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NONIDEAL HETEROJUNCTION CONDUCTIVITY

$CdS\text{-}Cu_2S$ heterojunction conductivity both on continuous, and on an alternating current strongly depends on barrier parameters which can vary under illumination influence. It is established, that space charge region resistance essentially depends on its width (this dependence is close to linear) at fixed barrier height. It can testify to prevalence of tunnel multistage mechanisms of transfer over researched structure, for example, tunnel-jumping conductivity

Nonideal heterojunction basic photo-electric characteristics impossible to explain without the assumption of a determining role differing from thermoemission mechanisms current through space charge region (SCR) carry [1, 2]. Such mechanisms usually have tunnel character. In this connection, detailed studying SCR parameters influence on heterojunction conductivity is very important, as allows to specify the losses mechanism in heterophotoelements. Especially interesting seems the investigation of barrier region conductivity dependence on its width in connection with the assumption currenttransport tunnel character. We shall consider, for example rather popular in one's time typical nonideal heterojunction $CdS\text{-}Cu_2S$.

It is established, that the barrier width concentrated in more wideband CdS effectively can be changed by light from cadmium sulfide intrinsic absorption region [3, 4], where in a short circuit current mode (no voltage bias) Fermi level position in quasineutral region is a constant value, not dependent on illumination intensity. In these conditions the barrier height does not change and it is possible to determine conductivity dependence solely on SCR width.

With this purpose the heterojunction current-voltage characteristics (CVC) were received at illumination it by various intensity light with $\lambda < 620$ nm (FIG. 1). A curve measured at various illumination levels has various heterojunction photocapacity values (C_{ph}). It is visible, that with photocapacity growth and, hence, SCR extent reduction, at constant barrier height in point U=0 junction differential resistance decreases considerably.

Investigation conductivity active component on an alternating current (f=20kHz) were carried out by a compensation method with the use of the alternating current bridge by which the junction capacity also has been measured, at that the signal measuring amplitude did not exceed 5 mV. If for each photocapacity value to calculate the barrier width it is possible to construct its conductivity or resistance dependence on extent for alternating or a continuous current (FIG. 2). In the latter case the heterojunction resistance analysis for zero bias determined from CVC shows (fig. 1) that with SCR width increase its resistance as on continuous (curve 2), and on alternating (curve 1) currents grows, remaining, however, on an alternating current essential smaller then stationary value, what is rather typical for tunnel-jumping transport mechanism [5].

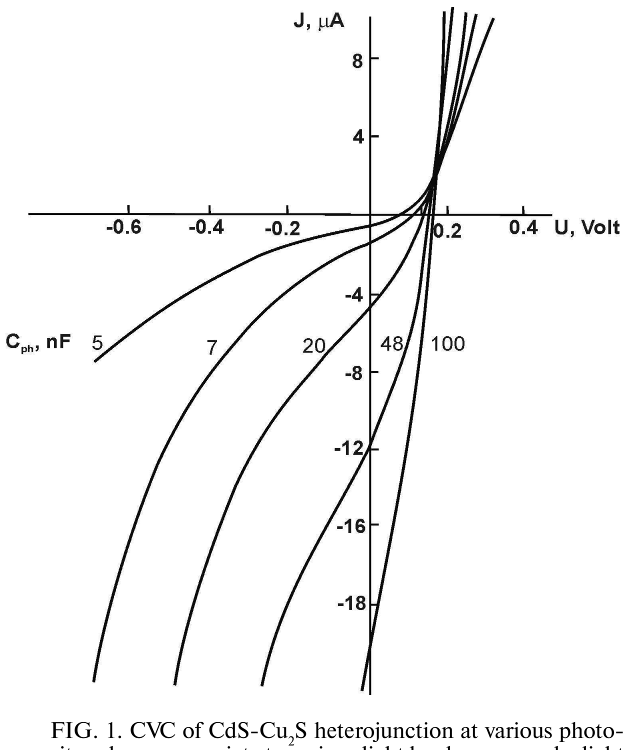

FIG. 1. CVC of $CdS\text{-}Cu_2S$ heterojunction at various photocapacity values appropriate to various light levels exposure by light from CdS intrinsic absorption region.

The given curves are not exponential, and find out much weaker dependence which is coming most likely to linear, that also testifies most likely the multistage transport mechanism, but not direct tunneling.

Dependences $CdS\text{-}Cu_2S$ heterojunction conductivity on continuous and alternating current on the applied bias value at various light levels exposure are given in FIG. 3. Though at illumination intensity growth conductivity always increase, however this growth for the big and small biases can be caused by the different reasons. From FIG. 3 it is visible, that at enough big biases conductivity on continuous and an alternating current differs much less, than at small biases. It can testify that with increase of an external continuous voltage in the current restriction series resistance begins to play an essential role in CdS base layer which conductivity is determined by free carriers, is not connected with the transport on the located states and does not depend therefore on a measuring signal frequency. Saturation of characteristics G=G(U) also testifies to it at biases close to barrier amount value.

