PHOTOELEMENT WITH SCHOTTKY BARRIER ON THE BASE OF THE MAGNESIUM PHTALOCYANINE ORGANIC SEMICONDUCTOR

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In this work the results of the study of the influence of the thermal processing in oxygen atmosphere on photoelectric properties of the Al/MgPc Schottky barrier in SnO_2 /MgPc/Al thin film structures are presented.

At present the great variety of film structures with the Schottky barrier on the base of inorganic semiconductors is used in microelectronics [1, 2]. At last years similar structures are created and broadly investigated also on the base of the organic semiconductors (OS), in particular, on the base of phthalocyanine and its complexes with metals [3, 4]. Development of the doping technology for OS will enable these compounds to form a serious competition to inorganic materials used now, and possibly, fabricating the semiconductor devices with qualitatively new characteristics.

By choosing respective electrode material one can form ohmic [5, 6], as well as rectifying [3, 6, 7] electrical contacts to semiconducting metal-organic compounds of the phthalocyanine class.

The investigation of the current characteristics of "sandwiches", in which OS magnesium phthalocyanine (MgPc) layer was equipped by Al or Ag electrodes have been conducted elsewhere [7]. Non-symmetrical volt-ampere characteristics (VAC) were explained by the formation of the p-n-junction in MgPc as the result of substitution of Mg atoms by Al ones during the heat treatment. The further study of the similar structures have shown the presence of the Schottky barrier in the Al/MgPc interface.

In this work the results of the study of the influence of the heat treatment in oxygen atmosphere on photoelectric properties of the Al/MgPc Schottky barrier in SnO2/MgPc/Al thin film structures are presented.

VAC of the Al/MgPc/Al thin film structures studied elsewhere [7], were symmetrical, while current in the Al/MgPc/Ag structure depended on polarity of the applied voltage. The fact that MgPc is a p-type semiconductor [7], and forward direction corresponds to the positive potential on Al-electrode, evidenced for the presence of the Schottky barrier in the Al /MgPc interface.

MgPc used by us in studies was additionally cleaned by the double sublimation in the vacuum. The SnO_2 /MgPc/Al thin film structures have been obtained by the thermal evaporation in the vacuum (~10^{-6} Torr) consistently MgPc and second Al electrode onto the quartz substrate, on which beforehand was deposited the transparent SnO_2 electrode. The thickness of the layer was 0,2÷2,0μm. The doping by the oxygen was produced by endurance of the film in the oxygen atmosphere at 390÷420K. All measurements have been conducted in the vacuum ~10^{-5} Torr.

The presence of the Schottky barrier in Al/MgPc interface determines main electrical as well as light characteristics of the element, which are described below.

Study of the dark current characteristics of the "sandwich" structures on the base of the *SnO_2 /MgPc/Al* structures shows, that the doping by oxygen essentially changes all electrophysical characteristics of the system. The height of the Schottky barrier, determined from the slope of the temperature dependence of the current, for the sample processed in the oxygen atmosphere (Φ=0.5eV) in two times is less, than for the sample processed in the high vacuum (Φ=1.0eV).

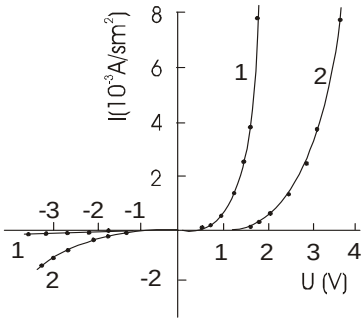

Fig. 1. Volt-ampere characteristics of the SnO_2 /MgP_c/Al structures, annealed in oxygen atmosphere: 1-dark, 2-under constant illumination L=5·10^4Lx.

On the fig. 1 the dark and light VAC are presented for the photoelement on the base of the SnO_2 /MgPc/Al, processed in the oxygen atmosphere at room temperature. It is seen from VAC that the dependence *I* on *U* is essentially non-symmetrical, which is connected with the effect of the Schottky barrier. At the illuminating the structure, non-equilibrium charge carriers form which influence on all characteristics of the structure.

