ABSTRACT

In this thesis we investigate the properties of stochastic processes which are used to model a type of breakdown mechanism in thin film capacitors subjected to test under high electric fields, The insulating film in the capacitor is regarded as a collection of N cells operating independently, In every cell a stochastic breakdown mechanism of the same type is under way, It proceeds until the first of the cells actually fails and causes a breakdown in the insulator as a whole: At such a time the processes in other cells either remain unaffected or return to an initial state, depending on experimental conditions and properties of the insulating material, and the mechanism restarts, Otherwise the only effect of the breakdown is a decrease in the number of operating cells.

In this work we consider those mechanisms for which breakdown in a cell may be modelled as the explosion of a birth-death process. When analysing a given model, we are interested in the behaviour of the resulting observed process of successive breakdowns and its possible dependence on the applied voltage, insulator area and other parameters. The key tool used in investigating this observed process is Extreme Value Theory, For the case when breakdown is caused by the explosion of a pure birth process, we develop an approach based on saddle point approximation method which simplifies the problem considerably in certain situations. This approach is used in two important cases. In the sixth chapter we prove a Tauberian theorem which relates the asymptotic behaviour of a distribution function to that of its

Laplace transform. This theorem may enable one to cope with the situation when the breakdown mechanism is of a more complicated nature than those mentioned above, and particularly when the transform is not regularly varying.

When the capacitor is subjected to test under an electric field, we may observe realizations of the process of successive breakdowns under various experimental conditions. These data may be used to help identify the breakdown mechanism which is operative in a given situation (or, at least to reject those mechanisms which are not consistent with the data). After the identification has been performed, the data may also enable one to estimate the parameters of the model of interest. These problems of identification of the operating breakdown mechanism and estimation of its parameters are also considered in the present work.