HIGH VOLTAGE SELENIUM ELEMENTS WITH ARTIFICIAL PN TRANSITION PREPARATION

AYGUN SULTANOVA HAJI gizi
Doctor of philosophy in Physics,
assotiate professor
aygunsultanova60@gmail.com
ALIZADE ARIFE FIKRET gizi (magistr)
elizadearife2001@gmail.com
Nakhchivan State University

Although they have largely been replaced by silicon diodes in modern electronic devices, they remain a topic of interest for electronics enthusiasts and historians. In this research paper, we will examine the properties, operations, and applications of selenium diodes to better understand their historical significance and continued relevance.

Selenium diodes, a type of semiconductor diode, have been used in various electronic applications for several decades.

A selenium diode is a semiconductor rectifier consisting of a layer of selenium between two metal electrodes, historically used in electronics [1].

Selenium diodes consist of a thin layer of selenium sandwiched between two metal electrodes, often made of aluminum or iron.

The selenium layer is usually doped with a small amount of impurity to form an n-type or p-type semiconductor. A diode can be created by evaporating selenium on a metal substrate or by sintering selenium powder onto the metal. The operation of the selenium diode is based on the principle of rectification, which is the conversion of alternating current (AC) to direct current (DC). When a voltage is applied across the diode, the electric field allows charge carriers to flow in one direction and blocks the flow in the other direction. This unidirectional current flow is very useful for repairing diodes.

Keywords: diode, electrode, voltage, resistance, additive.

Selenium diodes have a number of advantages compared to their more modern silicon counterparts. Some of these benefits include:

Low Reverse Leakage Current: Selenium diodes have a low reverse leakage current, meaning they can effectively block current from flowing in the reverse direction, making them an efficient rectifier.

High voltage rating: Selenium diodes can handle high voltage levels, making them suitable for use in high voltage applications

Temperature stability: The electrical characteristics of selenium diodes remain relatively stable over a wide temperature range, which can be beneficial in certain applications.

Low forward voltage drop: The forward voltage drop of a selenium diode is lower than that of silicon diodes, resulting in less power loss during operation.

Selenium diodes were widely used in a variety of electronic applications in the mid-20th century, including power supplies, voltage regulators, and radio receivers. One notable application was in early copiers, where selenium diodes were used as photodetectors to sense light reflected from a document being copied. However, as silicon diodes became more common and affordable, they gradually replaced selenium diodes in most applications.

The study of the structure and properties of the binding layer of selenium elements made it possible to understand the alignment mechanism and significantly change the electrical and thermal parameters of these elements. In addition, it was possible to prepare high-voltage samples from ordinary selenium elements by different methods, and artificial *pn*- junction elements with a direct resistance similar to that of ordinary technical rectifiers, and a much larger reverse resistance.

As shown above, CdS, Tl_2Se selenium cells with an artificial layer and gold top electrode $120\,\text{в}$ work CdS in reverse voltage up to , but their flat resistance is 2.5-3 times greater than that of conventional cells.

At the nominal current, it is necessary to reduce their voltage drop, in other words, their resistance. The electrode is not convenient and gives a large switching resistance with the mentioned electronic semiconductors. In these elements, if the gold top electrode is replaced by a cadmium-tin alloy, both forward and reverse resistances are significantly reduced.

Selenium elements with halogen addition, artificial layer and cadmium-tin cathode are highly voilable after molding at 30-40 *V* operating voltage for 2 hours. They also have the same resistance as conventional selenium elements.

High-voltage samples are also obtained from sulfurized factory elements by molding. In this case, molding is done for 4-5 hours $60-70\,\text{в}$.

Figure 1 CdS shows the static voltampere characteristic of the high-voltage sample with an artificial layer.

