TIME-RESOLVED CAVITY RINGDOWN MEASUREMENTS OF HO_2 RADICAL IN A HEATED PLASMA FLOW REACTOR

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Time-resolved, absolute HO_2 number density in diluted H_2-O_2-Ar, CH_4-O_2-Ar, and C_2H_4-O_2-Ar mixtures excited by a repetitive ns pulse discharge in a heated plasma flow reactor is measured by Cavity Ringdown Spectroscopy (CRDS). The experimental results are obtained at T=300-600 K and P=130 Torr, both during the discharge pulse burst and in the afterglow. The HO_2 number density is inferred from the CRDS data using a spectral model exhibiting good agreement with previous measurements of absolute HO_2 absorption cross sections. In the room-temperature H_2-O_2 mixture, as well as in CH_4-O_2 and C_2H_4-O_2 mixtures over the entire temperature range studied, HO_2 is generated only during the discharge burst and decays in the afterglow. However, in the H_2-O_2 mixture at elevated temperatures, T=400-600 K, HO_2 persists in the afterglow up to 10 ms after the discharge burst, comparable with the flow residence time in the reactor. Comparison with kinetic modeling shows that the sustained reactivity after the source of radicals is turned off is due to a chain propagation / hydrogen oxidation process, which dominates the radical recombination reactions. The kinetic modeling predictions are in good agreement with the relative HO_2 number density measured in all three mixtures, although the model unpredicts the absolute number densities in H_2-O_2 and CH_4-O_2 at T=400-600 K by up to a factor of two. Detection of the sustained low-temperature reactivity in H_2-O_2, initiated by the radical generation in the plasma, suggests that the plasma excitation may also affect kinetics of oxidation and reforming of fuels exhibiting low-temperature chemistry below hot ignition point. Development of a narrow linewidth optical parametric oscillator (OPO) for high-resolution, time-resolved HO_2 measurements during n-butane oxidation in a heated plasma flow reactor is underway.