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Studying the different effects of gamma and x-ray irradiation on the electrical properties of silicon diode type 1N1405

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Abstract

The silicon diode types 1N1405 subjected to different types of radiation like (x-ray and γ-radiation), it is measured by the forward and reverse bias voltage before and after irradiation, so this research study the different effect of two types of radiation on electrical properties of the diode .

Keywords: Gamma ray, Bias voltage, Silicon.

1. Introduction

X-ray and γ-radiation are formed by electromagnetic radiation; they can interact with matter in three types. 1. Photo Effect; 2. Compton Effect and 3. Pair production.

The x-ray and γ-radiation are extremely short wave length, the x-ray is from 10E-9m To 10E-12 and γ-radiation is from 10E-12 to 10E-14 which finds many important applications in since and medicine. Irradiation has helped agriculture, engineering and industry, and has saved thousands of lives through its medical and biological effects [1]. The p-n junction plays an important role, in both modern electronic applications and semiconduction devices .It is used extensively in rectification, switching and other operations in electronic circuits. It is the basic building block for the bipolar transistor, thyristors and JFETS [2,3,4,5].

2. Experimental method

Current values at different bias voltage were measured for diodes 1N1405, before and after subjecting them to x-ray and γ-radiation were plotted as shown in figs (1-8).

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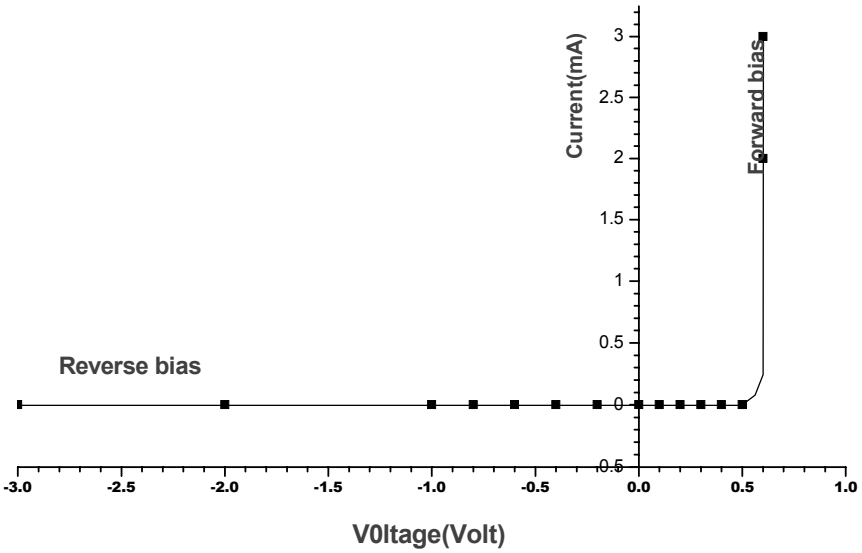

Fig. 1: Electrical properties of Silicon Diode type 1N1405 before irradiation.

The table 1 shows these characteristics together with the radioactive sources used in work and the energy of the x-ray. In the statement of γ-radiation the sample was irradiated in three times as shown in figs (6-8). In the statement of x-ray the sample was irradiated in three times as shown in figs (2-5).

Sample	Type of the source	First time irradiation	Second time irradiation	Third time irrdiation
Diode 1 N 1405	Co-60 Energy of γ-ray	7 day 5mci – 1.17,1.33MeV	7 day 5mci – 1.17,1.33MeV	7 day 5mci – 1.17,1.33MeV
	X- RAY Voltage and Energy Of X-ray	0.2 Sec	0.3 Sec	2.4 Sec
		55 KV 5.6 KeV	85 KV 8.52 KeV	85 KV 8.52 KeV

Table 1: Illustrate the energy of x-ray and γ-ray radiation and time irradiation. Time irradiation in (Sec.), Volt in (KV) and energy x-ray in (KeV) and γ-ray energy (MeV) and radioactivity of the source radiation in mci.

