ELECTROMIGRATION DEGRADATION MODEL OF METAL OXIDE VARISTOR STRUCTURES

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Summary

Ion migration in zinc-oxide semiconductor crystallites at long periods of the current flow has been simulated, and its influence on the current-voltage characteristics (CVCs) of varistor structures has been analyzed. The conditions and the parameters suitable for monitoring the process of varistor-structure irreversible degradation have been determined.

A component of the intergrain potential barrier generated by the space charge region in a crystallite, which turns out reverse-biased at the degradation current flow, was found to be the most prone to changes (the accumulation of near-surface donors, and a reduction of the barrier height and thickness). During the degradation, the varistor section in the direct (with respect to the degradation current) CVC branches becomes more shifted toward lower voltages, whereas the leakage current is more growing in the weakly linear section of the reverse CVC branch.

An agreement was obtained between the change tendencies predicted by a developed model for main varistor parameters (a reduction of the classification voltage, a reduction of the nonlinearity factor, and an increase of the leakage current) and the available experimental data. A possibility to estimate the diffusion coefficient of charged donors and to use this parameter to monitor the functionability of devices based on zinc oxide varistor structures with tunnel current-voltage characteristics has been demonstrated.