EFFECT OF NON-THERMAL PLASMA ON THE DYNAMICS OF A LEAN PREMIXED METHANE-AIR FLAME

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Recently, nanosecond repetitively pulsed (NRP) discharges were successfully applied to turbulent premixed flame configurations to control combustion instabilities. Full suppression of instabilities was achieved but, due to strongly coupled plasma–flame interaction mechanisms, detailed understanding of this effect is still lacking. The strong action of the plasma on flame stability has been attributed to coupled thermal and chemical activation of the fluid. Understanding which of these effects is dominant for the response of the flame is necessary to further improve the capabilities of plasma-assisted combustion in view of technical applications. In order to distinguish the individual effects, another regime of NRP discharges is considered here: the glow regime. The NRP glow regime is known for its reduced thermal impact, while offering a high level of chemical activation. However, since the energy deposition of this plasma is low, a noticeable effect can only be achieved for laminar flames. Therefore, in the present study, the response of a laminar lean premixed flame to excitation by NRP glow discharges is investigated. Since in combustion instabilities, one key factor is the response of the flame to acoustically induced velocity fluctuations, the two types of forcing are compared. Finally, in order to provide additional understanding of the chemical activation by NRP glow discharges, a spectroscopic analysis is conducted. The results validate the low thermal effect of the discharges, with a maximum of 100 K gas heating in the plasma region. The spectroscopic analysis shows the production of excited nitrogen ($N_2(C)$), ions (N_2^+), and an increase in the density of OH*. In contrast, the density of CH* appears to be insensitive to activation by NRP glow discharges. A possible mechanism for the plasma action is a significant local increase of the burning velocity due to the chemical effect of NRP glow discharges.

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