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# FUNDAMENTAL STUDY OF UNIPOLAR AND RF BREAKDOWN IN ATMOSPHERIC AIR*

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RF breakdown at 3.3 MHz is studied experimentally in centimeter sized gaps at atmospheric conditions. As a point of comparison, unipolar breakdown voltages utilizing brass and stainless-steel Bruce profile electrodes are measured to compare with RF breakdown. Various electrode combinations using brass and stainless-steel electrodes were tested, where brass cathodes yielded higher shot-to-shot breakdown voltage fluctuations compared to stainless steel cathodes. In the unipolar case, the choice of anode material caused noticeable breakdown voltage differences, pointing towards a photon governed feedback mechanism.

Gap distances of 1-10 mm were tested in both unipolar and RF cases with slow rise time, ˜ 5 V/ms, sources. Under these conditions, RF breakdown fields (crest field values) yielded approximately 80% of unipolar values, which compares favorably with results previously generated from Monte Carlo simulations. Speeding up the amplitude rise of the RF signal to the 100 V/μs range resulted in breakdown voltages up to 20% higher than the slow unipolar breakdown, along with drastically higher shot-to-shot breakdown field amplitude variation. Applying UV radiation with photon energies higher than the work function of the electrodes (less than ˜ 280 nm in wavelength) reduced the amplitude variation to a minimum, however, with the average still being higher than the slow unipolar values.
In order to address the magnitude of corona losses in antennas and other RF systems, one of the electrodes is replaced with lanthanated or pure tungsten needle electrodes of varying tip geometry. This corona study also compares the unipolar and RF case.

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