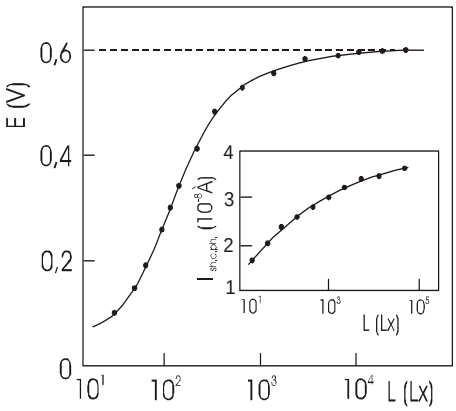

Fig. 2. The dependence of the photo e.m.*f.* on the illumination. Insert- short circuited photo-e.m.*f.* versus illumination.

Under the illumination the separation of the charge carriers between the *Al* and *MgPc* occurs and the photovoltaic effect is observed. On the fig. 2 the dependence of the photo-e.m.f. on illumination intensity *L* has been shown. As one can

see from the fig. 2, at great L the resistance of the barrier layer decreases so, that photo-e.m.f. approaches to the saturation – limiting value 0.5-0.6eV for the samples with the doped MgPc layer.

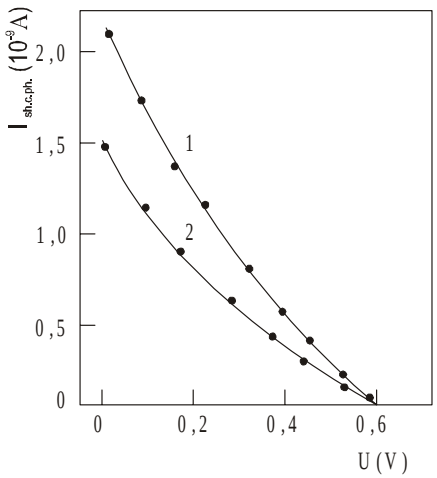

Fig 3. The dependence of the short circuited photo current $I_{sh.c.ph.}$ on the reverse bias voltage U, under illumination: -$8 \cdot 10^3$Lx, 2-10^4Lx.

This value corresponds to the Schottky barrier height, obtained from the analysis of the dark volt-ampere characteristics. On the insertion of fig.1 the dependence of the short circuit photocurrent I_{sc} on the light intensity L is shown. It is seen that the short circuit photocurrent I_{sc} increases with growing of the light intensity L.

The height of the Schottky barrier also can be determined from the dependence of I_{ph} versus the bias voltage under constant illumination. The dependence of the short circuit photocurrent on the inverse bias voltage is shown in fig.3. As would be expected, at the positive potential on the transparent SnO_2 electrode with the increase U the I_{sc} current decreases, and at $U \approx 0.6$ V for the MgPc layer doped by oxygen ($U \approx 0.1$V for source, which is determined from the dependence I versus $1/T$) $I_{sc}=0$, i.e. at $U \approx 0.6$V the short circuit current disappears. The determined value 0,6eV corresponds to a height of the potential Schottky barrier for the SnO_2/MgPc/Al structure doped by the oxygen. At the positive potential on Al-electrode, with the growing U only increase of the current in the structure occurs, what is also explained by the influence of U on the Schottky barrier in Al/MgPc interface.

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MAQNEZİUM FTALOSİANİN (MgPc) ƏSASLI ŞOTTKİ BARYERLİ STRUKTURLARIN DÜZLƏNDİRİCİ XASSƏSİNƏ OKSİGENİN TƏSİRİ

Nazik təbəqəli SnO_2/MgPc/Al strukturunda maqnezium ftalosianinin oksigen atmosferində istilik emalının Şottki çəpərinin fotoelektrik xassələrinə təsiri tədqiq olunmuşdur. Alınan nəticələr göstərir ki, MgPc nazik təbəqəsini oksigenlə aşqarlamaqla onun əsasında düzəldilən strukturun xassələrini idarə etmək olar.

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ФОТОЭЛЕМЕНТ С БАРЬЕРОМ ШОТТКИ НА ОСНОВЕ ОРГАНИЧЕСКОГО ПОЛУПРОВОДНИКА - ФТАЛОЦИАНИНА МАГНИЯ

В настоящей работе приводятся результаты исследования влияния термообработки MgPc в кислородной атмосфере на фотоэлектрические свойства барьера Шоттки Al/MgPc в пленочных структурах Al/MgPc. Полученные результаты показывают, что легированием пленки MgPc кислородом можно управлять свойствами структур на основе MgPc.

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