The experimental study of the enhancement of hydrogen-air mixture ignition promoted by the singlet oxygen molecules

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The influence of electronically excited oxygen molecules on the processes of ignition and combustion is under current investigations [1, 2] due to the possible prospects for the pollution decrease and combustion enhancement. Chemical activity and long lifetime of oxygen molecules in $a^1\Delta_g$ state encourages the production of these active particles in the electric discharge and their introduction to the burning mixture. There are few researches [3, 4] devoted to the experimental determination of the role of the electronically excited oxygen molecules in the ignition and combustion processes. Unfortunately, these experimental data does not cover the essential temperature range.

In this work, the induction zone length of the hydrogen/air mixture with different concentrations of oxygen molecules in the $a^1\Delta_g$ state was measured in the low-pressure flow reactor at 780-1000 K temperature range. Singlet oxygen molecules were produced in the glow discharge. Cowering of the discharge cell and supply duct by HgO [5] was performed in order to reduce the concentration of the atomic oxygen and ozone molecules in the discharge products. The special attention was paid to the diagnostics of discharge products. Spectroscopic techniques were applied for the measurements of the $O_2(a^1\Delta_g)$ and O_3 concentrations. Singlet oxygen deactivation on the walls was found to be significant along the reactor and must be taken into account in numerical simulation of the processes inside the reactor. It has been shown that the introduction of 3.5% $O_2(a^1\Delta_g)$ to the lean hydrogen/air mixture shortens the induction zone length by 10-50%, which is equivalent to the ~20 K heating.

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