THE INTERMEDIATE CdO LAYER INFLUENCE ON SOLAR ENERGY CONVERSION IN CdS/CdTe HETEROJUNCTIONS

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All processes of charge carrier separation and current formation in CdS/CdTe solar cells occur in CdTe layer, therefore it plays a crucial role in the assuring of high efficiency of the given heterostructures. The formation of a tunnel-transparent CdO nanolayer between CdS and CdTe layers leads to the enhancing of solar cell energetic parameters.

CdS/CdTe heterojunctions were obtained by successive deposition of CdS and CdTe layers on the glass substrates ($2x2cm^2$) covered by a conducting (~10^{-3} Ω·cm) transparent SnO_2 layer by using quasi-closed volume method. CdS thin layer had the thickness of 0,3÷0,6 μm and the electrons concentration $1,6÷2,3.10^{18}cm^{-3.}$ Figure 1 shows an AFM image of the CdS thin film. The Root Mean Square (RMS) of the surface of the film is 19, 5 nm. The AFM image show some pin holes on the film and reveal a surface with a series of peaks and troughs of varying heights, depths, and spacing.

CdTe layers had the thickness of 8÷14 μm and the holes concentration of ~$(2÷8).10^{15}cm^{-3}$.

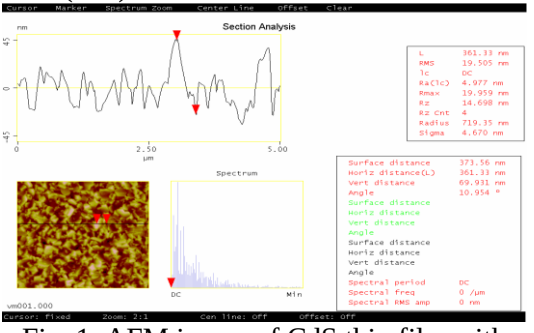

Fig. 1. AFM image of CdS thin film with illustration of surface roughness

Before the deposition of CdTe layer a CdO layer with the thickness of 2÷50 nm was deposited on to the CdS layer surface CdO layers were obtained by magnetron sputtering at a constant current intensity of Cd target in the atmosphere of oxygen. The CdO layer thickness was controled by the time of sputtering and was determined by using a graduated curve of layer thickness dependence on the sputtering time. The typical morphology of the different interfaces of thin films are shown in the Fig.3. and information about images are shown in the Table 1.

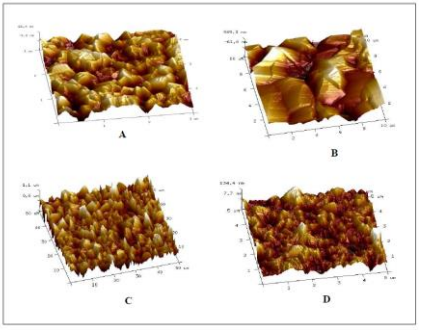

Fig.2. AFM imagea of the different surfaces of the different thin films

Table 1

Root-mean-square (RMS) surface and roughness of different of the solar cell

AFM analysis			
	Top layer	Roughness : Rq, nm	Bearing: Mean diameter, µm
A	CdS/CdO	29.3	0.254
B	CdTe/CdO/Cds	274	1.128
C	CdTe/CdS	299	1.342
D	CdS	31.1	0.272

As one can see from table 1 CdO smoothes the surface of CdS which leads to the improvement of the photovoltaic parameters of the CdS/CdTe structure. The investigation of the current-voltage characteristics I-U in the dark (fig.3 (a)) shows that the introduction of CdO layer at the interface of the device does not change the kind of current mechanism flow in CdS/CdTe structure but only improve the values of the electrical parameters.

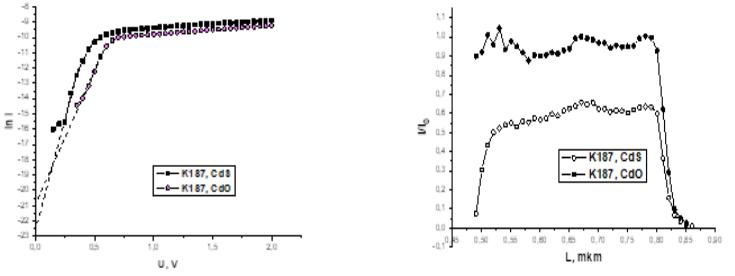

Fig.3. The lnI=f(U) dependencies (a) and the spectral sensitivity (b) of the CdS/CdTe and CdS/CdO/CdTe devices

The main electrical parameters of CdS/CdTe and CdS/CdO/CdTe devices fabricated in the same technological cycle are given in the Table 2.

Table 2

The saturation current (I_o), diffusion potential (U_D), series (Rs) and shunt (R_{sh}) resistances of devices

samples	***I_0, A***	***U_D, V***	***R_S,Ω***	***R_{Sh}, Ω***
G160, CdO	$2,06*10^{-9}$	1,2	$1,4*10^4$	$5,1*10^6$
CdS	$6,2*10^{-9}$	0,95	$1,0*10^4$	$1,7*10^5$
K187, CdO	$7,5*10^{-10}$	0,53	$2,2*10^4$	$3,6*10^6$
CdS	$1,5*10^{-10}$	0,38	$1,8*10^4$	$5,18*10^6$

The photoelectrical parameters of SnO_2/CdS/CdO/CdTe/Ni structures with the optimum values of CdO layer thickness (5÷8) nm at 300K

and illumination 100 mW/cm^2 have the next values: open circuit voltage (U_{oc}) =0,79÷0,83 V, intensity of the short circuit current (I_{sc})=24,6÷24,8 mA/cm^2, fill factor (FF) =0,54÷0,57, efficiency (η) =11,1÷11,8%.

The spectral sensitivity of SnO_2/CdS/CdO/CdTe/Ni structures covers the wavelength region 0,52 ÷0,86 μm (Fig 3 (b)) and is constant in all visible region which indicates to low concentration of the recombination centres at the heterostructure interface. Introduction of CdO layer with a thickness of 5 ÷8 nm increases the spectral sensitivity by 1,4÷1,7 times.

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