A－3－5 4000V, 1500A Light Triggered Thyristor

T. Nakagawa, T. Miyajima, A. Kawakami, A. Tada, K. Yamanaka* and K. Ohtaki*

Kitaitami Works, Mitsubishi Electric Corporation

*LSI R & D Lab, Mitsubishi Electric Corporation

4-1 Mizuhara, Itami, Hyogo 664, Japan

This paper presents the results of the development of a 85mm, 4000V, 1500A light triggered thyristor, whose dv/dt and di/dt capabilities are approximately equal to those of conventional electrically triggered thyristors, and whose minimum light triggering energy is less than 7mW.

The main problems for actualization of these high power devices are how to realize the high light triggering sensitivity with enough capabilities of di/dt, dv/dt which are required in the practical applications.(1) (2) (3)

We have overcome this problems by a new gate structure shown in Fig.1, based on following methods.

(1) The gate structure of a high power light triggered thyristor has to be able to realize both uniformity of on-state current distribution all over the large main emitter area and enough high di/dt capability to flow the rush current of snabber circuit at high voltage switching. Two stage amplifying gate structure, therefore, is adopted, and each emitter peripheral length l_1, l_2, l_3 and sheet resistance R_1, R_2, R_3 under each emitter region shown in Fig.1 are designed to be optimum values, taking account of dv/dt, di/dt capabilities.

(2) In order to realize high dv/dt capability, it is effective to reduce the displacement current of light sensitive area when dv/dt is applied. It was realized by etching down the light sensitive area for limitting the expansion of the depletion layer.

(3) High light sensitivity is obtained by concentrating light activated electrical charge by means of the stripe emitter structure for both the first and second stage gates.

As a result of these improvements, the 4000V, 1500A high power device has been realized with light triggering energy of less than 7mW, and dv/dt capability of more than 1500V/μs, and di/dt rating of 250A/μs.

Fig.2, 3, 4 show typical characteristics of this device. Fig.2 shows the on-state characteristic. Fig.3 shows the case temperature dependence of dv/dt capability. Fig.4 shows optical power dependence of delay time. Fig.4 shows that delay time draws near the saturation value of about 2μs at the optical energy of 40～50mW which is approximately 7～10 times the minimum light triggering energy. This value of the delay time is equivarent to conventional 4kV high power thyristor.

In order to drive this device by enough optical triggering power, a high power LED unit of which optical power is 70mW at the end of optical bandle fiber has been developed at the same time.(4)

In conclusion, a high power light triggered thyristor has been obtained by using newly de-

veloped gate structures and process technologies of the big size device.

This device will bring great advantages to high voltage thyristor value applications in the near future.

References

(1) S. Hashimoto et al : in EDD of IECE of Japan, EDD 78-73 (1978)

(2) V.A.K.Temple et al : 7th IEEE/PES. Trans. Dist. Conf. Aplil 1 6 P213 (1979)

(3) P.D.Bruyne et al : IEE Second. Inf. Conf. 18 (1977)

(4) S.Horiuchi et al : will be published in IEEE Specialist Conf. on the Technology of Electroluminescent Diodes. September (1980)

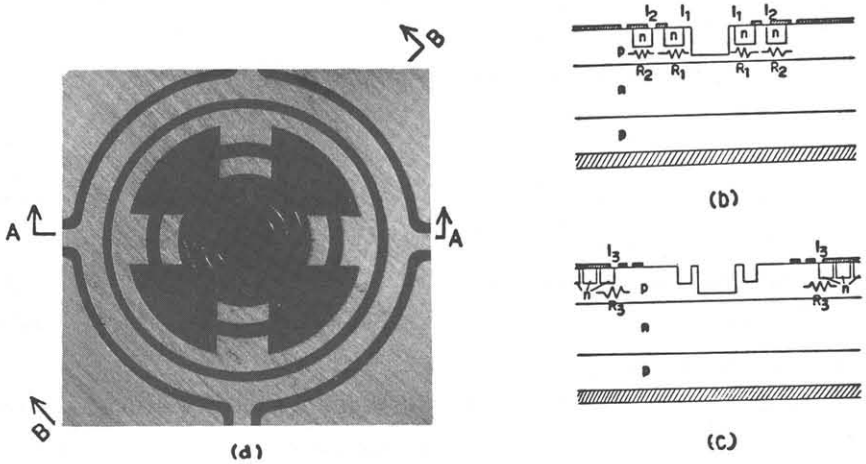

Fig.1 a) a top of view of gate structure b) a sectional view taken along line A—A
c) a sectional view taken along line B—B

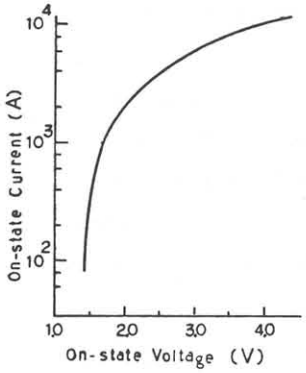

Fig.2

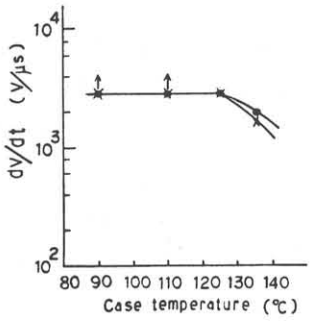

Fig.3

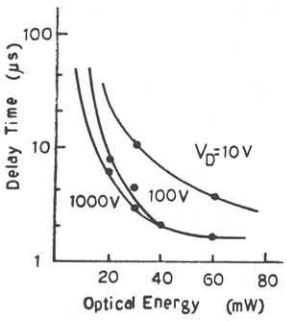

Fig.4