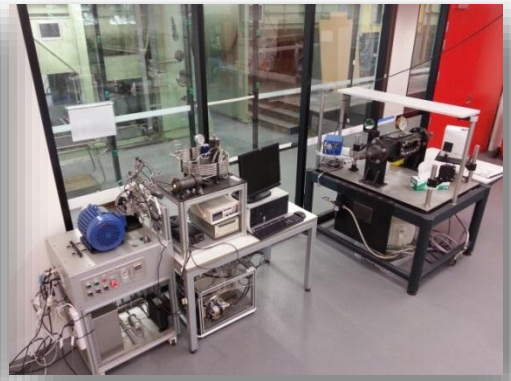

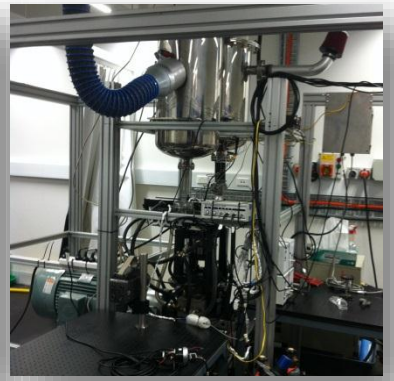

In-flame and exhaust soot particles under the influence of jet-jet interactions in a small-bore diesel engine

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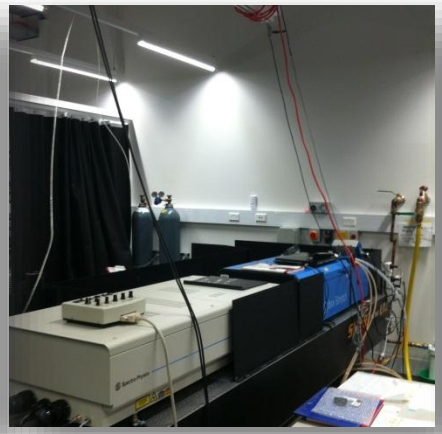
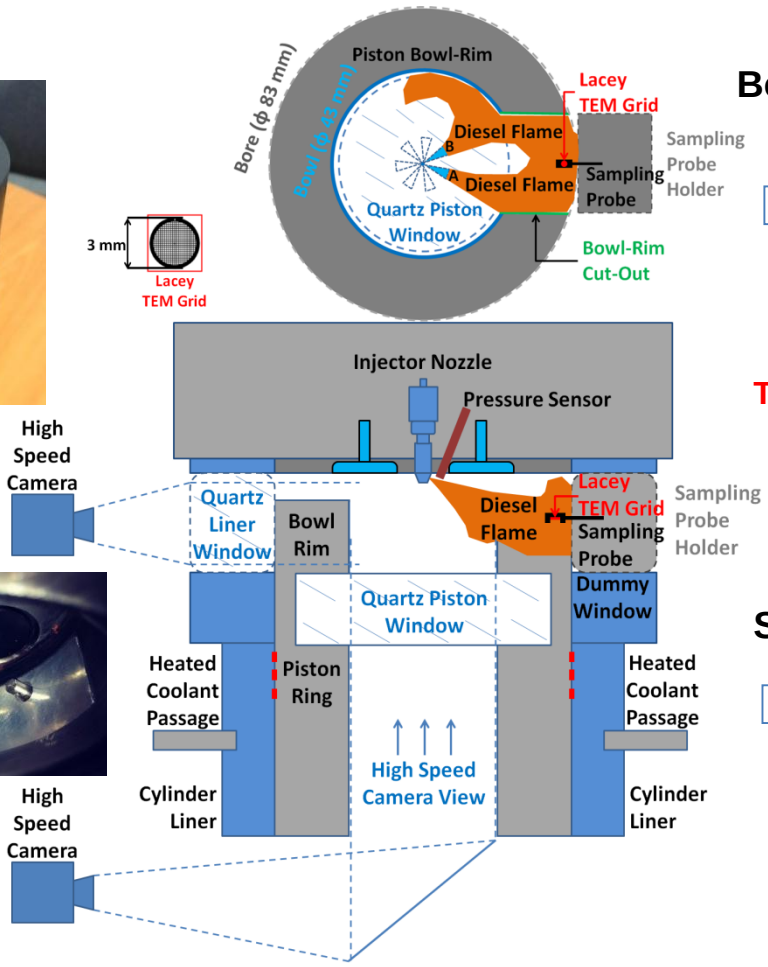


