at 37 kHz in a ultrasonication bath. Dropping the solution on the water surface of KSV 5003 device allow obtaining the hysteresis curves after 30 minutes of benzene solvent evaporation and homogenization of solution over the water surface. We have followed the π – A compression-extension curves. The compression and decompression was achieved by moving the barriers on the water surface with a speed of 7.5 mm per minute and stable hysteresis effect has been revealed for more than two consecutive cycles of compression – extension.

Deposition of 5 layers was performed on ceramic body with platinum electrodes with 1 mm/min deposition rate and 25 N/m pressure deposition. During the deposition all the environmental conditions were motorized. Magnesium phthalocyanine optical and electrical characterization was made in order to determine the UV sensitivity. The deposition of the material with magnesium phthalocyanine as a package of five ordered layers gave rise to a material with strong sensitivity to UV radiation. UV irradiation has been carried out with a medical UV lamp made by Electrotehnica-Bucharest, having the main emission lines in the range of 330-340 nm at the power density of 116 $\mu W/cm^{2.}$

3. Results

The hysteresis curves were obtained with a rate of compression-extension of Langmuir KSV 5003 device barriers of 7.5mm/min. After the two cycles a stable effect of hysteresis curves has revealed for Magnesium, Copper and Zinc.

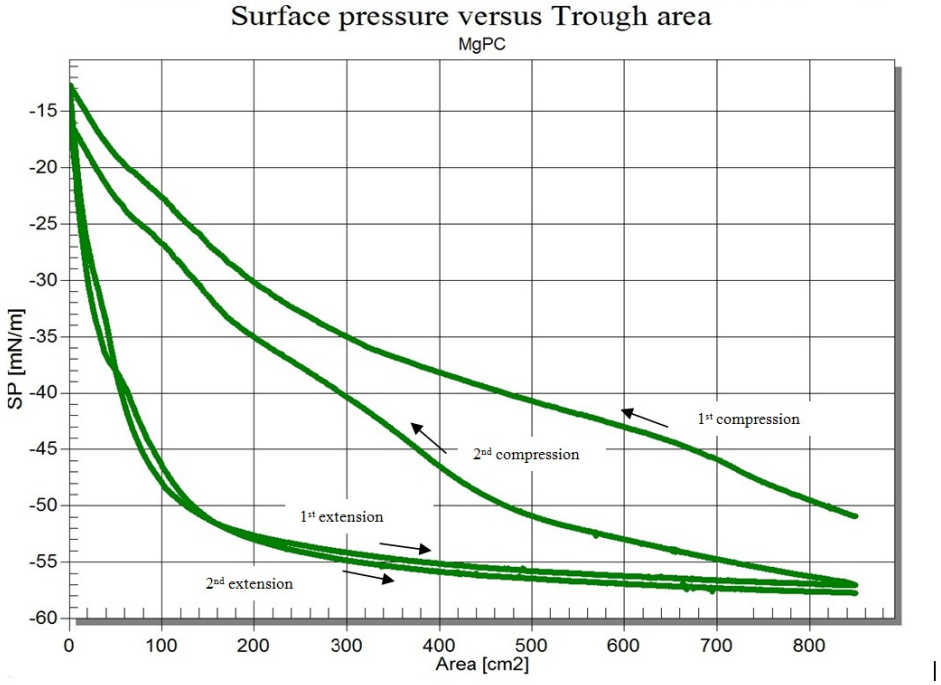

Fig.1. Shows the hysteresis curves, surface pressure versus area curves of Barium stearate and carbon nanotubes with Magnesium phthalocyanine

