Die Ermittlung physikalischer Entladungsparameter in Isoliergasen und Isoliergasgemischen mit einer verbesserten Swarm-Methode

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Publication Date:
1985

Permanent Link:
https://doi.org/10.3929/ethz-a-000397035

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Die Ermittlung physikalischer Entladungsparameter in Isoliergasen und Isoliergasgemischen mit einer verbesserten Swarm-Methode

ABHANDLUNG
zur Erlangung des Titels eines Doktors der Technischen Wissenschaften
der
EIDGENÖSSISCHEN TECHNISCHEN HOCHSCHULE ZÜRICH

vorgelegt von
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SUMMARY

For discharge modeling and for the calculation of breakdown phenomena in gases, in particular for the successful application of gaseous dielectrics to high voltage insulation problems, quantitative data of the relevant physical processes, so-called swarm parameters, must be available over a wide range of field strength. The present work studies phenomena associated with the charge carrier production by electron impact ionization and by electron attachment (i.e. ion production), as well as transport processes of electrons and ions.

The theoretical part deals with the relationship between the microscopic description of basic processes using collision cross sections and the macroscopic behaviour of charge carrier swarms. Based on the knowledge of the fundamental processes, the field strength dependences of swarm parameters have been derived and criteria are given for the optimization of the insulating performance of electronegative gases and gas mixtures.

The main emphasis of the present work lies on the experimental determination of swarm parameters. The technique used is the time resolved Townsend method (TRT), this is observing the displacement current pulses due to electron and ion swarms in a uniform electric field. This technique was significantly improved in four ways: 1) generation of primary electrons by a pulsed u.v.-laser system, 2) high time resolution and detection sensitivity of the current measuring system, 3) current recording with a fast transient digitizer, 4) computer aided data processing and parameter evaluation. With the measuring system described here, swarm data sets of high consistency and high accuracy have been determined including the following parameters: drift velocities and diffusion coefficients of electrons, mobilities of positive and negative ions, effective reaction rate coefficients, ionization and attachment coefficients.

As a result of the present investigation swarm data sets are presented for: nitrogen (N$_2$), sulfurhexafluoride (SF$_6$), hexafluoropropylene (n-C$_3$F$_6$), dichlorotetrafluoroethane (1,2-C$_2$Cl$_2$F$_4$) and SF$_6$-mixtures with N$_2$, CO$_2$ and Argon. The macroscopic data of each gas and gas mixture is analysed with regard to the dielectric strength determined in breakdown experiments.