CARS and chemiluminescence diagnostics of a diffusion flame of boron nanoparticles in isopropanol with oxygen

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The analysis of diffusion combustion of a composite fuel (formed by addition of boron nanoparticles, NPs, to isopropanol in the amount of 0.5 wt %) with oxygen was performed. For these purposes an experimental stand was developed and built, consisting of a special burner equipped with the diagnostic system to detect CARS and chemiluminescence radiations for the measurements of temperature distributions in the diffusion flame, the ignition delay time, and the velocity of a flame front propagation.

The morphology of the boron powder particles was studied using a transmission electron microscope, the diffraction patterns were measured on an X-ray diffractometer, and the size distribution of the NPs was determined using a disk centrifuge. The diffractogram showed that the boron NPs were amorphous with the presence of a crystalline phase of boron hydroxide B(OH)3. The mass distribution of the particles was bimodal, and most of the boron mass (99%) was concentrated in large particles with diameters on the order of 750 nm. At the same time, most of the particles were less than 50 nm in size. The number of large particles was small (<0.1%) [1].

The flame temperature distributions were derived from CARS spectra of N2 molecules along the direction, perpendicular to the axis of the flame propagation, at a few distances from the nozzle exit of the burner. The experimental results showed that during combustion of the composite fuel temperature in the flame front region increased by approximately 150°C compared with that in the flame of pure isopropanol [1].

The ignition delay time and the velocity of the flame front propagation were measured upon the photo dissociation of O2 molecules by the resonance 193-nm laser radiation. The experiments on recording the chemiluminescence of OH(A2+) radicals indicate that it is possible to ignite a composite fuel with oxygen at rather low temperatures <600 K, which are below the auto ignition temperature, under the action of the focused laser radiation with the pulse energy of ~25mJ. The induction time was rather small and varied in the range of 200–400 ns depending on mixture parameters and the pulse energy.

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References

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