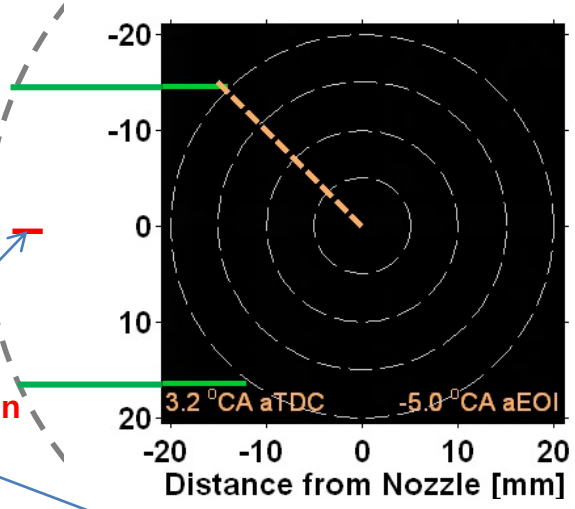
Hot soot luminosity movies suggest successful sampling of “in-flame” soot particles based on thermophoresis.

[SAE 2013-01-0912]

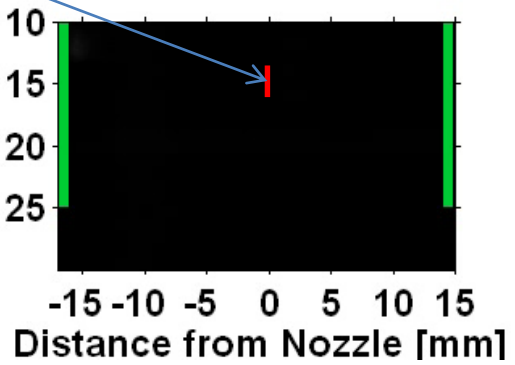


Bottom view

TEM grid location



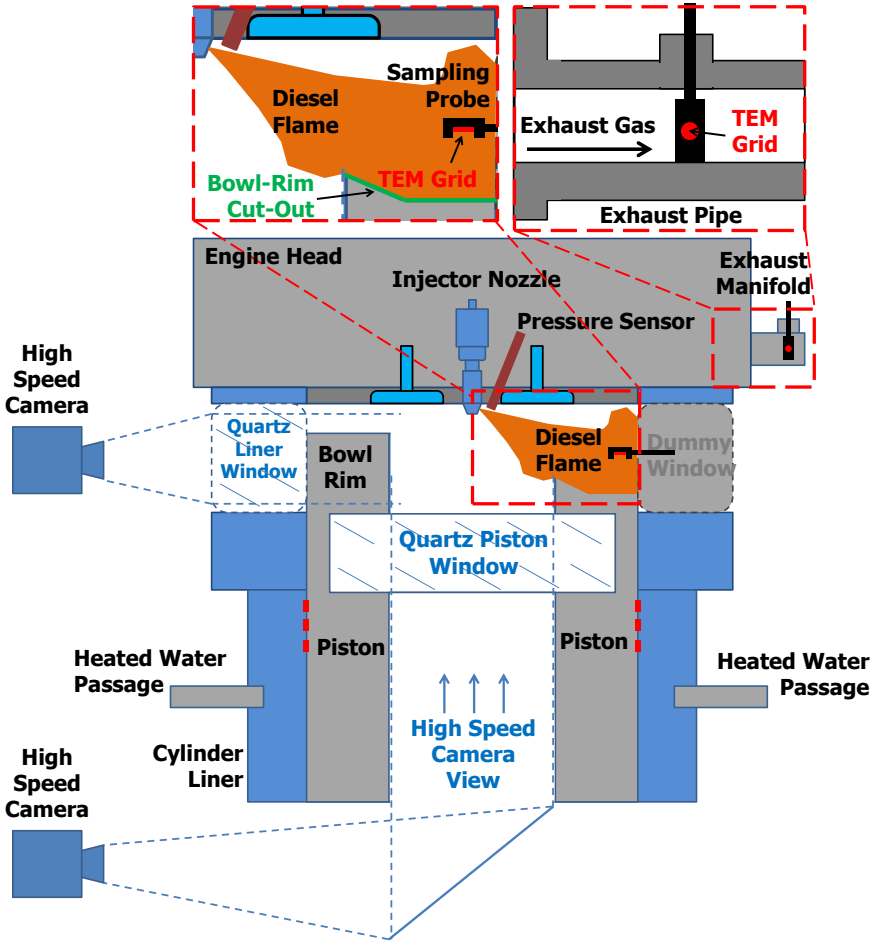
Side view



The same sampling/imaging was performed for “engine-out” soot particles and repeated for three jet configurations.

