BREAKDOWN CHARACTERISTICS OF ARGON IN PARTIAL VACUUM UNDER KHZ PULSED VOLTAGE WITH VARYING DUTY CYCLE FOR POINT-TOPOINT ELECTRODE GEOMETRY

M. Lipham, H. Zhao, and H. Kirkici
Electrical and Computer Engineering, Auburn University, Auburn, AL, United States

Power devices and systems operating in partial vacuum are susceptible to partial discharges, corona, or volume discharge [1]. In most cases, it is important to understand the characteristics of the discharge such as the space-charge distribution, the electron energy distribution, and collision processes in which the species are involved. Breakdown and spectroscopic studies of the discharge are the most commonly used methods of obtaining such information [2].The breakdown characteristics of Argon as a function of pressure for kHz and dc applied fields are presented in partial vacuum of 0.1 Torr to 3 Torr. A unipolar pulsed signal is applied to a point-to-point electrode configuration [3]. It is found that the breakdown voltage vs pressure data resembles the well known Paschen curves for dc. It is determined that the minimum breakdown voltage corresponds to approximately 0.4 to 0.5 Torr pressure for 1 cm electrode gap. It is o b s e r v e d that the pulsed breakdown voltages are relatively lower than the dc data for the same experimental conditions. Furthermore, it is determined from the breakdown data as a function of pressure at constant pressure, that the breakdown voltage is a decreasing function of frequency. There different frequencies, namely 20 kHz, 50 kHz, and 100 kHz with varying duty cycle from 10% to 90% are used in the experiments to determine the duty cycle effects on the breakdown voltage. For these experiments the pressure is kept at a constant. Three sets of data are obtained for three different pressure values, namely 0.4 Torr (the minimum breakdown voltage), 0.8 Torr, and 1.2 Torr. As expected, the breakdown voltage curves resemble a parabolic function. As the duty cycle decreases from 40% to 10%, the breakdown voltage increases, approaching the "impulse" breakdown voltage. Similarly, as the duty cycle increases to 90%, the breakdown voltage increases and approaches to dc breakdown voltage.

[1]. K. Koppisetty, H. Kirkici, D.L. Schweickart, "Partial vacuum breakdown characteristics of H e at 20 kHz for inhomogeneous field gap", *IEEE Trans. on Dielectrics and Electrical Insulation*, Vol. 14, pp. 553 -559, 2007
[2]. K. Koppisetty, M. Serkan, H. Kirkici, "Image Analysis: A Tool for Optical-Emission Characterization of Partial-Vacuum Breakdown", *IEEE Trans. on Plasma Science*, Vol.37, pp.153 – 158, 2009
[3]. K. Koppisetty, H. Kirkici, "Breakdown characteristics of helium and nitrogen at kHz frequency range in partial vacuum for point-to-point electrode configuration", *IEEE Trans. on Dielectrics and Electrical Insulation*, Vol. 15, p749 – 755, 2008.