3. Result and discussion

The γ-ray and x-ray radiation are electromagnetic form of radiation, they interact with matter in three types interaction, photo effect, Compton Effect, and pair production. In using x-ray and γ-ray irradiation we find that the response diode before and after irradiation are significantly different as shown in figs (1-8).We see in figs.(2-8) that in the first, second and third of γ-ray and x-ray irradiation, the electrical properties were changed .For the first time γ-ray irradiation as shown in fig.6 the value of Potential barrier is 0.6 voltage, there is no change after gamma irradiation and the current start at 3 Am and increases in one line at voltage 0.6 volt to 14 mA. But in x-ray irradiation we see different results. In fig.2 the potential barrier was changed from 0.6 voltage before irradiation to 0.5 voltage after irradiation but in both case x-ray and gamma ray as shown in fig. (2,6) we see the current increasing that means electron-hole is produced in the forbidden gap after breaking the equivalent band .

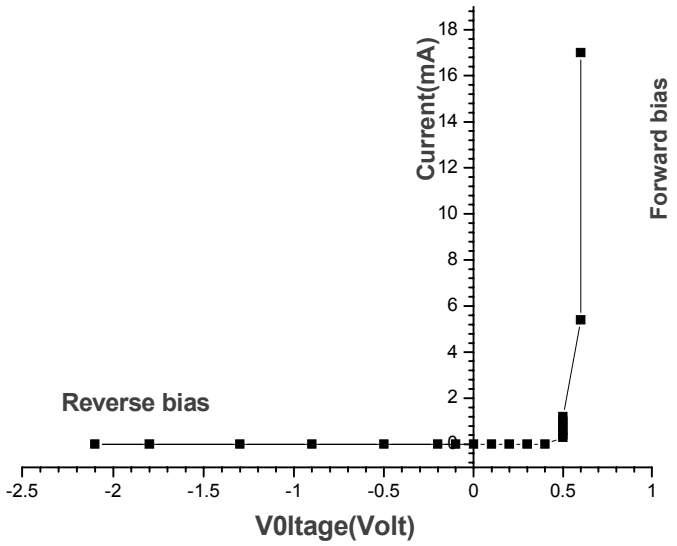

Fig. 2: Effect of X-ray irradiation (t=0.2Sec, V=55 KV,0.0056 MeV) after one time irradiation on Silicon Diode type 1N1405.

At the second time γ-ray irradiation having two parts as shown in fig. 7 the first part has potential barrier 0.6 volt and the current starts at 4Am and end to14mA but the second part is directed to 0.7 volt and the current starts at 18mA and increases to 28mA.In the second time x-ray irradiation as shown in fig. 3. we saw three points potential barrier (0.4, 0.5 , 0.6)volt and changed from 0.6 volt to 0.4 volt, at the point 0.4 volt the current is 0.1 mA and at the second point 0.5 volt the current is 2.4 mA and at the third point the current increased to 5.4 mA .This mean in both way irradiation we can work at different points depending on the current we need as shown in figs (3,7).

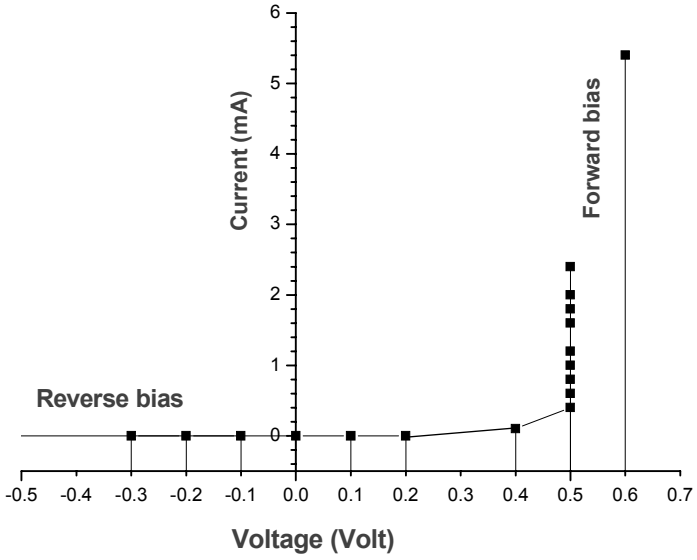

Fig. 3: Effect of X-ray radiation on Silicon diode type 1N1405 after second time irradiation (t=0.3 sec, V=85 KV,E=0.00852 MeV).