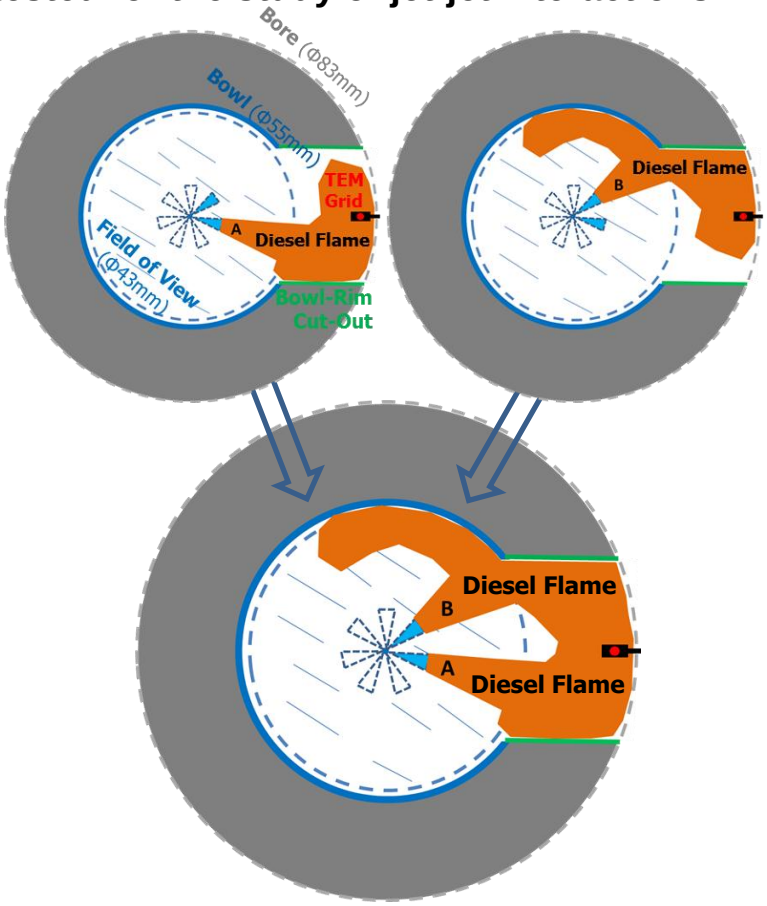
- The exhaust gas temperature was still high enough to cause thermophoresis.

[Comb Flame 162(6):2720-2728, 2015]



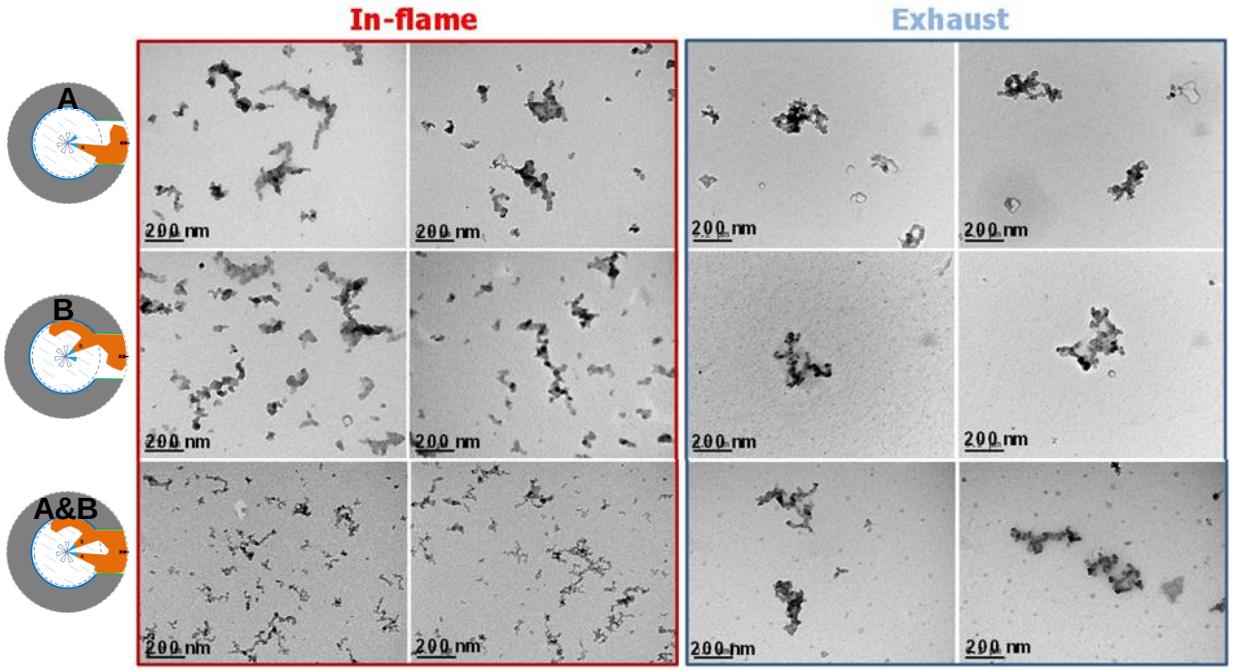
[SAE 2015-24-2444]

