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INVITED: Current Status of Thyristors

Dr.Eberhard Spenke

Siemens Aktiengesellschaft

D-8000 München 46
Frankfurter Ring 152 BR Deutschland

Abstract

One criterion for the performance of a thyristor is the maximum voltage which it can block. As another criterion one would like to choose the current with which the turned-on thyristor can be loaded. But this depends on the amount of cooling. Therefore, average currents are not characteristic for the thyristor alone. Thus, the maximum surge current of a 10 msec pulse was choosen as the other criterion for the thyristors. Using the maximum voltage and the maximum surge current as a criterion, at first a survey is given on a series of modern power thyristors. Further surveys show the historical development and the contrast between power thyristors and frequency thyristors. But the main part of the talk will deal with some newer developments in the physics of thyristors which are not so well known.

At first I shall talk about infrared observations which have yielded new results concerning thyristor turn-on. The strong local concentration of the current in the beginning of the turn-on implies an enhancement of the t o t a l losses. Still more enhanced is the d e n s i t y of the losses. Therefore, destruction of the thyristor threatens. These effects become the more intensive and the described dangers become the more critical, the smaller the triggering pulse is. A way out of these difficulties is accomplished by integrating into the main thyristor an auxiliary thyristor which is fired first. Its load current is strong enough to fire at once the total rim of the main thyristor. The details of the functioning of this arrangement are shown in infrared pictures.

The second new development in the physics of thyristors is checking the breakdown behaviour by infrared methods. Here two methods have to be distinguished which are different at least in principle. One can observe the "bremstrahlung" of the avalanching junctions in a $ps_n n$-structure. Or one looks for the recombination radiation of the emitter of a pnp-structure. Because these structures are thin in comparison of their extent the current is concentrated on those parts of the cross section where the collector has broken down. Therefore the recombination radiation of the forward biased emitter indicates the broken down parts of the reverse biased collector.

The last section of the talk will be concerned with faults and defects in the silicon crystals and the their influence on performance of thyristors. The differences between striations, swirls and dislocations are shown in some pictures of etch patterns. Autoradiographs prove that gold tends to precipitate in dislocations and in swirls. Resistivity variations in striations make the avalanche behaviour of the structures inhomogenous. The consequences of these effects on vidicons and the turn-on times of thyristors are presented.

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