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CALCULATION OF BREAKDOWN VOLTAGE OF GAS GAPS WITH ARBITRARY GEOMETRY ON EXAMPLES OF SPHERES AND TOROIDS

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Breakdown voltage (BDV) is calculated for two electrode structures, namely sphere and donut gaps, operating in air at atmospheric pressure. The calculation is based on the streamer breakdown criterion. Comsol software is used for field analysis and calculation of critical number of electrons by assessing integrals of the efficient ionization coefficient along field lines. Thus, also lengths of critical avalanches that can propagate from both electrodes were obtained. First, simulations were performed for sphere gaps at standardized by IEEE conditions to derive critical number of electrons for highly reliable experimental data. It was shown that that these numbers deviate greatly from the widely accepted 10^8 number, and that clear tendencies for the deviations exist depending on the gap to sphere diameter ratio. This guided us in the second part of this work, which is a description of a spark gap (SG) formed by two unequal concentric toroids (donuts). Only low-potential electrode has a support to ground; the HV electrode is mounted on the low-voltage one. Thus, SG is compact compared to sphere ones. It can serve as a closing switch, and as a crude HV measurement means. The toroidal SG was tested with the capacitor charger described in an accompanying paper. BDVs were calculated and compared to experimental results in the voltage range up to 200kV. These two examples illustrate a convenient method of BDV calculation in arbitrary geometries with weakly non-uniform field; it can be used with industry-standard software in daily HV practice.

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