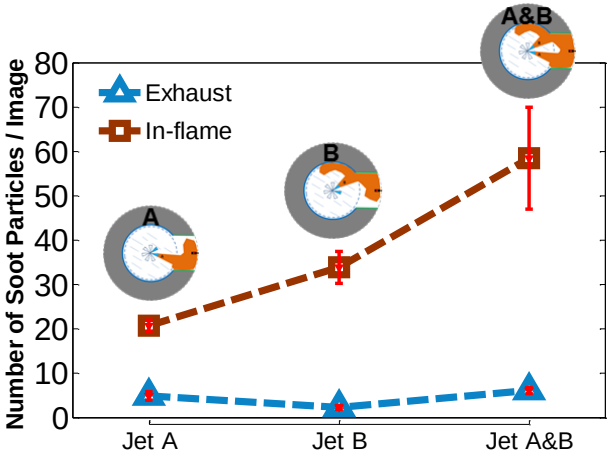
- Two different single jets and a double jet were tested for the study of jet-jet interactions.



The jet-jet interaction leads to higher number of soot particles that are not larger but smaller in size.

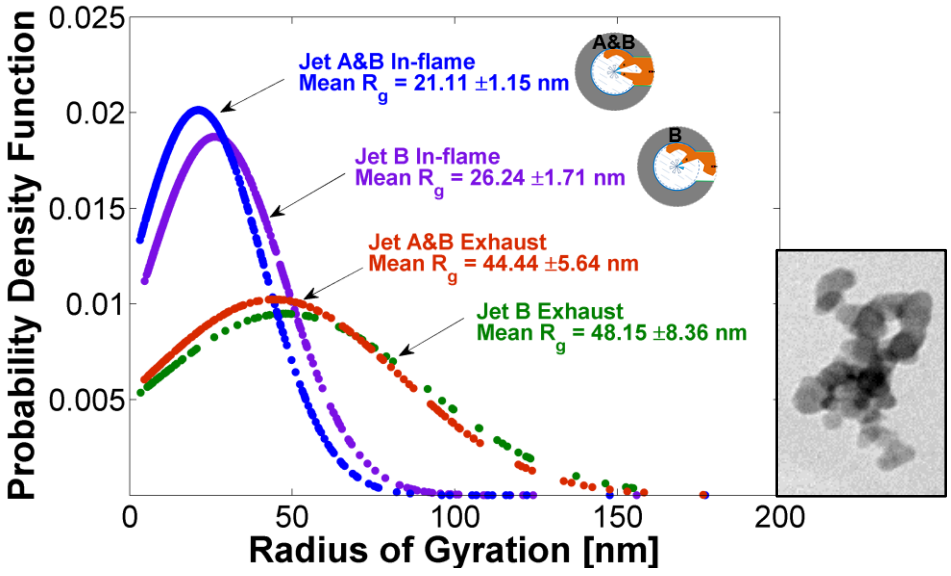
- Higher soot formation was due to locally rich mixtures in the jet-jet interaction region.
- <u>However, the in-flame particles look smaller.</u>
- The impact of jet-jet interactions on exhaust soot particles is unclear.

