Discharge properties in gas filled micro voids in XLPE material

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Micro voids belong to typical defects in medium voltage cross-linked polyethylene (XLPE) cables. Application of high voltage can causes micro discharges in the medium, which fills the void. Besides the liquid products, methane and ethylene are the major components in a void. Properties of the micro discharges in a dielectric encapsulated void of typical size 3-10 µm have been studied by time- and space-dependent numerical model in a wide range of pressures and applied voltages. Basic features of the model will be presented. Temporal evolutions of electrical properties, species densities are presented and discussed. Typical discharge duration of less than 1 ns has been found. The discharge development is characterized by fast propagating waves of ions and electrons, as well as pronounced deviation from quasineutrality. The role of various electron production mechanisms is discussed.

1. Introduction

Parasitic micro discharges in high voltage apparatus can lead to it destruction. Understanding of discharge phenomena is therefore of a great importance. Discharge behaviour in a micro void, typical defect of XLPE cable, is studied by a numerical model.

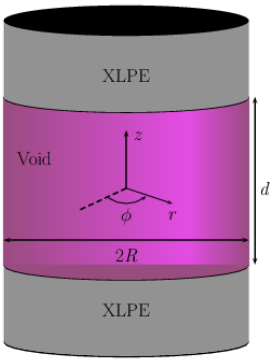

Figure 1: Schematic picture of discharge geometry.

2. Brief model description

The void is represented by cylindrical filament (Fig.1) with a length d=(3-10µm) and a radius R=d/2, encapsulated between two 1 cm thick XLPE specimens. The model [1] was adopted and extended for analysis. The plasma-chemical model of a discharge in methane or ethylene considers besides the electrons, neutral species and various positive and negative ions. Corresponding reaction rates and transport data were obtained by solution of electron Boltzmann equation. The model includes the surface emission [2] as possible electron production mechanism.

3. Example of results

Fig. 2 shows the spatio-temporal evolution of the electron density n_e and of the main ion density CH_4^+ in atmospheric pressure methane discharge. Clear differences in the species behaviour are obvious. Detailed explanation and discussion of this and other results of will be given in presentation.

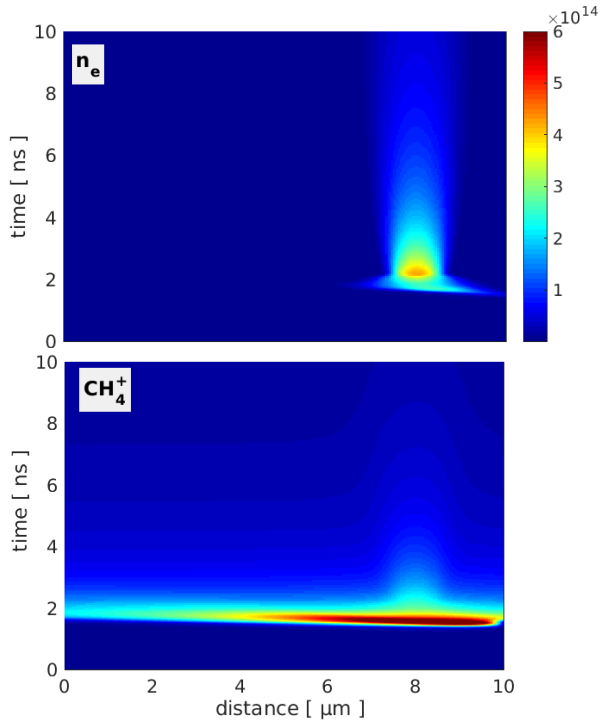

Figure 2: Spatio-temporal evolution of charged particles in methane.
P=1 bar, U_0= 20 kV. Cathode z=0, anode z=10 µm

4. Acknowledgement

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5. References

[1] M. M. Becker et al., J. Phys. D: Appl. Phys. **46** (2013) 355203.

[2] L. Niemeyer, IEEE TDEI **2** (1995) 510.