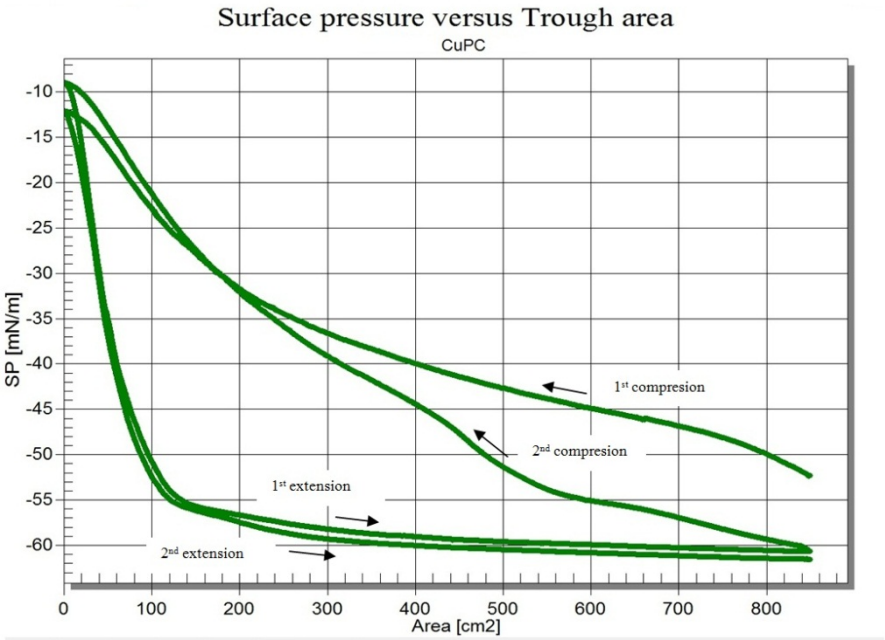

Fig.2.The hysteresis curves, surface pressure versus area of Barium stearate and carbon nanotubes with Copper phthalocyanine

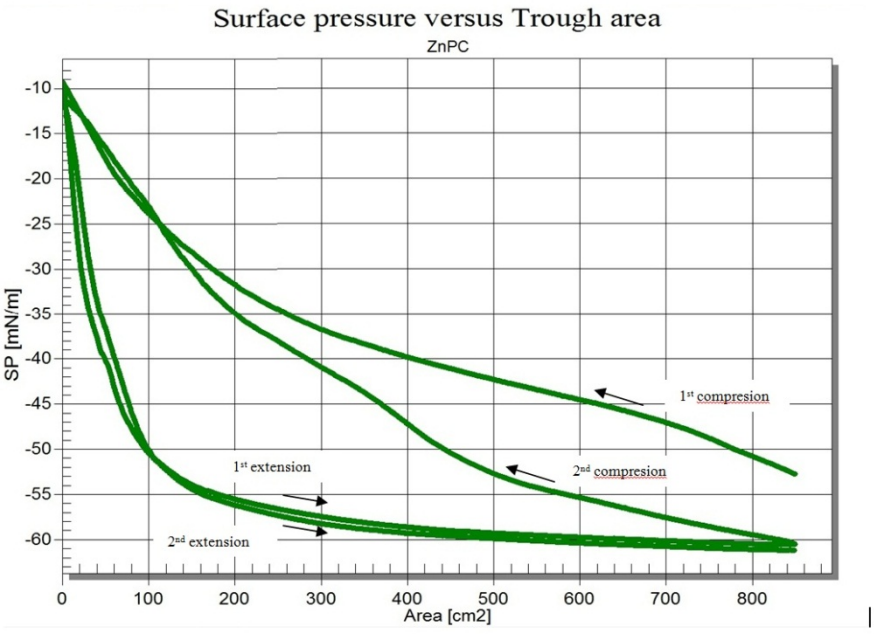

Fig.3. The hysteresis curves, surface pressure versus area of Barium stearate and carbon nanotubes with Zinc phthalocyanine

After deposition of 5 layers on ceramic body with platinum electrodes with 1 mm/min deposition rate and 25 N/m pressure deposition, electric resistance measurements were performed using a medical UV lamp with emission in the range of 330-340 nm at the power density of 116 $\mu W/cm^2$.

