Implementation Of A Cathode Directed Streamer Model In Air Under Different Voltage Stresses.

Francis Boakye-Mensah[1], Nelly Bonifaci[1], Rachelle Hanna[1], Olivier Lesaint[1]

[1]Univ. Grenoble Alpes, CNRS, Grenoble INP*, G2Elab, France

Abstract

Although SF6 gas is characterized by a strong global warming potential, traditionally, it has been employed universally as the dielectric insulation gas for most electrical equipment because of its excellent technical performances. With the emergence of environmental regulations for climate change mitigation, an active search into environmentally friendly replacements is currently ongoing. A viable alternative for medium voltage applications is compressed air and for proper evaluation of its replacement capabilities, the withstand voltage is used as the dimensioning criteria and this is dependent on the initiation and propagation of streamers which are precursors to electrical breakdown. For design optimization, a thorough understanding of the initiation and propagation mechanisms of such electrical discharges under different stresses, pressure etc. ought to be studied experimentally and numerically also via a predictive model. There has been a lot of implementation through homemade codes however streamer models are not readily available in commercial software because of the complexity and non-linearity of such computations and this provides challenges for equipment manufacturers. Thus implementation and validation of streamer discharge models in air for different voltage stresses have therefore been done in a commercial finite element software, COMSOL Multiphysics® and its Plasma Module. Results of simulations for short gaps (≤ 5 mm) under standard temperature and pressure (STP) conditions have been presented, analyzed and compared with some classical papers to evaluate the suitability of such a model for further studies of non-thermal electrical discharges.

Figures used in the abstract

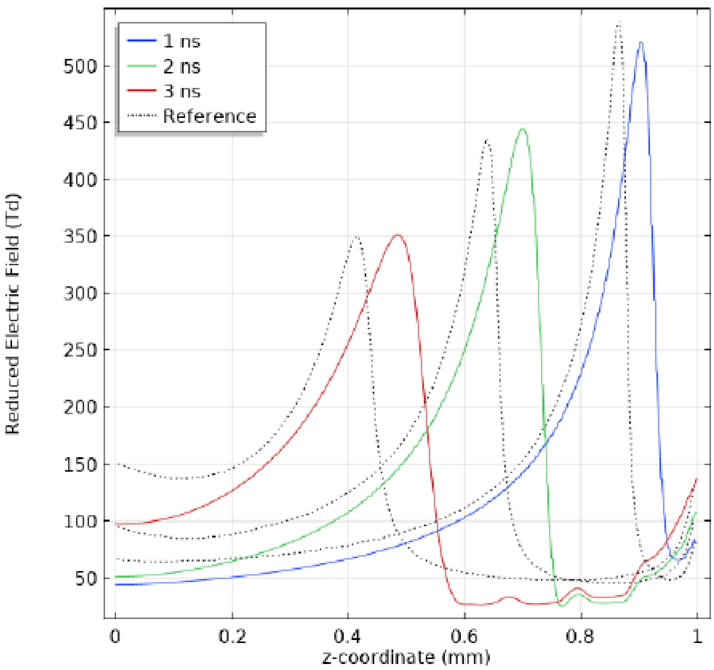

Figure 1 : Figure 1: Reduced electric-field variation of a streamer propagating in a 1 mm gap, work in COMSOL compared with homemade model.

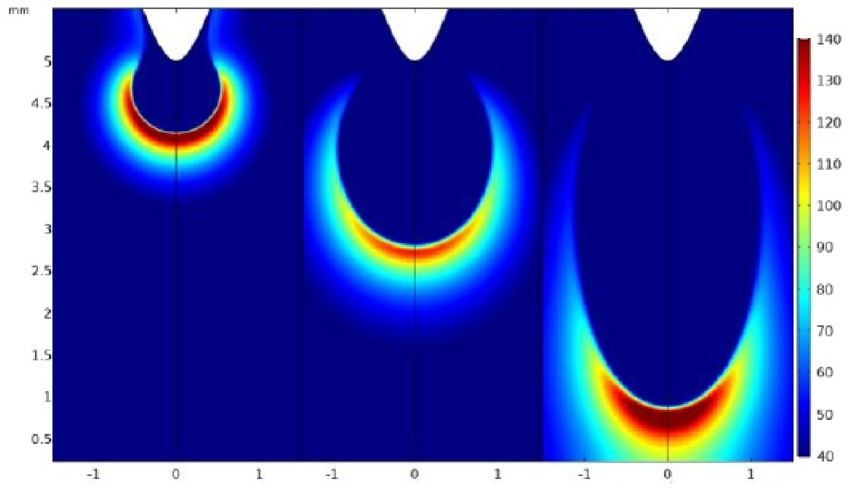

Figure 2 : Figure 2: 2D surface plots of electric field distributions of a streamer propagating in a 5 mm air gap at times t = 1.0, 2.5 and 3.9 ns.

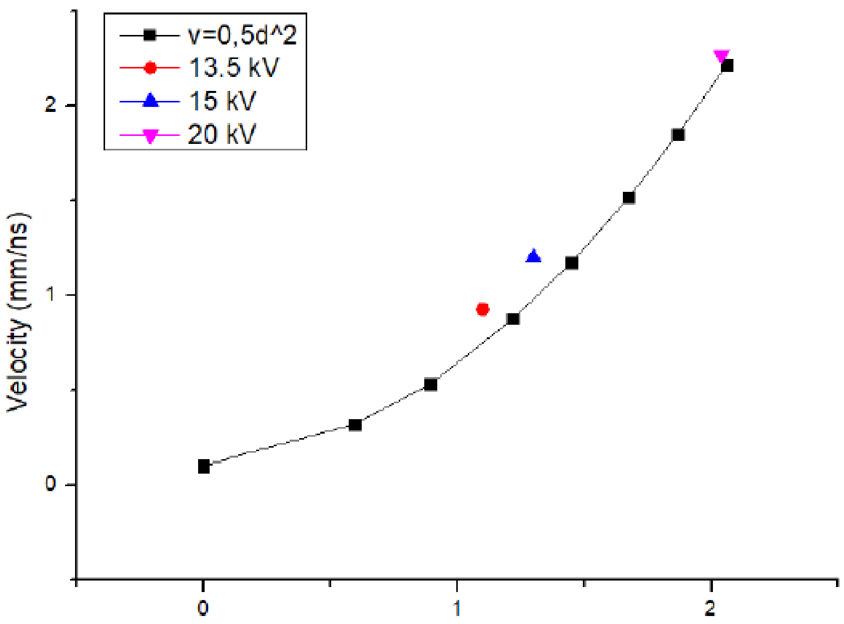

Figure 3 : Figure 3: Plot of streamer velocity vs diameter for voltages 13.5 kV, 15 kV and 20 kV against a reference experimental curve.