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Repetitively Pulsed Nonequilibrium Plasmas for Plasma-Assisted Combustion, Flow Control, and Molecular Lasers

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The paper presents results of three experiments using high voltage, short pulse duration, high repetition rate discharge plasmas. High electric field during the pulse (E/N∼500-1000 Td) allows efficient ionization and molecular dissociation. Between the pulses, additional energy can be coupled to the decaying plasma using a DC field set below the breakdown threshold. While the DC sustainer discharge adds 90-95% of all the power to the flow, it does not produce any additional ionization. The pulser and the sustainer discharges are fully overlapped in space. Low duty cycle of the pulsed ionizer, ∼1/1000, allows sustaining diffuse and uniform pulser-sustainer plasmas at high pressures and power loadings. The first experiment using the pulsed discharge is ignition of premixed hydrocarbon-air flows, which occurs at low pulsed discharge powers, ∼100 W, and very low plasma temperatures, 100-200^0 C. The second experiment is Lorentz force acceleration of low-temperature supersonic flows. The pulsed discharge was used to generate electrical conductivity in M=3 nitrogen and air flows, while the sustainer discharge produced transverse current in the presence of magnetic field of B=1.5 T. Retarding Lorentz force applied to the flow produced a static pressure increase of up to 15-20%, while accelerating force of the same magnitude resulted in static pressure rise of up to 7-8%, i.e. a factor of two smaller. The third experiment is singlet delta oxygen (SDO) generation in a high-pressure pulser-sustainer discharge. SDO yield was inferred from the integrated intensity of SDO infrared emission spectra calibrated using a blackbody source. The measured yield exceeds the laser threshold yield by about a factor of three, which makes possible achieving positive gain in the laser cavity. The highest gain measured so far is 0.03%/cm.