Laser-induced breakdown ignition of natural gas in a 2-stroke engine

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Laser-induced ignition for internal combustion engines is investigated intensively after demonstration of a compact “laser plug”. Laser spark benefits as compared to traditional spark plugs are: higher compression rate and possibility of almost any fuel ignition, so lean mixtures burning with lower temperatures could reduce harmful exhausts (NOx, CH, etc.). No need in electrode and possibility for multi-point, linear or circular ignition can make combustion even more effective. Laser induced combustion wave appears faster and is more stable in time, than electric one, so can be used also for ramjets, chemical thrusters, and gas turbines. Laser ignition takes place due to gas breakdown followed by plasma and shock wave formation, those lead to deflagration core onset (detonation and autocatalytic reaction are also possible). We have tested methane and isobutene–propane mix for our 2-stroke model engine. DPSS laser pulses (1064 nm, 12 ns, 30 mJ) were synchronized to top dead center for up to 100 Hz. Ignition possibility has been checked in a broad range of air/fuel ratios. Combustion brightness temperature measured was up to 2600 K, and peak pressure reached 45 bar (at 16 bar compression). Indicated horsepower was ~15% greater than specified for gasoline, that is slightly higher than known for gas fed 4-stroke engines. NOx concentration in exhaust 16 ppm was measured, that is significantly lower than traditional automotive engines have. Soot deposits on laser spark plug protective sapphire window were ablated at beam path. Laser ignition system allows use multiple fuels in lean mixtures at higher compression ratios, so it can be used for high performance engines (e.g. for UAV) and for harmful emissions reduce from industrial power plants.