the n semiconductor is formed during molding , the halide dopants in the hole region of the *pn* junction are reduced. This change is likely because the applied voltage in the junction direction mainly falls on *the pn* junction, while the field voltage moves the negative ions of the halogen dopants. As a result, both forward and reverse resistance increases.
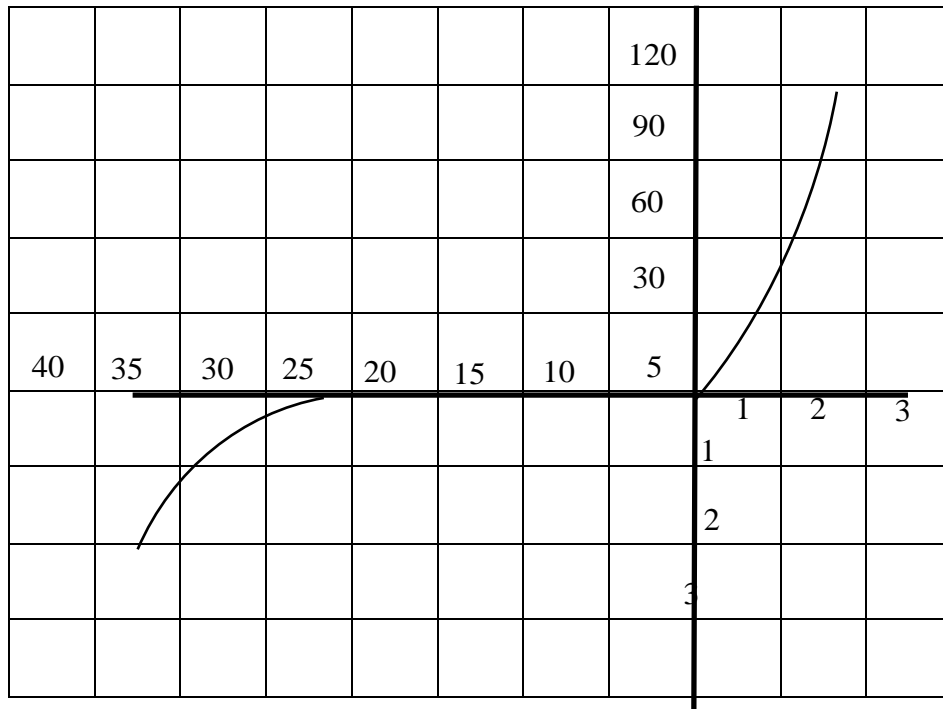
Fig. 1 . Artificial pn junction selenium elements static voltammetric characteristic.

It can be seen that in this case, a thick homogeneous CdS layer is obtained and the concentration of halogen additives in the p region decreases. 200 high-voltage elements were obtained by this method. However, in these elements substantial wear and reverse current flow are observed during molding, which causes partial molding failure after the voltage is cut off. The instability of the parameters is related to the change in the distribution of the concentration of halides in selenium and its boundary with the *n* semiconductor.

The reduction of the resistance of the elements after the opening of the molding current is related to the back diffusion of the halogen additives.

a pn junction is formed between pure CdS or $CdSe$ pure selenium, the reverse resistance increases rapidly, but the forward resistance is large. A small amount should be added to reduce flat resistance and create a concentration gradient during molding. However, this *pn* creates unfavorable conditions for the development of the physical bonding layer.

In order to obtain a high-voltage selenium cell, it is necessary to create a system in which there are halogen additives that can reduce the resistance in the direct direction, and there are no additives in the contact layer with *the n* -semiconductor.

For conventional selenium elements in static field, the value of reverse current at 18v $1-3ma/sm^2$ and $50ma/sm^2$ potential drop in direct direction should not exceed *1.2-1.4v* . High voltage artificial pn junction selenium cells also have the same parameters after fusion stress. After molding, the current for these samples is taken at $1-3ma/sm^2$ 80-90 *v,* and the voltage drop is *1.1-1.4 v* in the direct direction .

Figure 2 shows the static voltampere characteristics of two high-voltage selenium elements with an artificial pn junction . Curve number 2 refers to $CdSe$ the layered sample and curve number 3 CdS to the layered sample.

During operation, the temperature of high-voltage elements should not be higher than ordinary elements. Therefore, as the reverse voltage increases, the current density must decrease proportionally in this direction. For example, the nominal reverse current for 18 *v* selenium elements is limited to 1-3 *ma / cm*[2, for 30] *v* elements it is twice less, i.e. up to 0.5-1.5 *ma / cm* [2] and so on. should be According to such calculations, the value of the effective voltage for high-voltage artificial *pn* junction samples is 40-50 *v* . Individual elements can work at 60-65 *v.* At a constant voltage of 1 *v*, the correction factor reaches 10[6] [2].

In those elements, from -80 [o to] +60 [o] , the reverse current decreases with increasing temperature. The sign of the temperature coefficient of flat resistance is negative, that is, as the sign of the temperature coefficient increases in both directions, the voltage drop decreases.

Experiments show that the sign of the temperature coefficient of reverse resistance at positive temperatures is determined by the concentration of halogen additives in the hole region of the pn junction, while the sign of the temperature coefficient of direct resistance depends on the amount of halogens in selenium.

