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Initial Evaluation of Pulse Width and Rise Time Impact on Transient Plasma Ignition for Combustion

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Transient plasma ignition (TPI) uses short (typ. nanosecond durations) high voltage pulses to generate highly non-equilibrium plasmas for combustion ignition. TPI allows lean-fuel combustion, improves ignition or combustion efficiency with potentially reduced emission [1,2]. This study evaluates the effect of pulse duration and rise time of >10 kV pulsed plasmas on the ignition plasma formation and combustion chemistry in a static chamber containing methane and dry air at atmospheric pressure. Repetitive, nanosecond, up to 20 kV pulses with different pulse durations (e.g. 10 ns, 30 ns, and 100 ns) and rise times (2 ns, 8 ns, and 80 ns) were used to generate transient plasmas between a pin-to-plate electrode configuration that was the same as a typical spark-plug igniter. Ignition delay, peak pressure and pressure rise time were compared among the transient plasmas driven by different nanosecond pulses. Hydroxyl radicals as important indicators to evaluate combustion chemistry were evaluated using optical emission spectroscopy and laser induced fluorescence. The work has been supported by the Department of Energy (STTR) and in part by the Air Force Office of Scientific Research (FA9550-17-1-0257).

[1] F. Wang et al., "Transient plasma ignition of quiescent and flowing air/fuel mixtures," in IEEE Trans. on Plasma Sci. 33(2), (2005) 844-849.

[2] D. Singleton et al., "The role of non-thermal transient plasma for enhanced flame ignition in C2H4–air,"in J. Phys. D: Appl. Phys. 44 (2011) 022001.

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