

Abstract

Corona is the partial breakdown of a gas in an electric field and involves many complex phenomena including the production of space charge and excited molecular states of its constituents. Air is predominantly made up of nitrogen and oxygen, both of which have a wide range of excited states. Oxygen itself is additionally an electronegative gas and has the ability to attach electrons. Together these phenomena combine to influence the electric field and the production of secondary electrons to give corona its distinctive modes.

A particular state of excited molecular oxygen, known as singlet oxygen, has the characteristic that it remains excited for a relatively long period of time. It is known that singlet oxygen plays a role in the detachment of electrons from the negative oxygen ions and its role in corona discharges has been accounted for through theory and models, but due to the difficulties of measurement of the singlet oxygen, the influence it does have on corona discharges is not entirely clear.

On this basis the gas processes associated with the corona discharge in air

have been explored, where a Boltzmann equation solver, the electron energy distribution function, transport coefficient and Townsend coefficients are used to understand the phenomena and provide input to a flux correct transport algorithm model. The model clearly indicates the presence of singlet oxygen, however its the space charge that plays the critical role in the repetitive nature of corona due to the collapse and recovery of the electric field.

Experimentally it was convenient to define and compare the modes of corona under different conditions by its peak amplitude and repetition rate. The experiments included manipulated the environment with air-flow and exciting oxygen through a 1064 nm Nd:YAG laser as well as detecting 1270 nm emission from singlet oxygen. There was no evidence to suggest that the repetition rate of the corona discharge could be related to singlet oxygen. There were no emissions detected from various configurations, whilst visible corona was clearly seen.

Together with the evidence from the model, the results showed that the presence of both negative ions and singlet oxygen is relatively low in the region that should provide seed electrons. It could be inferred that a relationship between repetition rate and the presence of singlet oxygen is not a dominant process in the corona discharge.