SIMULATION OF HIGH-VOLTAGE DC BREAKDOWN FOR ANGLED DIELECTRIC INSULATOR INCLUDING SPACE-CHARGE EFFECTS

M.P. Aldan, J.P. Verboncoeur
UC Berkeley, Department of Nuclear Engineering
Berkeley, CA, U.S.A, 94720-1730
E-mail: aldan@berkeley.edu

R.L. Ives
Calabazas Creek Research, Inc., 690 Port Drive
San Mateo, CA, U.S.A, 94404-1010

This work reports on 2D Particle-In-Cell (PIC) simulations of a Bergeron geometry similar to that used in Ref. [1], focusing on DC multipactor breakdown initiated near a presumed triple-point current source. The simulations in this work use an improved PIC model developed by Taverniers, et al. [2]; additionally, models for space charge, dielectric charging, and secondary-emission are included. Simulation parameters are dielectric insulator angle, gap width, and applied voltage.

Breakdown is declared for system configurations in which the secondary-electron population is significantly higher than the primary-electron population at the point that either population has reached the anode. Primary electrons from the source can multiply upon impact on the dielectric if their energy is between the first and second crossover energies [3]; secondary electrons can further multiply under the same criterion, hence multipactor. For cases above the breakdown threshold potential, secondaries make several bounces before reaching the anode. Electron growth by multipactor is observed for a few tens of nanoseconds, after which saturation occurs when surface charging becomes significant. For cases below the threshold, insufficient secondaries are produced leading to a net negative charging of the dielectric which can further retard electron impact. Breakdown voltage as a function of angle is presented and compared to theory.

A system using Teflon as the dielectric has been constructed, and experiments will be conducted and compared to simulation and theory. Experiments look for breakdown correlated to variations in surface roughness, insulator angle, and applied voltage.

1. Jordan, N.M., et al., "Electric field and electron orbits near a triple point," J. Appl. Phys., 102, 2007.
2. Taverniers, S., et al., "2D Particle-In-Cell Modeling of Dielectric Insulator Breakdown," ICOPS 2009 Proceedings, 2009.
3. Vaughan, J.R.M., "A New Formula for Secondary Emission Yield," IEEE Trans. Electron Dev., Vol. 36, No. 9, 1989, pp.1963-1967.

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