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Non-equilibrium kinetics of plasma-assisted combustion: the role of electronically excited atoms and molecules[1]

NIKOLAY POPOV, Moscow State University

A review of experimental and theoretical investigations of the effect of electronically excited atoms and molecules on the induction delay time and on the shift of the ignition temperature threshold of combustible mixtures is presented. At relatively low initial gas temperature, the effect of excited $O(^1D)$ atoms on the oxidation and reforming of combustible mixtures is quite significant due to the high rates of reactions of $O(^1D)$ atoms with hydrogen and hydrocarbon molecules. The singlet oxygen molecules, $O_2(a^1\Delta_g)$, participate both in chain initiation and chain branching reactions, but the effect of $O_2(a^1\Delta_g)$ in the ignition processes is generally less important compared to the oxygen atoms. To reduce the ignition delay time and decrease the temperature threshold of fuel-air mixtures, the use of gas discharges with relatively high E/N values is recommended. In this case the reactions of electronically excited $N_2(A^3\Sigma_u^+$, $B^3\pi_g$, $C^3\pi_u$, $a'^1\Sigma_u^-)$ molecules, and atomic particles in ground and electronically excited states are extremely important. The energy stored in electronic excitation of atoms and molecules is spent on the additional dissociation of oxygen and fuel molecules, on the fast gas heating, and finally to the triggering of chain branching reactions.

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