Measurements of Soot Volume Fraction under Conditions Relevant to Engine Exhaust Using Four-Colour LII and Different Laser Energies

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Available experimental evidence shows that the apparent soot volume fraction (SVF) determined from two-colour LII (at 450 and 780 nm) for soot initially at near ambient room temperature displays a laser fluence dependence: it first increases with increasing the laser fluence until it reaches a maximum, after which it decreases with further increasing in laser fluence, due to sublimation. It is suggested that the low-fluence SVF anomaly is attributed to changes in soot emissivity in the 350 to 500 nm spectral range as a result of evaporation of condensed volatile organic compounds from soot particle surfaces due to laser heating. However, there is currently a lack of direct evidence to confirm the cause of the low fluence anomaly and a lack of detection strategy on how to avoid the low fluence SVF anomaly. The current approach using the two-colour LII technique is to operate the laser fluence around 2.1 mJ/mm^2 with a 1064 nm laser, see Fig. 1.

In an attempt to address these two questions experimental measurements of SVF were conducted in a soot aerosol at near room temperatures at different laser fluence. A Nd:YAG laser of 6 ns FWHM operated at 532 nm was used to excite the soot particles. The resultant LII signals were detected at four spectral bands (with spectral widths varying between 12 to 40 nm) centered at 400, 631, 780, and 840 nm. The experimental results from this work provide useful insights into the cause of the low fluence SVF anomaly and an effective strategy to avoid this anomaly through detection of LII signals at longer wavelengths.

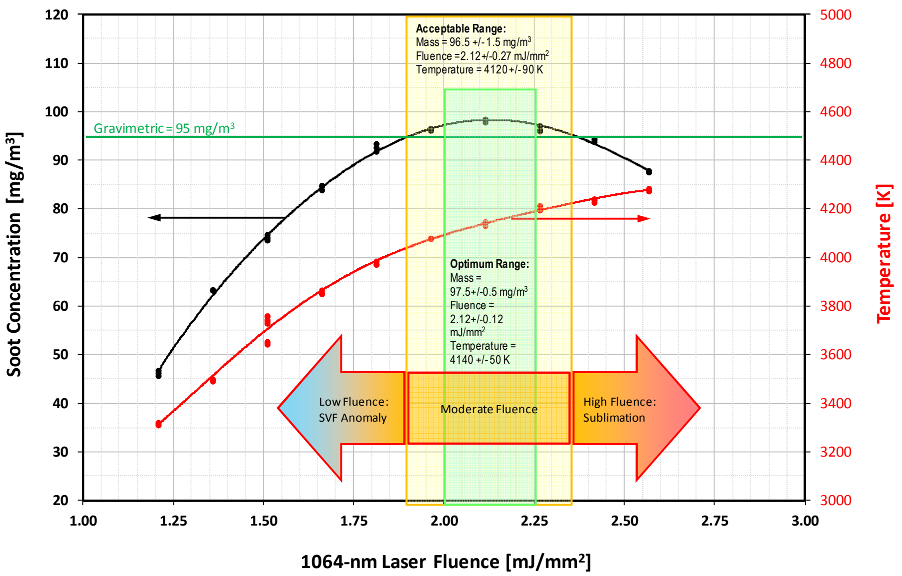

Fig. 1 Variation of soot concentration and temperature with laser fluence.