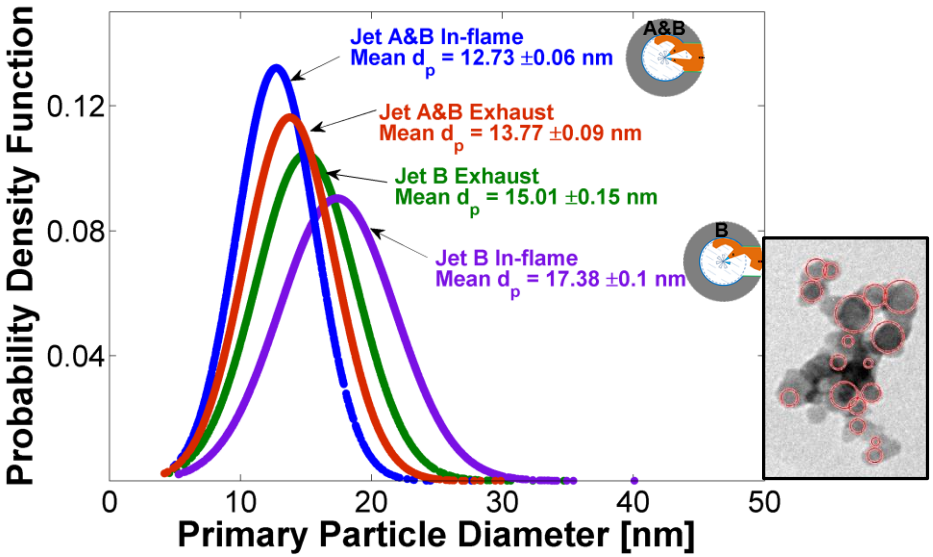




Both soot aggregates and primary particles sampled from the jet-jet interaction region are smaller in size.

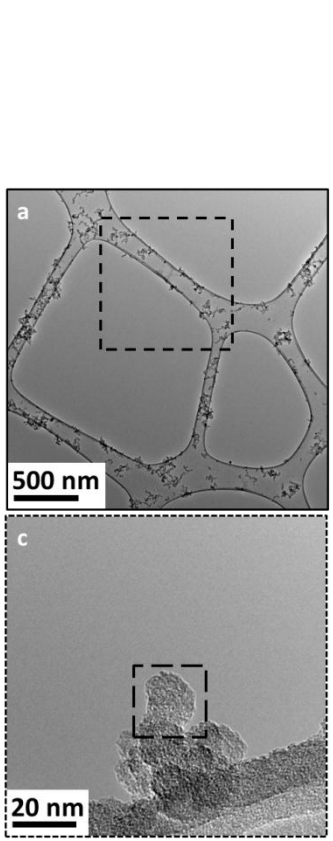
- **This suggests soot particles in the jet-jet interaction region are in the earlier stage of soot formation.**
- **The same trends are found for exhaust soot particles but the differences are less** due to soot oxidation occurred inside the cylinder of the engine before the particles exit through the exhaust.

