EVOLUTION OF THE LASER INDUCED INCANDESCENCE SIGNALS OF SOOT PARTICULES MEASURED IN LOW-PRESSURE METHANE FLAMES

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The understanding of soot formation mechanisms in flames, and more specifically the nucleation process, is still under debate. To deal with this crucial step, low pressure laminar flames are particularly well suited because of the large reaction zone, offering the possibility of examining the early soot formation zone. The number of soot particles is however much lower than at atmospheric pressure, requiring the use of sensitive techniques such as Laser Induced Incandescence (LII).

In this work, we have used the LII technique to probe soot particles formed in various low-pressure premixed methane/oxygen/nitrogen flames stabilised for different equivalent ratio (Φ = 2.32, 2.05, 1.95) and pressure (P = 18.66 kPa (140 torr) and 26.66 kPa (200 torr)). Heating of the particles has been achieved by using the 1064 nm excitation wavelength of a YAG laser, the energy profile of which has been shaped as top hat. Temporal LII signals were measured by a photomultiplier whereas we complementary used an intensified CCD camera coupled to spectrometer in order to record the associated emission spectra. Measurements have been done for different heights above the burner (HAB), included the very beginning (nucleation step) of the soot formation processes in the flames.

By this way, we observed significant and surprising differences, mainly concerning the evolution of the temporal signal according the flame height, between the lowest equivalent ratio (Φ=1.95 and 2.05) and the reference flame (Φ=2.32). While this last flame is characterised by the increase of the LII decay with HAB, corresponding to the increase of the particles size as expected, no such evolution is observed for the two other ones. In these conditions, the temporal LII decays remain constant for all the heights above the burner, therefore questioning about the nature of the formed species. As a consequence, examination has been focused on those flames including fluence curves, measurement of relative volume fraction profiles and spectral analysis.