Streamer models for development of predictive tools for plasma-assisted combustion

Stuart Reyes and Shirshak K. Dhali
Department of Electrical and Computer Engineering
Old Dominion University, Norfolk VA 23320

Many positive laboratory results that have been reported in which non-thermal plasmas, particularly repetitive nano second pulses, showed a reduction of ignition time delay and extension of flammability limits. However, there is a need for predictive models for designing practical systems. We present the results of a self-consistent model and simulation results of plasma assisted combustion of hydrogen air fuel mixture. The electrical discharge phase is modeled as a streamer discharge which is followed by the combustion kinetics phase. Nonequilibrium population of excited states leads to an increase in the reactivity and facilitates ignition and flame propagation. We have quantified some macroscopic properties of streamers such as radical production efficiency which will lead to the development of predictive tools. The concentration of radicals depends on the electrical energy density which is critical in determining ignition. We find that short duration streamers do not deposit enough energy to ignite hydrogen air mixtures. Also, the spatial and temporal electric energy density will influence the ignition delay and flame propagation velocity etc.

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