Digest of Tech. Papers The 7th Conf. on Solid State Devices, Tokyo, Sep. 1975

B-5-3 LIGHT ACTIVATED HIGH POWER BI-DIRECTIONAL THYRISTORS

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A bi-directional thyristor,[1] which is effectively two thyristors connected in inverse parallel and can be switched by an electrical gate signal into both directions, is a very useful device for the control of alternating current.

However, conventional bi-directional thyristors have the following disadvantage;[2] they tend to run-away from the external control during current commutating periods in high current applications. This is caused by a mutual interference between the two thyristors which are composited in one silicon crystal to be triggered by an electrical gate signal supplied through one gate electrode. Consequently, most of the present devices have poor current handling capability of the order of 5 - 10 amperes.

To improve the commutating characteristics, we have developed a light activated bi-directional thyristor.

Figure 1 shows a schematic diagram of the new device. Two thyristors connected in inverse parallel are mounted on a base, and a gallium-arsenide light emitting diode is provided between the thyristors. These elements are optically coupled so that both thyristors can be directly triggered by a light signal from the light emitting diode.

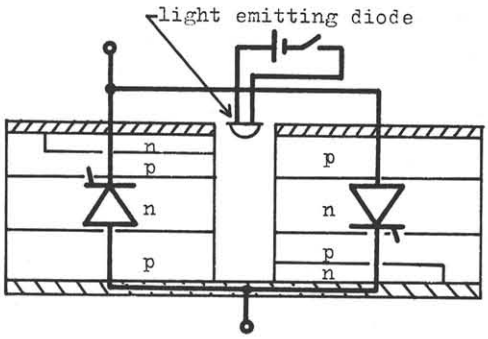

Fig.1 schematic diagram of the light activated bi-directional thyristor.

In this device, the thyristors are separated completely, so the mutual interference is avoided. Consequently, this device operates without commutating failures in a high power circuit. Also, the improvement of commutating characteristics makes a high current, high voltage bi-directional thyristor to be available. In addition, this device is a kind of photo-coupler, so the main circuit can be electrically isolated from the control circuit. This is very convenient for circuit designers.

There were two difficult problems in development of the new device. The one problem was a trade-off between a triggering sensitivity and a allowable voltage increasing rate, dv/dt. In high power thyristors, the shorted emitter structure is usualy used to obtain a high dv/dt. However, this results in a

decrease of the light triggering sensitivity. The other problem is the unbalance of the triggering sensitivity between the two thyristors.

In order to solve these problems, we improved the thyristor junction for triggering by a light signal and developed a high efficient light coupling between the light emitting diode and the thyristors.

Figure 2 shows an exterior view of the newly developed light activated bi-directional thyristor. A light emitting diode is connected to the control terminals, which are electrically isolated from the main terminal. When an electrical control signal is supplied into the control terminals so as to bias the light emitting diode positively, this device turns on into the both directions.

Table 1 shows the electrical characteristics of the device. The performance of the commutating dv/dt, di/dt is far advanced from the ordinary bi-directional thyristors.

In this paper, the design features and the electrical characteristics of the newly developed light activated bi-directional thyristors will be discussed in detail.

REFERENCES

1) F.E. Gentry et al : Proc. of IEEE, 53, (1965) 355 - 369

2) G.D. Bergman : Int. J. Electronics, 21, (1966) 17 - 35

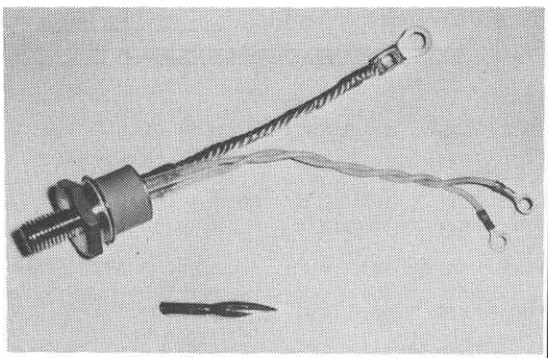

Fig.2 the developed light activated bi-directional thyristor.

Table 1 electrical characteristics

peak blocking voltage	1,000 V
average current	100 A
forward voltage drop	2.3 V (300A)
gate trigger current	100 mA
gate trigger voltage	1.5 V
static dv/dt	100 V/μs
commutating dv/dt	100 V/μs
commutating di/dt	100 A/μs
turn-on time	6 μs
gate isolating voltage	1,500 V
operating temperature	125 °C