Graduate Student Research Seminar

Spring 2026

On the use of a sensitivity-enhanced algorithm to quantify sooting dynamics in droplet combustion of highly sooty fuels

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Monday, April 6th

3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

This work describes a sensitivity-based algorithm for extracting the soot volume fraction (SVF, f_v) from digital video images of organic liquid droplets burning under conditions that promote spherically symmetric gas transport. The algorithm was applied for the first time to digital video images of *n*-propylbenzene (*n*P) droplets with initial diameters (D_0) ranging from 2.1 mm to 5.8 mm. The SVF was obtained by measuring the intensity of light along rays-of-interest (ROIs) through a droplet's center on the images. A "greedy algorithm" was employed to calculate the dynamic Coefficient of Variation to optimize the number of ROIs and thus enhance the repeatability and accuracy of SVF data. These data analysis efforts reveal many new physical insights into the sooting dynamics of heavily sooty fuels, *n*P. The results showed that f_v increased with time for a given D_0, reached a maximum ($f_{v,\,max}$), then decreased. Also, $f_{v,\,max}$ coincided with the measured soot shell location. The actual mass of soot formed as a function of time followed this same trend, increasing first because of fuel pyrolysis and then decreasing because of oxidation. While the peak value of $f_{v,\,max}$ over the entire duration of a burn ($f^*_{v,\,max}$) decreased with increasing D_0, the maximum mass of soot ($m_{s,\,max}$) itself increased linearly with D_0^2.

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