Fabrication and properties of the photosensitive anisotype *n*-$Cd_{1-x}Zn_xO$/*p*-CdTe heterojunctions

V.V. Khomyak[1], V. V. Brus[1], M. I. Ilashchuk[1], I.I. Shtepliuk[2], G.V. Lashkarev[2]

[1]Fedkovich Cherinvtsi national university, 2 Kotsubinsky str., 58012 Chernivtsi, Ukraine
e-mail: v.khomyak@chnu.edu.ua
[2]Frantsevich institute for problems of materials science NAS Ukraine,
3 Krzhizhanivsky str., 03680 Kyiv, Ukraine

A high conductivity and transparency of the ZnO are reasons for its evergrowing use as wide band-gap semiconducting material in surface-barrier heterojunctions. The growth of the solid solutions based on the metal oxides gives a possibility to change controllably their physical properties and band-gap energy. It is very important for designing the photovoltaic devices to improve their performance in different spectral regions.

Here we present the results of the studies of the electrical and photovoltaic properties of the anisotype *n*-$Cd_{0.5}Zn_{0.5}O$/*p*-CdTe heterojunctions. Dominant current mechanisms at the forward and reverse bias were determined. It was shown the possibility of the practical use of the obtained structures in the photodiode mode.

The heterojunctions were fabricated by means of the deposition of $Cd_{0.5}Zn_{0.5}O$ thin films on the freshly-cleaved surface of the CdTe single crystal (using the reactive magnetron sputtering of the Cd-Zn alloy target). Argon and oxygen were utilized as the working and reactive gases (with a gas ratio of 4:1), correspondingly. It should be mentioned that the studied heterostructures differ from the previously investigated structures [1] by the method of forming of the $Cd_{0.5}Zn_{0.5}O$ film on CdTe. P-type CdTe crystals were grown by Bridgman technique at low vapor pressure of cadmium. These crystals have following electrical parameters at T=300 K: electrical conductivity $\sigma = 8.9 \cdot 10^{-2}\ \Omega^{-1} \cdot cm^{-1}$, hole concentration $p = 7.2 \cdot 10^{15}\ cm^{-3}$. The $Cd_{0.5}Zn_{0.5}O$ films were low-resistance, making it possible to form the electrical junction in cadmium telluride. The latter is confirmed by the potential barrier height at $T = 0$ K ($e\varphi_к$=1.6 eV), which was determined from the analysis of the direct branches of the current-voltage characteristics. It is well consistent with CdTe band-gap energy.

It was found that the fabricated *n*-$Cd_{0.5}Zn_{0.5}O$/*p*-CdTe structures refer to abrupt *p*-*n*-junctions. Current-voltage (*I*-*V*) characteristics of these heterostructures in the wide voltage range ($V \le 0.8$V and $V \le 1.5$ V at the direct and reverse bias, respectively) are defined by the generation-recombination processes in the electrical junction. Recombination of non-equilibrium charge carriers occurs via impurity centers, which are located in the forbidden band of CdTe. In this case, the depth of the impurity energy level is 0.5 eV that may correspond to complex defect involving the doubly charged cadmium vacancy and a background donor impurity. In this voltage range, no tunnel-recombination mechanism of current transport that is proper for most of heterojunctions [1] was observed. It can be caused by better structural properties at the interface between components.

In addition, the studied *n*-$Cd_{0.5}Zn_{0.5}O$/*p*-CdTe heterojunctions were photosensitive. These structures are characterized by the presence of the saturation photocurrent in the range of $0.5 \le V \le 1.5$ V. A ratio of photocurrent to dark current was about $4 \cdot 10^3$, suggesting the possibility of use of these structures in the photodiode mode.

[1]. V. V. Brus, M. I. Ilashchuk, V. V. Khomyak, Z. D. Kovalyuk, P. D. Maryanchuk, K. S. Ulyanytsky, *Semiconductors* **46**, 1152 (2012).