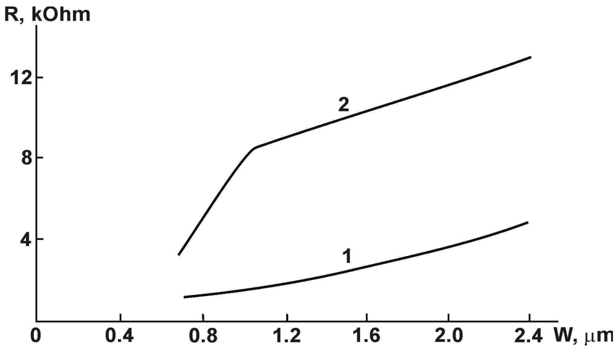

FIG. 2. Dependence of heterojunction resistance on continuous (curve 1) and alternating (f = 20 kHz, curve 2) current.

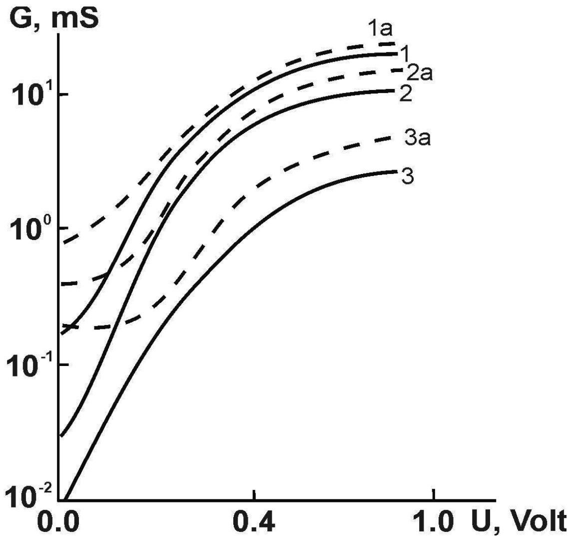

FIG. 3. Dependence of conductivity on continuous (solid curves) and alternating (dotted curves) current on positive bias value at various levels of illumination (1 and 1a- 100 rel. un.; 2 and 2a — 20 rel. un.; 3 and 3a — 2 rel. un.).

At stimulating light large intensities change to ohmic current on voltage dependence occurs at lower biases. Conductivity growth at illumination for large voltage, apparently, is caused by CdS base layer conductivity increase, and for small — barrier region conductivity growth due to SCR width reduction. As it was marked above, the measuring signal amplitude made units of millivolt, that is much less then the external bias voltage and a measuring signal did not influence on a barrier parameters. At the absence of external bias the difference between conductivity on continuous and alternating current is maximal, as in this case the running current is determined almost exclusively by a barrier height and width which conductivity can be caused by the frequency-dependent mechanism of transport on the located states [5]. Such G=G (U) dependence character can results in anomalies CdS-Cu_2S volt-farad characteristics for positive biases because of measuring alternating signal voltage drop redistribution inter photo cell various layers at reduction junction resistance with the applied continuous voltage growth.

Thus, conductivity at rather small biases depends not only on height, but also on barrier width and can be determined by tunnel-recombination transport mechanism. Nonideal heterojunction conductivity both on continuous, and on an alternating current strongly depends on the barrier parameters, which can vary under illumination. Such dependence testifies to prevalence tunnel-recombination transport mechanism.

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Abstract
CdS-Cu_2S heterojunction conductivity both on continuous, and on an alternating current strongly depends on barrier parameters which can vary under illumination influence. It is established, that space charge region resistance essentially depends on its width (this dependence is close to linear) at fixed barrier height. It can testify to prevalence of tunnel multistage mechanisms of transfer over researched structure, for example, tunnel-jumping conductivity
Key words: heterojunction, barrier, tunnel — jumping conductivity

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ПРОВІДНІСТЬ НЕІДЕАЛЬНОГО ГЕТЕРОПЕРЕХОДУ

Резюме

Провідність гетероструктури $CdS\text{-}Cu_2S$ як на постійному, так і на змінному струмі сильно залежить від параметрів бар'єра, які можуть мінятися під впливом освітлення. Встановлено, що опір області просторового заряду істотно залежить від її ширини (ця залежність близька до лінійної) при незмінній висоті бар'єра. Це може свідчити про перевагу тунельних багатоступінчатих механізмів переносу в структурі, що досліджується, наприклад, тунельно-стрибкової провідності.

Ключові слова: гетероперехід, бар·єр, тунельно — стрибкова провідність.

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ПРОВОДИМОСТЬ НЕИДЕАЛЬНОГО ГЕТЕРОПЕРЕХОДА

Резюме

Проводимость гетероструктуры $CdS\text{-}Cu_2S$ как на постоянном, так и на переменном токе сильно зависит от параметров барьера, которые могут меняться под действием освещения. Установлено, что сопротивление области пространственного заряда существенно зависит от ее ширины (эта зависимость близка к линейной) при неизменной высоте барьера. Это может свидетельствовать о преобладании туннельных многоступенчатых механизмов переноса в исследуемой структуре, например, туннельно-прыжковой проводимости.

Ключевые слова: гетеропереход, барьер, тунельно — прыжковая проводимость.