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# COMPLEX LANGMUIR-BLODGETT FILMS BASED ON BARIUM STEARATE MULTILAYERS WITH CARBON NANOTUBES AND $As_2S_3$ NANOPARTICLES[♣]

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We have prepared complex multilayer films based on Barium stearate. The multilayer samples have been deposited by the Langmuir-Blodgett technique. The complex multilayers were also deposited on body sensor. The sample was then subjected to the illumination with UV light. We observed changes in the resistivity of the multilayer during the illumination

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## 1. Introduction

The carbon nanotubes become more and more used in applications due to their special properties related to electrical conduction and chemical affinity for various chemical species [1]. The Langmuir-Blodgett films of various compositions are prospective materials to be used as substrates for active species appropriate for chemical and biochemical sensing [2] and are suggested for drug delivery systems [3]. The ordered lattice of the long chain alkylic molecules are ideal host for various chemical molecules.

The Langmuir-Blodgett multilayers are good materials for preparing sensing elements for gases and liquids, as well as for the detection of biochemical substances. In our previous paper we have demonstrated the role of the mixture of barium stearate with carbon nanotubes for sensing of ammonium nitrate dissolved in water [4]. A patent based on Langmuir Blodgett films of alkylic layers with carbon nanotubes has been deposed [5]. Recently, we reported the preparation of Langmuir-Blodgett films bassed on barium stearate and carbon nanotubes [6]. Investigations have shown that $As_2S_3$ appear to be suitable materials for optical sensors [7]. Micro and nanoelectrodes for array sensors have been also developed recently [8].

## 2. Experimental

A sandwich of 5 layers of barium stearate has been deposited by Langmuir-Blodgett technique( Fig. 1) in a KSV double-trough. The solution for deposition was prepared by mixing barium stearate, single-wall carbon nanotubes, dodecyl benzene sulfonate and $As_sS_3$ powder stirred in a ultrasonic unit for five 30 minutes. There were made two solutions, one with $As_sS_3$ powder and one without $As_sS_3$ powder.The samples consist in 5 layers deposited from the complex solution consisting of a mixture of barium stearate with 0.05g, (SWCNT) 0.005g, dodecyl benzene sulfonate (SDB) 0.05g and 0.01 g $As_sS_3$ powder in 16ml Benzene.

Barium stearate molecules have been obtained from stearate powder p.a. (Sigma-Aldrich) dissolved in benzene. Carbon nanotubes have been purchased from Alfa Aesar. They are 1.5

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micrometer long and with small diameters. From the Raman spectra has been deduced the rough composition of the nanotubes in conducting and not conducting components. The fraction of the conducting nanotubes is around 25 % mol as estimated. The $As_sS_3$ powder is a technical grade substance. There was also used dodecyl benzene sulfonate in the solution in order to facilitate a better dispersion of the SWCNT.

From the solution with $As_sS_3$ and from the one without $As_sS_3$ has been deposited on two sensors from the surface of one of the Langmuir-Blodgett trough and then the other by compressing it at a given surface pressure and transferring the layer by layer from the trough. The sensor consists of a ceramic (Al2O3) body provided with platinum electrodes.

The sensing properties of the LB films deposited have been tested tested against the UV radiation. The measurements of electric resistance have been made in a special device built especially for this type of measurements connected to a Keithley Multimeter unit. 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 µW/cm2.

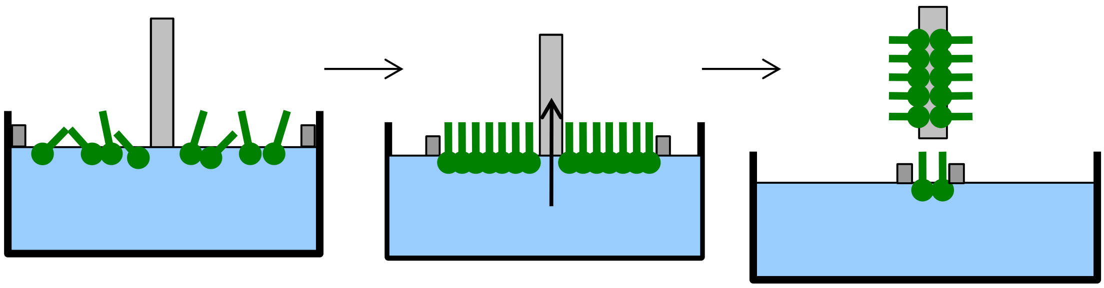


*Fig. 1 Langmuir-Blodgett deposition method*

### 3. Results

The material, deposited using the Langmuir Blodgett technique, based on SWCNT, barium stearate and $As_2S_3$ is carrefuly selected because the stearate plays the role of a matrix in which the nanotubes are dispersed, 33% from the nanotubes have a strong metallic character, thus exibits the electric resistance of the layer and $As_2S_3$ is considerd to be a good activator in the presence of UV light.The sensor without $As_2S_3$ show an unusual behaviour of the resistance under the action of the UV-radiation. The resistance of the sensitive material increases along a curve with the tendency to saturate for increasing time of radiation (see the Fig. 2). The resistivity increase and saturates after 3-4 minutes.