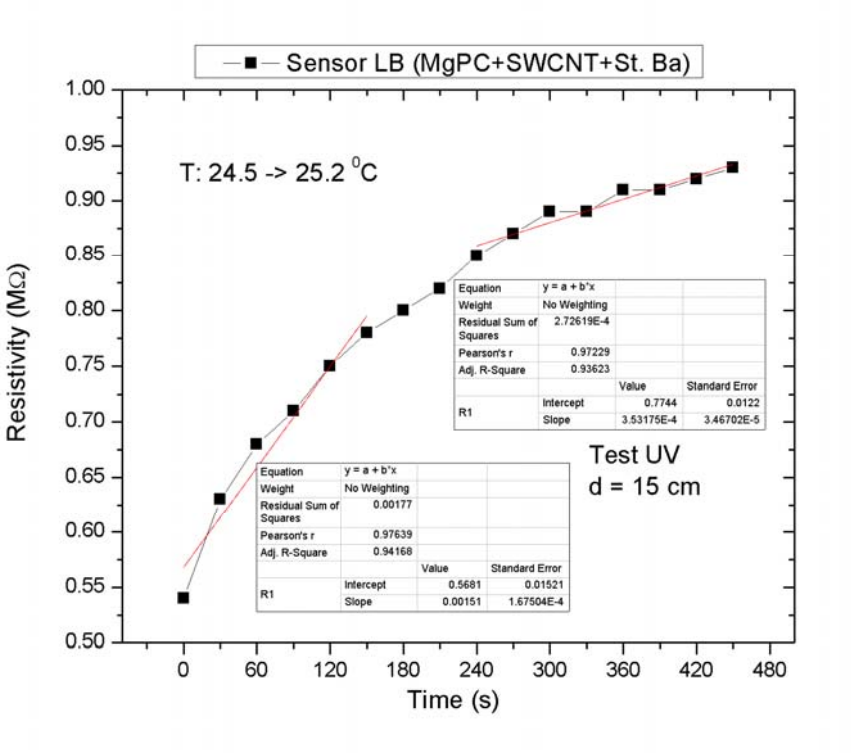

Fig.4 The effect of UV radiation of 5 Langmuir Blodgett thin layers sensor based on Mg – phthalocyanine, Barium stearate and carbon nanotubes

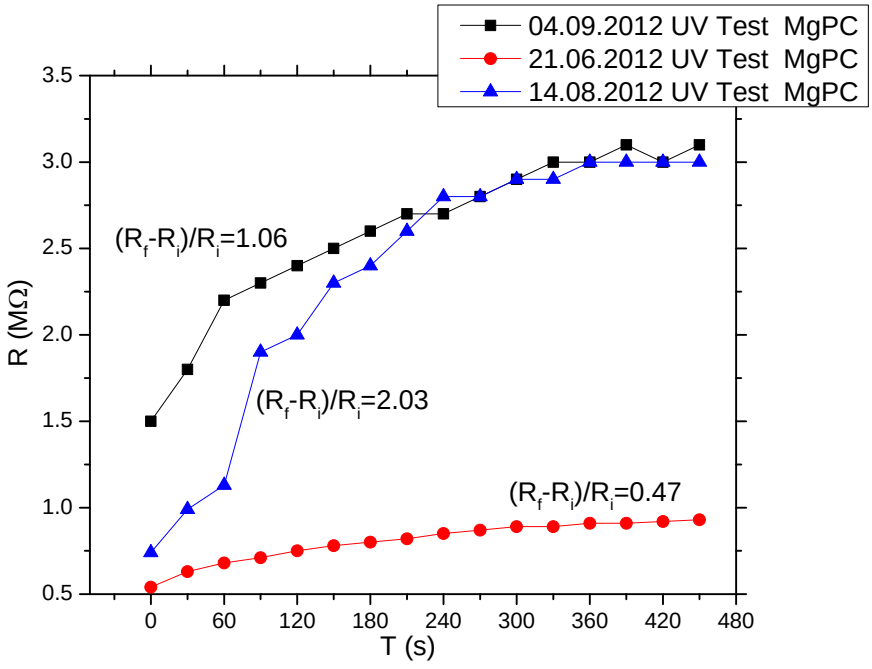

Fig.5. UV radiation effect on 5 Langmuir Blodgett thin layers sensor based on Mg – phthalocyanine, Barium stearate and carbon nanotubes for a period of time of three months (Rf= final resistivity, Ri= initial resistivity)

4. Discussion

There was evidenced a hysteresis effect in the pressure-area cycles. Layers based on Barium stearate was used in all cases. The hysteresis energy for different additives (phtalocyasnines, nanocarbons…) to fatty acid used in preparation of the films show large differences. The energy of hysteresis cycle seems to be largely dependent on both on the structure of fatty acid molecules and on the additives used for building the Langmuir layer.

The complex multilayers proved to be good materials for sensing gases, as proved in other papers published by various authors and by us [8-14].

5. Conclusions

We have obtained the optimum surface tension at which a thin Langmuir-Blodgett film can be deposited.

A hysteresis effect has been revealed in thin films based on fatty acid molecules Barium stearate) we have designed a sensor for detection of ultraviolet radiation of high sensitivity.

The deposition of the material with magnesium phthalocyanine as a package of five ordered layers gave rise to a material with strong sensitivity to UV radiation.

Acknowledgements

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