At large concentrations, both coefficients are negative, and at small concentrations, they are positive. As for the sudden decrease of the voltage drop after forming, it can be assumed that this phenomenon is related to the change of chlorine in the thickness of the selenium. After long-term crystallization, halogens fly from the surface layer of selenium, which is confirmed by our experiments with radioactive isotopes.
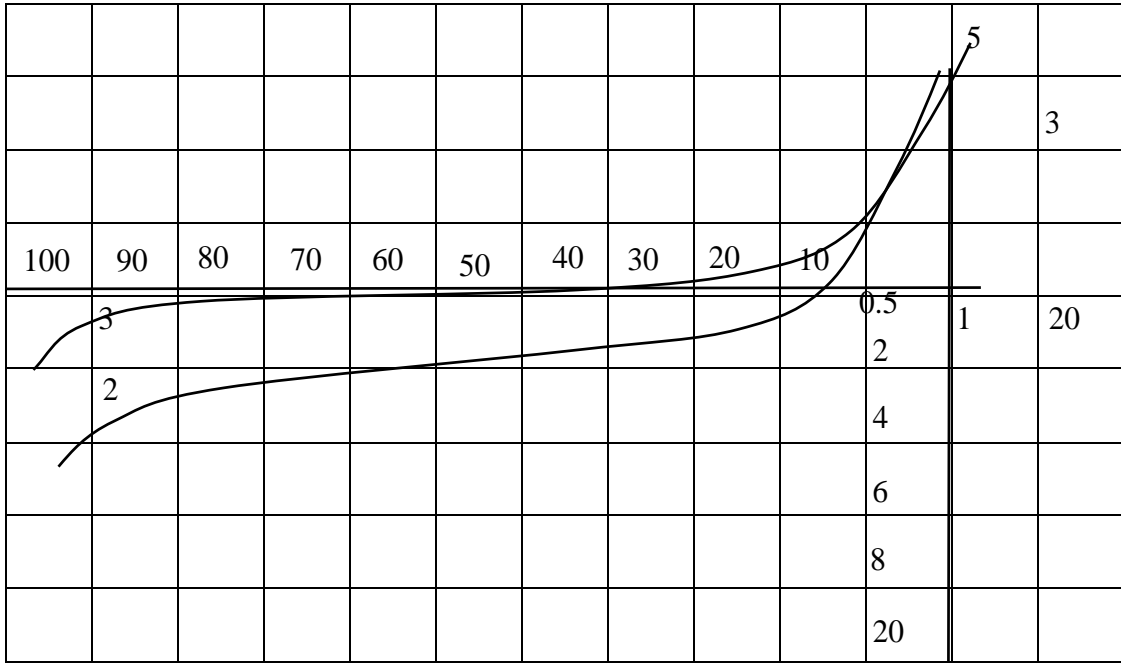
										5			
												3	
100	90	80	70	60	50	40	30	20	10				
	3									0.5	1	20	
	2									2			
										4			
										6			
										8			
										20			

Fig. 2 . Two high voltage selenium with artificial pn junction static voltamper characteristics of elements.

Under the influence of an external electric field, halogen additives are distributed in such a way that, as a result, the total resistance in the straight direction decreases. In the case of pure selenium, *the n* semiconductor layer becomes thicker during molding, which leads to an increase in resistance in both directions. The stability of flat resistance after molding is explained by the fact that its increase due to the thickness of the *n* semiconductor and its decrease due to the change in the distribution of halogen additives compensate each other, and the result remains unchanged experimentally.

The hypothesis of a change in the distribution of halogen additions in selenium and a consequent decrease in flat resistance was tested as follows.

In the dichlorinated sample, a pure selenium layer and then CdS were deposited on the semiconductor surface. The upper electrode was made of cadmium-tin alloy. A reverse voltage was applied to this element for 1 hour. After such processing, the flat resistance of the sample decreased by about 15% at 50ma/cm ^{2}. Thus, it became clear that when a concentration gradient is sought as a result of electric molding, halogen additives are distributed almost evenly throughout the entire volume of selenium, thus, the resistance of the element decreases in the straight direction.

It can be shown that if a concentration gradient of halogens is created as a result of the processing of selenium samples and is evenly distributed (or the gradient decreases) after electroforming, then the resistance of selenium should decrease in the latter case. Thus, the voltage drop in the straight direction is determined by the resistance of the main thickness of the cell; then after molding it should shrink.

Let's keep it simple. Assume that the selenium layer on the sample is cylindrical and the halogen dopants are uniformly distributed throughout the volume. Its height and cross-sectional area are equal to *l* and *S*. As a result

of thermal treatment, the concentration of halogens in the half of selenium located on the surface was n_1, and in the other half it was $n_1 < n_2$ n_2 [2].

These two halves are serially connected to each other. Then the total resistance of the sample is determined by the following formula:

$$R_1 = \frac{1}{2S\,ue}\left(\frac{1}{n_1} + \frac{1}{n_2}\right) \qquad (1.1)$$

Here, *u* and *e* are the permeability and charge of the hole.

