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Spectral Characteristics of Solar Cells Based on Cu $_{2-X}$ S-Cds With Deep Impurity Levels

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Abstract: With a doped layer thickness of the order of several hundred angstroms, due to the Cd concentration gradient in Cu2-xS, an electric field of about 105 V/cm should appear. Many experimental data on the study of electrical and photoelectric characteristics of Cu2-xS-CdS heterojunctions confirm the validity of these considerations. A band diagram of solar cells based on Cu2-xS-CdS is proposed.

Keywords: Cu2-xS-CdS, Spectral dependence of U xx SE Cu 2-x S-CdS, Cu 2-x S-CdS confirm the validity of these arguments.

Introduction . The question of the spectral sensitivity of Cu $_{2-x}$ S-CdS heterojunctions is important not only from the point of view of the efficiency of solar light conversion, but also for understanding the mechanism of the photovoltaic effect in these structures. Without detailed knowledge of the spectral characteristics, it is impossible to purposefully control the technological process in order to obtain highly efficient Cu $_{2-x}$ S-CdS heterostructures [1,2].

The type of spectral characteristic depends on the properties of the materials that make up the heterojunctions and on the design of the photoconverter. The nature of the long-wave photosensitivity of the Cu $_{2-x}$ S –CdS heterojunctions beyond the edge of the intrinsic absorption of CdS has been the subject of a long-term discussion. This is due to the existence of various Cu $_{2-x}$ S phases with a high sulfur content overlapping with impurity absorption in CdS involving copper centers [3,4].

METHODS OF ANALYSIS

Fig. 1 shows the spectral distribution of short-circuit current ($I_{кз}$) photoconverter Cu $_{2-x}$ S-CdS obtained by immersing CdS films and single crystals in an aqueous solution of CuCl for different periods of time [5].

It is evident from the figure that with increasing time of CdS treatment in solution the photoresponse in the long-wave region of the spectrum decreases with a shift of the maximum toward shorter wavelengths. According to the authors, with prolonged treatment of CdS in solution a layer of Cu $_{2-x}$ S with a high sulfur content and with a high concentration of the main carriers – holes in Cu $_{2-x}$ S is formed. The absorption of light by the latter is non-photoactive in the sense of formation of photo-emf. The absorption of light by free carriers increases with increasing wavelength, which leads to a shift of the maximum toward the short-wave part of the spectrum with increasing sulfur content. Shifts of the long-wave edge of photosensitivity toward shorter wavelengths are also observed during annealing of Cu $_{2-x}$ S-CdS in sulfur vapor. These results lead the authors [6] to the conclusion that the long-wave photosensitivity of the Cu $_{2-x}$ S-CdS heterostructure is associated with the absorption of light in copper sulfide.

[1] Fergana branch of TATU named after Muhammad al-Khorazmi, assistant
[2] Fergana branch of TATU named after Muhammad al-Khorazmi, assistant
[3] Fergana branch of TATU named after Muhammad al-Khorazmi, assistant

RESULTS AND DISCUSSION

Figure 2 shows a family of curves of the dependence $U_{xx} \sim f(\lambda)$, where curve A was obtained before heat treatment. In the spectral characteristics, the peak due to absorption in CdS is absent before heat treatment. Curves B, C, D were obtained after heat treatment at 200 ^{o} C for 2, 4, 20 minutes, respectively. As follows from the figure, a main maximum near 0.6 µm appears in the peak To, which, in the author's opinion, is associated with optical absorption at copper acceptor centers in i -odon formed as a result of copper diffusion in CdS during heat treatment. In this case, tunneling of electrons is significantly hampered. This explains the decrease in the long-wave sensitivity of Cu_{2-x} S- CdS after heat treatment. However, within the framework of this model, the experimentally observed increase in the value of I_{sc} after heat treatment remains unexplained . The photoresponse near 0.7 µm is associated with absorption in $Cu_{1.96}$ S. And the sensitivity at λ=0.92 µm (or ~1.2 eV) is associated with indirect optical transitions in Cu_2 S. Finally, in [6] it is noted that the spectral sensitivity of the Cu_2 S-Cd S heterostructure beyond the intrinsic absorption edge of CdS is due to both impurity absorption in cadmium sulfide and band-to-band absorption in copper sulfide.