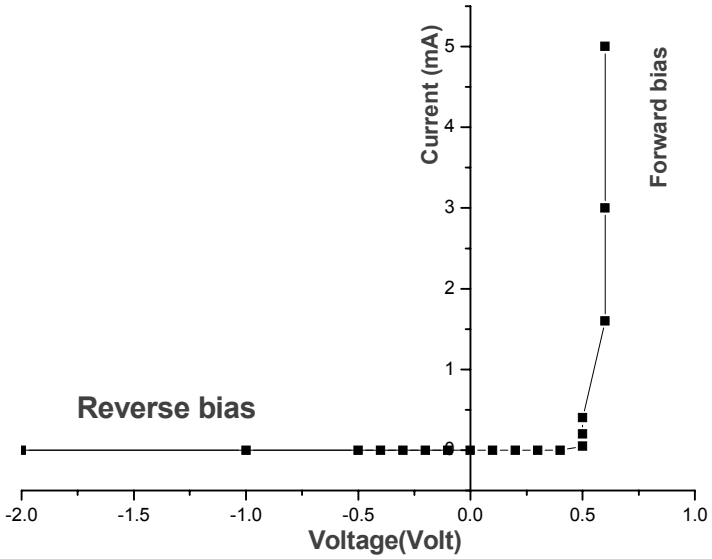

Fig. 4: Effect of X-ray radiation on Silicon diode type 1N1405 after third time irradiation (t=2.4 sec, V=85 KV, E=0.00852 MeV).

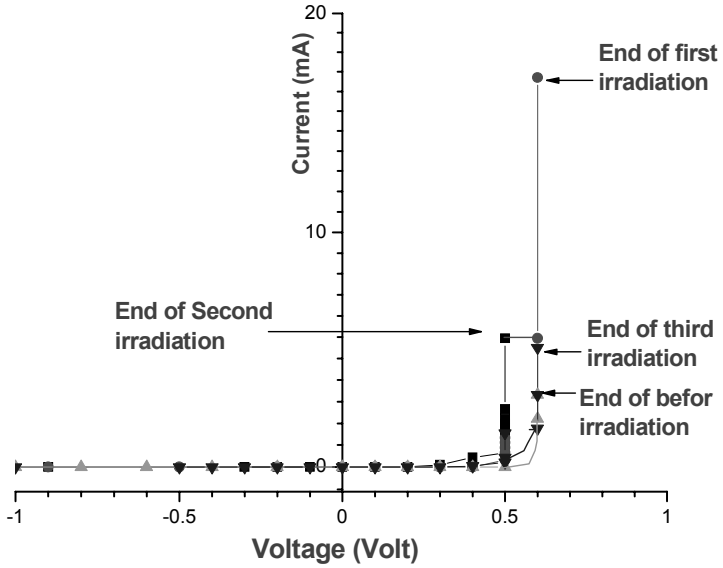

Fig. 5: Effect of X-ray irradiation on Silicon Diode type 1N1405.

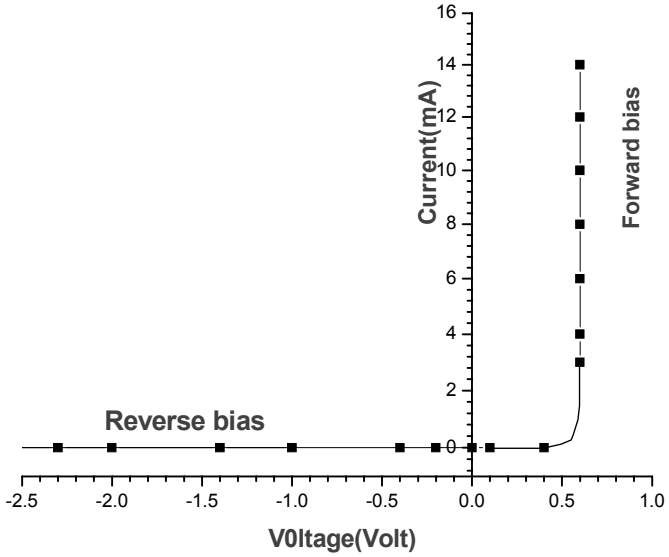

Fig. 6: Effect of Gamma ray (Co-60, Energy=1.17, 1.33 MeV,Time irradiation after one time irradiation on Silicon Diode type 1N1405 7Days).

