

MIXED DIMENSIONAL MODELING OF PARTIAL DISCHARGES IN ELECTRICAL TREEING

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ABSTRACT

Electrical Treeing is one of the main causes for the degradation of the insulating components of cables: if there is a gas filled defect in the polymer, subject to strong electrical fields, partial discharges can occur creating a self-propagating structure that resembles a tree. This phenomenon can be modeled by a system of PDEs [1], describing the movement of charges in the defect and the evolution of the electrical field and potential in both the gas and the solid dielectric material. However, the geometry of the defect makes the problem very challenging: such ramified subdomain with very small diameter can hardly be discretized by a 3D mesh in realistic cases. To overcome this limitation we approximate the treeing as a one-dimensional graph, and derive a mixed-dimensional 3D-1D system of equations, reducing the problem complexity. The approach bears similarities to the 3D-1D modeling of wells and roots in porous media, or microcirculation in living tissues, but has some unique features in the coupling conditions between 3D and 1D and in the need to preserve information on the transverse components of the 1D solution.

The numerical solution is based on Mixed FEM for the electrostatic problem [2] and Finite Volumes for the charges movement [3], and on a splitting to manage the multiphysics coupling with reactive phenomena. The method is implemented in the parallel C++ code Morgana.

REFERENCES

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