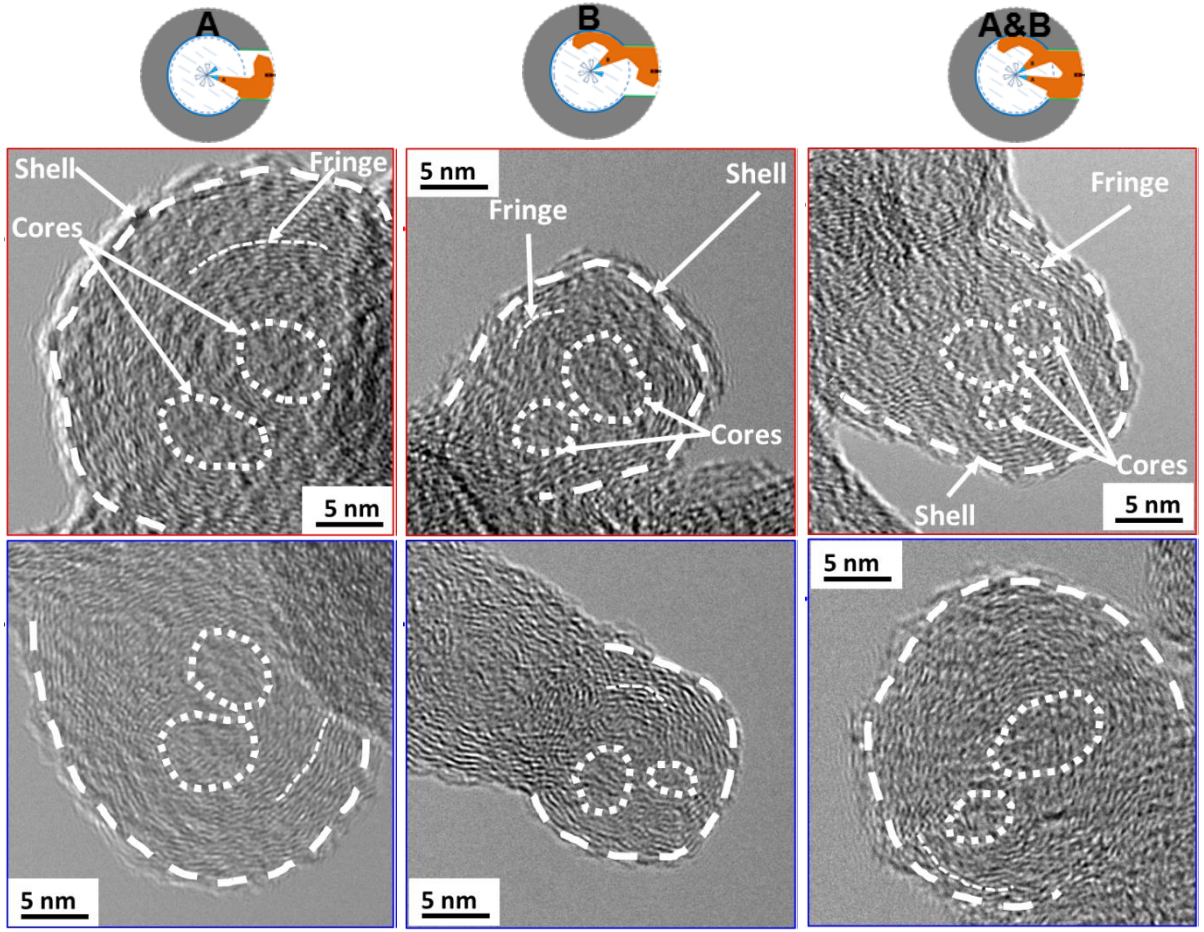




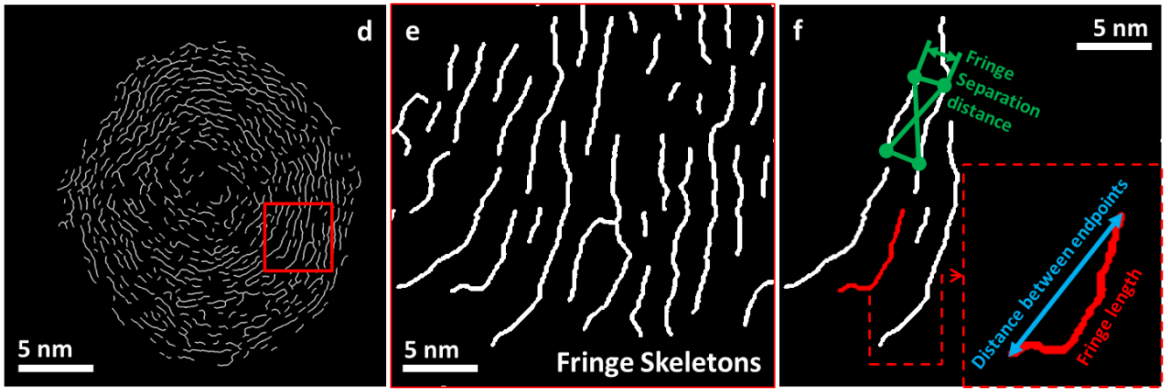
Using lacy TEM grids and a high-resolution TEM, nano-scale structures of soot particles were also looked at.