It is assumed that the conductivity of the semiconductor increases proportionally with the concentration of additives. During molding, halogens are regularly distributed and their concentration is *n* throughout the volume . It is clear that $n_1 < n < n_2$

$$\frac{n_1 + n_2}{2} = n \qquad (1.2)$$

then the resistance is expressed by the following formula:

$$R_2 + \frac{l}{Suen} \qquad (1.3)$$

Showing that RR is the minimum value of $_1$. To find the minimum of R $_1$ from the necessary condition, if we find n_2 from (1.2) and substitute it in (1.1), take the first derivative and make it equal to zero:

$$\frac{dR}{dn_n} = \frac{l}{2SUe}\left[-\frac{1}{n_1^2} + \frac{1}{(2n - n_1)^2}\right] = 0 \qquad (1.4)$$

From here

23

$$-\frac{1}{n_1^2}+\frac{1}{(2n-n_1)^2}=0$$

we get which is $n = n_1$ gives

It shows that the most of R_1 small price additives equal when distributed is taken .

In this case, the minimum purchase for enough condition-second of the derivative positive to be conditional too is paid . Really :

$$\frac{d^2R}{dn_1^2}=-\frac{1}{2Sue}\left[\frac{2}{n_1^3}+\frac{2}{(2n-n_1)^3}\right]>0,$$

because $n > n_1$ it is

In the usual form of selenium elements, the flat resistance increases. This is mainly due to the formation and thickening of the n semiconductor layer and the violation of the equal distribution of halogens in selenium.

Selenium forms several allotropes that interconvert with temperature, depending somewhat on the rate of temperature change. When prepared in chemical reactions, selenium is usually an amorphous, brick-red powder. When rapidly melted, it forms a black, glassy form.

Such a change in the distribution of additives in high-voltage elements occurs during molding, that is, when the voltage reaches 100-120 $v.$ At this time, the resistance increases. Probably, the increase in flat resistance when voltage is applied in this direction and its complete recovery after 20-24 hours when the current is cut off are also related to these changes. It can be expected that if various additives are added to this connecting layer area, which increase the resistance of selenium, and to the lining area, which decrease the resistance of selenium, high-voltage rectifiers with new properties can be obtained [2].

A high-voltage power system generally consists of a complex configuration. Overhead and underground conductors to deliver power to users with generators, long-distance transmission lines and localized distribution networks as we know them. A wide variety of high-voltage components depend on it for successful operation. It depends on the proper selection of electrical insulation for the specific application and voltage level.

The condition of insulation materials when new and especially when worn is a critical factor in determining the life of many pieces of equipment.

The need for efficiency takes a case, in many cases including continuous insulation monitoring. Active management of existing and planned energy systems is an important requirement. As the voltages and powers to be transferred have increased over the past hundred years, basic dielectrics have improved greatly following extensive research by industry and industry. Specialized high-voltage laboratories are used where most of this work is carried out.

Experiments show that the reverse current increases with a drop in temperature at large voltages in CdS, $CdSe$, Tl_2Se, $SnSe$, etc. it is also observed in high-voltage selenium elements with artificial layers. However, the current increase here occurs at voltages above 20-25 V. From the static voltamperes characteristics of the CdS layered high-voltage element, it can be seen that the reverse current decreases in the temperature range from -60° C to $+60^o$ C at large voltages. At positive temperatures, the direct current experimentally does not depend on temperature, and at negative temperatures, reductions occur.

When the temperature is low, the increase in reverse current occurs at large voltages. At voltages of 100, 70 and 50v, the increase in current with a decrease in temperature begins at +20, - 40 and -70°C, respectively .

CONCLUSION

Knowing the significant effect of various additives on the electrical properties of selenium, it is interesting to study the effect of those additives on heat conduction.

Pure selenium (99, 994%) was mixed with $SeCl_4$ in order to prepare samples of selenium with different chlorine additives, and the amount of chlorine in the obtained samples was determined by the colometric method with the amount of opgentometric iodine. [3].

It is known that measuring thermal conductivity is divided into stationary and non-stationary methods. A stationary method is usually used to measure the thermal conductivity, which, although the latter requires a long time, does not give an error of more than 1-2%. Although the non-stationary method requires very little time, it is possible to leave an error of up to 10%. In both methods, the heat flux through the sample is measured either calorimetrically or electrically.

[1] *Q.A. Akhundov.* Wire conductors. Baku, 1966.

[2] *H.B. Abdullayev.* Selenium rectifiers. Baku, 1956.

[3] *M.M. Zarbaliyev.* Physics of semiconductors. Baku-2008. p. 454.

[4] *R.T. Humbatov.* "Electronics" Part I. Baku, "Maarif" publishing house. 2002.

[5] *V.M. Abbasov, A.M. Taghiyeva, Z.A. Hasanov, Sh.V. Salmanzadeh.* Chemistry and Life Baku. "Kovsar". 2011 p. 234.