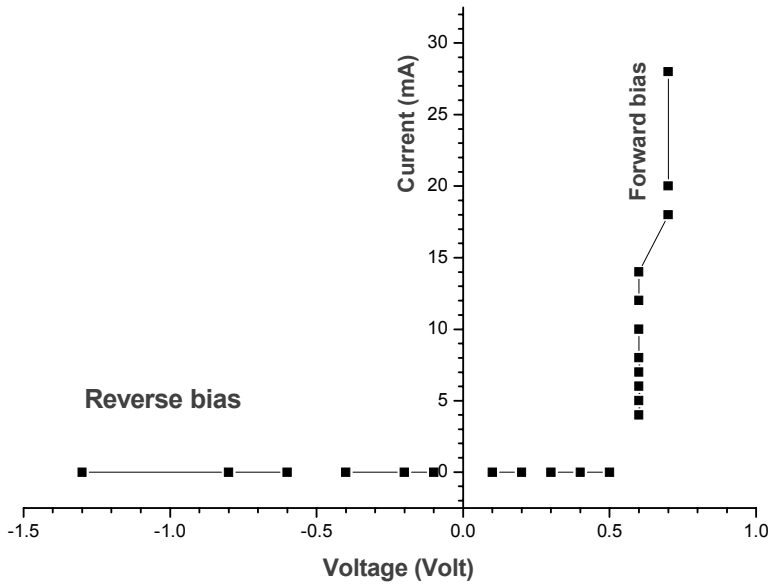

Fig. 7: Effect of Gamma ray (Co-60, Energy=1.17, 1.33 MeV,Time irradiation after second time irradiation on Silicon Diode type 1N1405 7Days).

In the third time γ-ray irradiation having three parts as shown in fig. 8 we see three parts, in the first part, the value of potential barrier is 0.4 voltage having current value 0.08 mA and the curve is displacement from the point 0.6 volt, in the second point, the potential barrier is 0.5 volt and the current is limited from 0.5 to 1.4mA and in the third part at point 0.6 volt the current is limited from 3 to 8.9 mA. Third time irradiation of x-ray **I**s shown in fig. (4), the curve consists of three points. In the points it is not different from second irradiation but the current at point 0.4 volt is 0.05mA,at the second point 0.5 volt is 1.4 mA and at the third point 0,6 is5 mA. But in this case the first, second and third part in γ-ray and x-ray the current is decreasing as shown in fig.4, 8. The decreasing current is produced as a result of

dislocations, vacancies and imperfections and damage after irradiation of all these reasons may act traps. Trapping is, of course, undesirable because it means loss of part of the charge carriers, thus, causing a reduction in its current .in the reverse bias no change after irradiation.

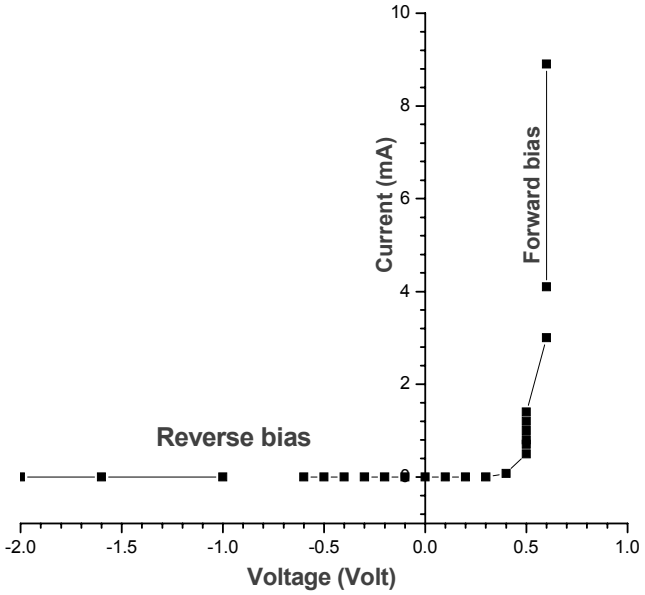

Fig. 8: Effect of Gamma ray (Co-60, Energy=1.17, 1.33 MeV, Time irradiation after third time irradiation on Silicon Diode type 1N1405 21 Days).

4. Conclusion

After x-ray and γ-ray irradiation the electrical properties of the diode are different and we get different result between the effect of Gamma and x-ray irradiation. This gives the information about the effects of ionizing radiation on different types of electronic devices that are widely applicable to the filed of radiation detectors. So we can say especially which device can be used according to the type and energy of the detected radiation. This result gives the information in which energy of x-ray or γ-ray we can increasing the current or damage semiconductor diode to ordinary conductor and after that we can limit the place depending indecently on the sample and the forward bias voltage.

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