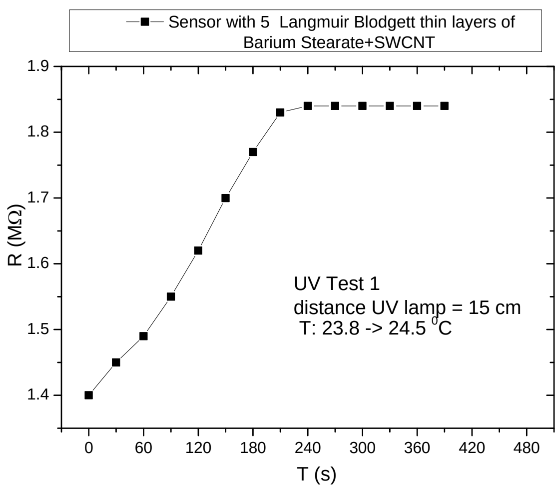



*Fig. 2 The effect of UV radiation for the sensor without $As_2S_3$*

We have compared the sensor with barium stearate layer with SWCNT with the sensor $As_2S_3$. For the sensor with $As_2S_3$, the electrical resistence shows a smaller increase during UV irradiation, also the scale of resistance is mush smaller. The response to UV radiation is proportional with the time of radiation. The sensor with $As_2S$ has a good linear response to the irradiation. Compareed to the sensor without $As_2S_3$ , for this sensitive material was not observed a saturation effect of ultraviolet light. (Fig. 3).

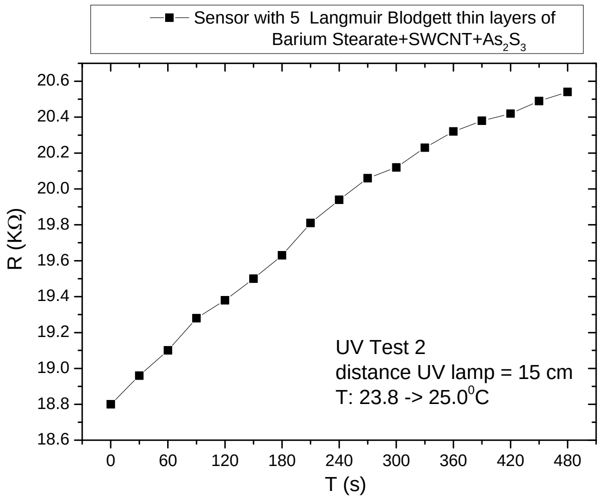
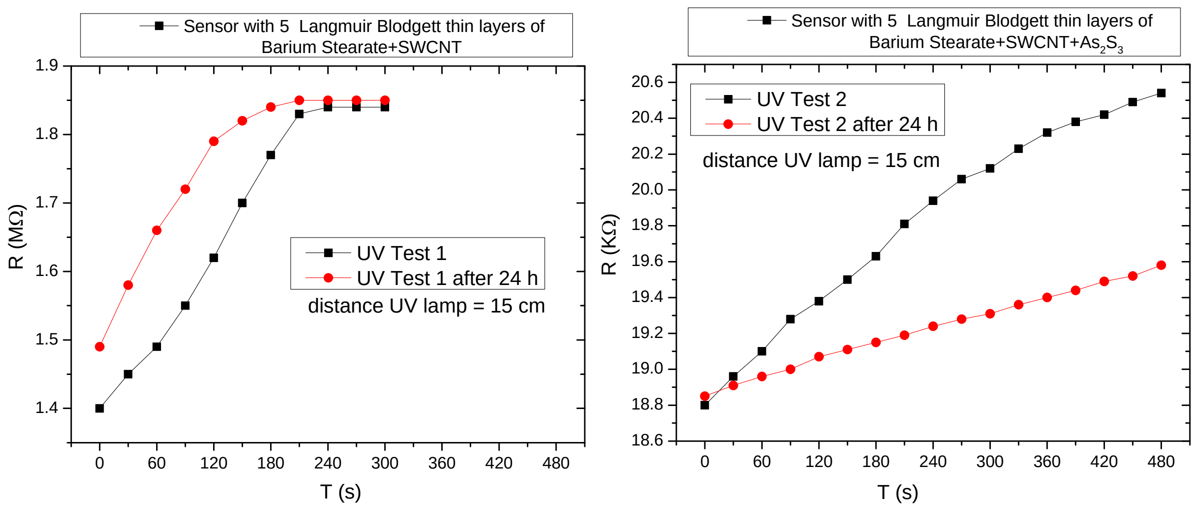



*Fig. 3. The effect of UV radiation for the sensor with $As_2S_3$*

After turrning off the UV - lamp the resistance does not recover to the initial value immediately. The sensor is not fully reversible and it was observed that during ageing the sensitivity of the sensor slighly decreases (Fig. 4). Further experiments are necessary to understand the phenomenon, to improve the sensitivity of the material and to get rapid reaching of the initial state after UV radiation.




*a)* *b)*

*Fig. 4. Ageing effect of UV radiation for the sensor:*
*a) without $As_2S_3$b)with $As_2S_3$*

## 4. Conclusion

Complex multilayers have been prepared by the Langmuir-Blodgett method. The surface properties of the complex layers with $As_2S_3$ barium stearate and SWCNT have been studied. We have tested the sensitivity of the material for ultraviolet radiation. The sensor resistivity increases nearly linear in the case of the one with $As_2S_3$. The sensor without $As_2S_3$ saturates after 3-4 minutes of irradiation.

The high sensitivity to UV radiation of the material and the linearity of the resistivity for long time irradiation was explained by trapping of the charge carriers generated by UV radiation on the surface of the nanoparticles of $As_2S_3$. The defects in $As_2S_3$ nanoparticles can be regarded as capture centres for the electrons generated by UV light.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