SPECTRAL ANALYSIS OF VACUUM ULTRAVIOLET EMISSION FROM PULSED ATMOSPHERIC DISCHARGES

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It is commonly accepted that vacuum ultraviolet (VUV) radiation, corresponding to emission from 180 nm to 115 nm and below, is responsible for photoionization contributing to streamer propagation during the initial stages of atmospheric discharges. An experimental setup was constructed to observe the VUV emission of pulsed surface flashover along a dielectric surface between atmosphere and vacuum. However, VUV radiation is highly attenuated in the atmosphere, which makes observation of detailed spectra difficult. For VUV transmission down to 115 nm the light emitted by surface flashover across an MgF_2 window (front side of window in air, backside in vacuum) was focused by an MgF_2 lens onto the entrance slit of the spectrograph. The high speed detection scheme consists of a VUV sensitive ICCD camera and a photomultiplier, both with nanosecond temporal resolution. Spectra were measured in various gas mixtures at atmospheric pressure with a flashover spark length of about 8 mm with a 35 kV pulsed excitation, and spectral calibration was done utilizing a VUV calibration lamp with a known emission spectrum. Virtually all lines from 115 to 180 nm can be identified as atomic oxygen and nitrogen transitions during flashover in dry air, with most VUV emission occurring during the initial breakdown stage (current rise). The extremely fast decay of VUV emission intensity following this initial stage is evidence of radiationless quenching of the excited energy levels associated with the observed spectral lines. Flashover studies were also performed in pure oxygen and nitrogen environments to reinforce the observed emission trends. Spectroscopy must be carefully detailed, for instance, the Oxygen-I line at 130.2 nm (which corresponds to a ground level transition) is shown to be strongly self absorbed in the atmospheric spark when compared to a similar oxygen emission line at 130.4 nm. Full spectra were simulated using SpectraPlot, a temperature dependent spectral software suite developed at Texas Tech. It has been concluded from the comparison of simulated and measured Nitrogen spectra between 140 and 150 nm that the electronic temperature is about 4.5 eV, assuming that the electronic nitrogen energy level population density is Boltzmann distributed. The measured spectra will be discussed in relation to the physics of surface flashover and volume breakdown at atmospheric pressure.

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