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Pure Rotational CARS Studies of Thermal Energy Release and Ignition in Nanosecond Repetitively Pulsed Hydrogen-Air Plasmas YVETTE ZUZEEK, IGOR ADAMOVICH, WALTER LEMPERT, Ohio State University — Pure rotational CARS thermometry is used to study kinetics of low-temperature plasma assisted fuel oxidation and ignition in a repetitive nanosecond pulse discharge in hydrogen-air mixtures, with number of pulses in a 40 kHz burst varying from a few to a few hundred. Results are shown to agree well with predictions of a new hydrogen-air plasma chemistry model, which incorporates non-equilibrium plasma processes, H2 – air chemistry, non-empirical scaling of nanosecond pulse energy coupled to the plasma, and quasi-one-dimensional conduction heat transfer. In particular, the results demonstrate that the heating rate in low temperature hydrogen-air plasmas is much faster than in air plasmas, primarily due to energy release from exothermic reactions of fuel with O and H atoms generated in the plasma. At intermediate temperatures, 500 – 600 K, OH formation from chain branching processes increases, with rapid concurrent increase in heat release, leading to rapid temperature rise and, in some cases, volumetric ignition. Kinetic sensitivity analysis is used to identify dominant plasma and chemical processes and demonstrates that removal of the radical generation processes by the nanosecond pulsed plasma from the model completely blocks subsequent exothermic chemical reactions, thus making ignition impossible.

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