- **Both in-flame/exhaust soot particles show a typical core-shell nanostructure with multiple amorphous cores and a concentrically-oriented carbon-layer shell.**

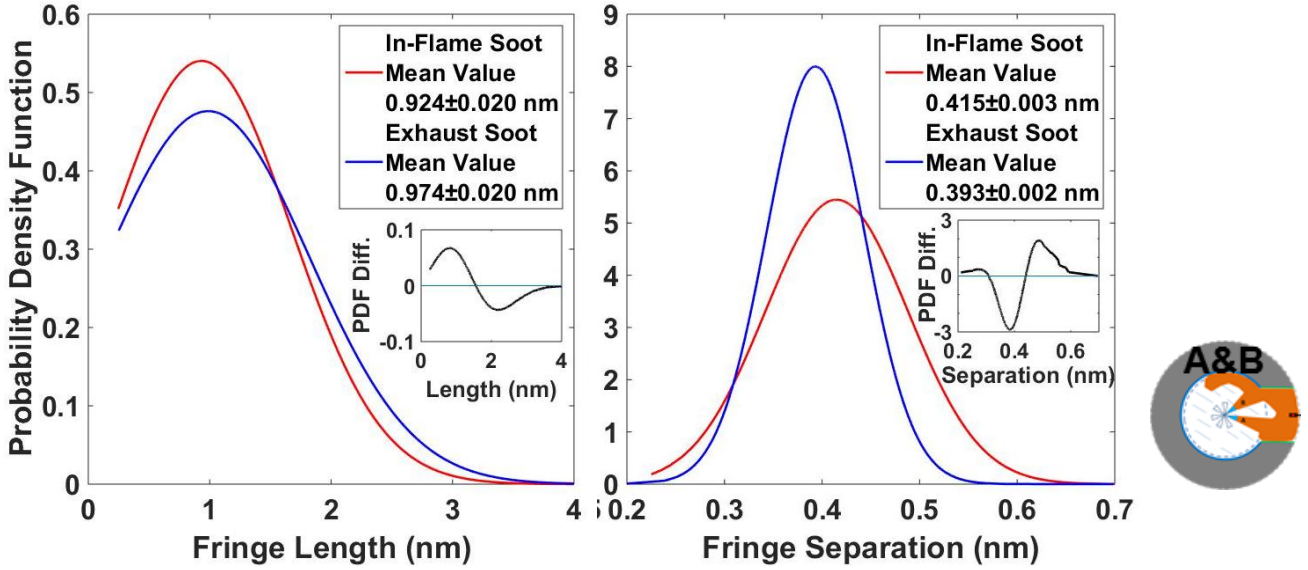




For each case, over 5000 carbon fringes were processed to obtain nanostructure parameters such as fringe length and fringe separation.