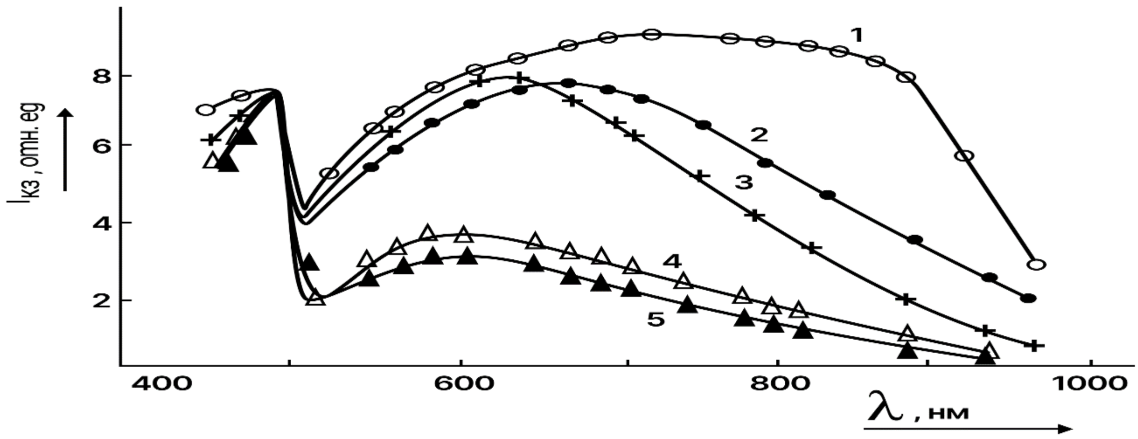

Fig.1 Spectral distribution of I_s of the Cu_{2-x} S-CdS heterostructure for different treatment times in an aqueous CuCl solution. Treatment time.sec: 1-2, 2-4, 3-6, 4-8, 5-10

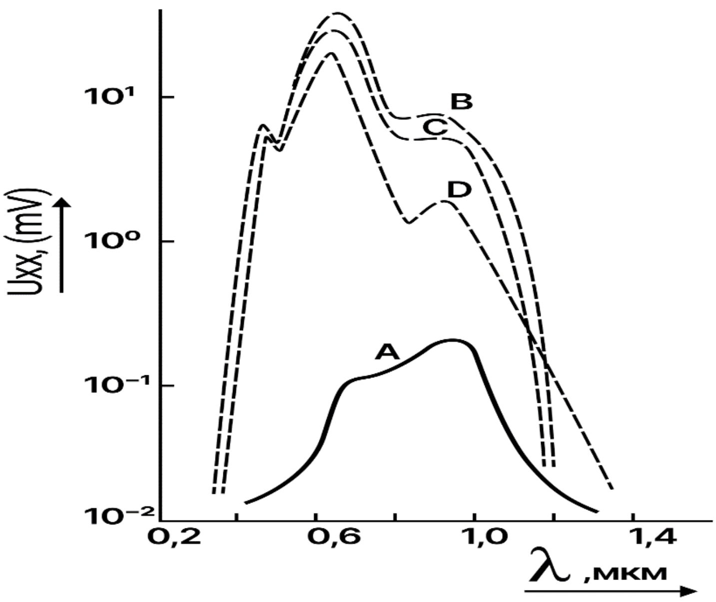

Fig. 2 Spectral dependence of U_{xx} of Cu_{2-x} S-CdS SE before (A) and after heat treatment at 200 ^{0} C for 2 (B), 4 (C) and 20 min (D)

SUMMARY

With a doped layer thickness of the order of several hundred angstroms, due to the Cd concentration gradient in Cu $_{2-x}$ S, an electric field with a strength of about 10^5 V/cm should appear. Many experimental data on the study of electrical and photoelectric characteristics of Cu $2-_x$ S-CdS heterojunctions confirm the validity of these considerations. *A band diagram of solar cells based on Cu $_{2-x}$ S-CdS is proposed.*

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