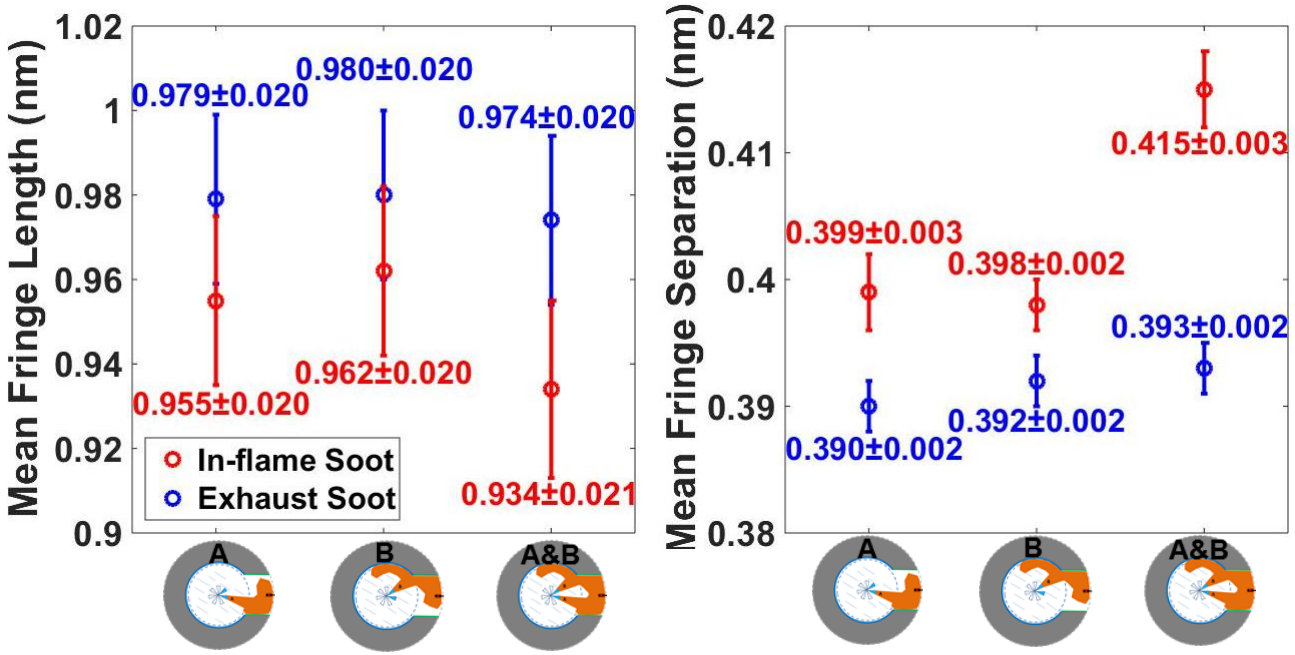


- **Exhaust particles comprise longer carbon fringes with decreased fringe-to-fringe distances, indicating soot oxidation.**



Soot particles in the jet-jet interaction region show the increased proportion of short carbon fringes and higher fringe separation.

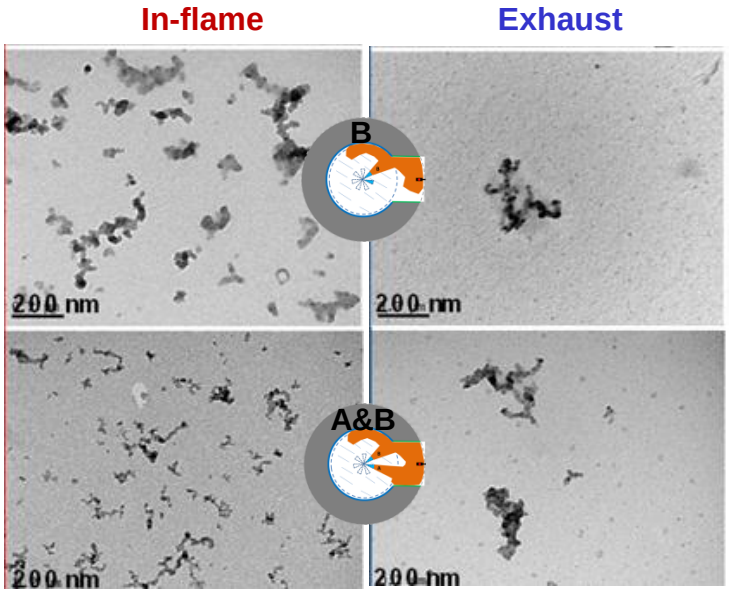
- The soot particles in the fuel-rich jet-jet interaction region are more pre-mature and reactive than those formed in the single-jet head region, i.e. earlier stage of soot formation.
- Once again, the same trends are found for exhaust soot particles with decreased gaps as they are further oxidised before exiting through the exhaust.

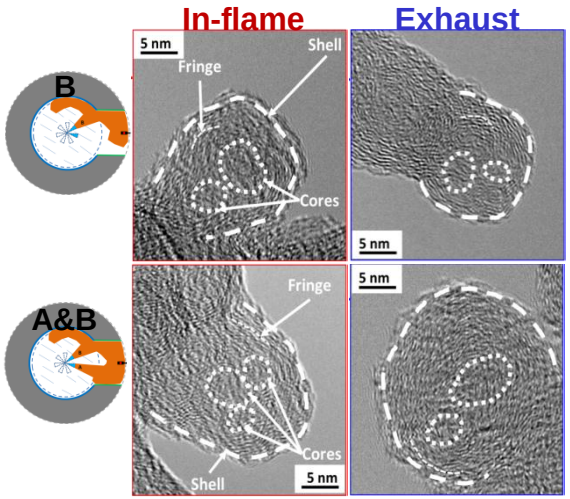


Summary

- The number of soot particles is higher in the jet-jet interaction region than the single-jet head region.

- Both the soot aggregates and primary particles in the jet-jet interaction region are smaller in size, suggesting the earlier stage of soot formation.





- Higher fringe separation distance and the increased proportion of highly reactive short carbon fringes also suggest that soot particles formed in the fuel-rich jet-jet interaction region are more premature and reactive.

- For the exhaust samples, both the soot aggregates and primaries become smaller due to jet-jet interactions; however, the differences are much less.