

# High throughput generation of aircraft-like soot



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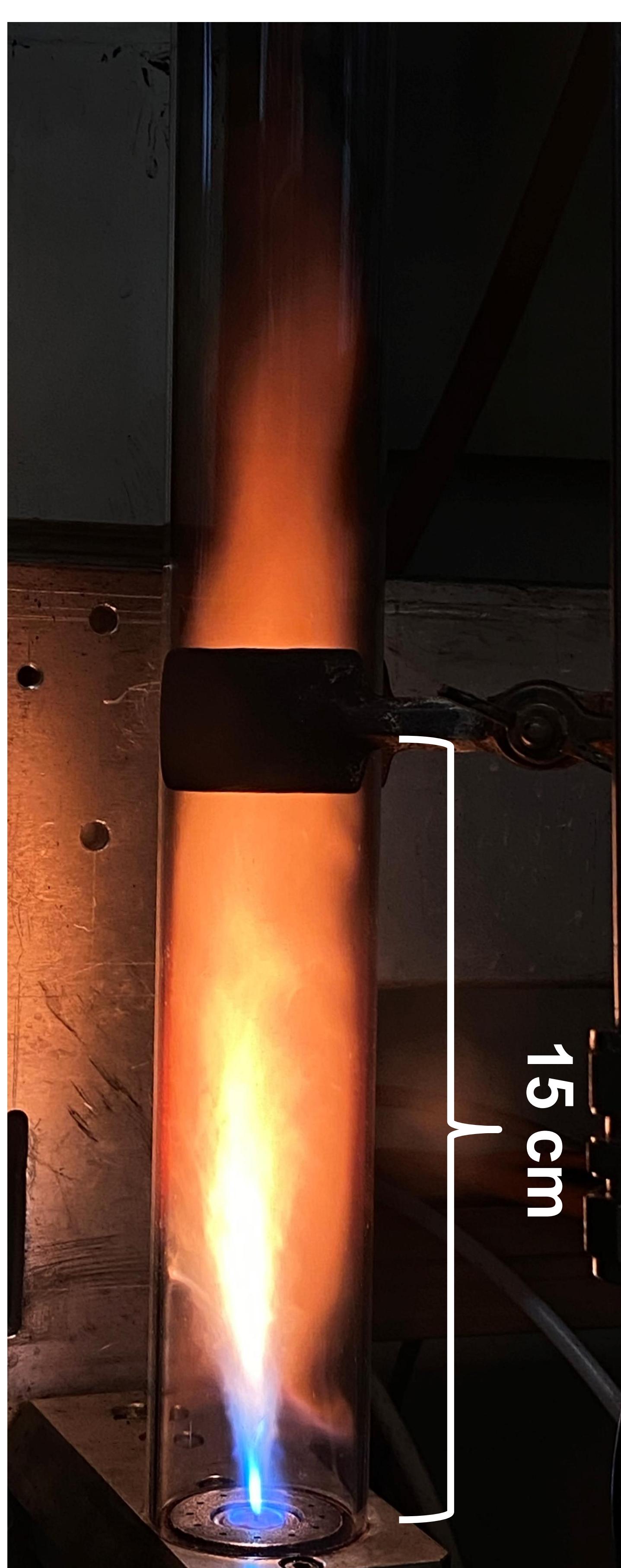
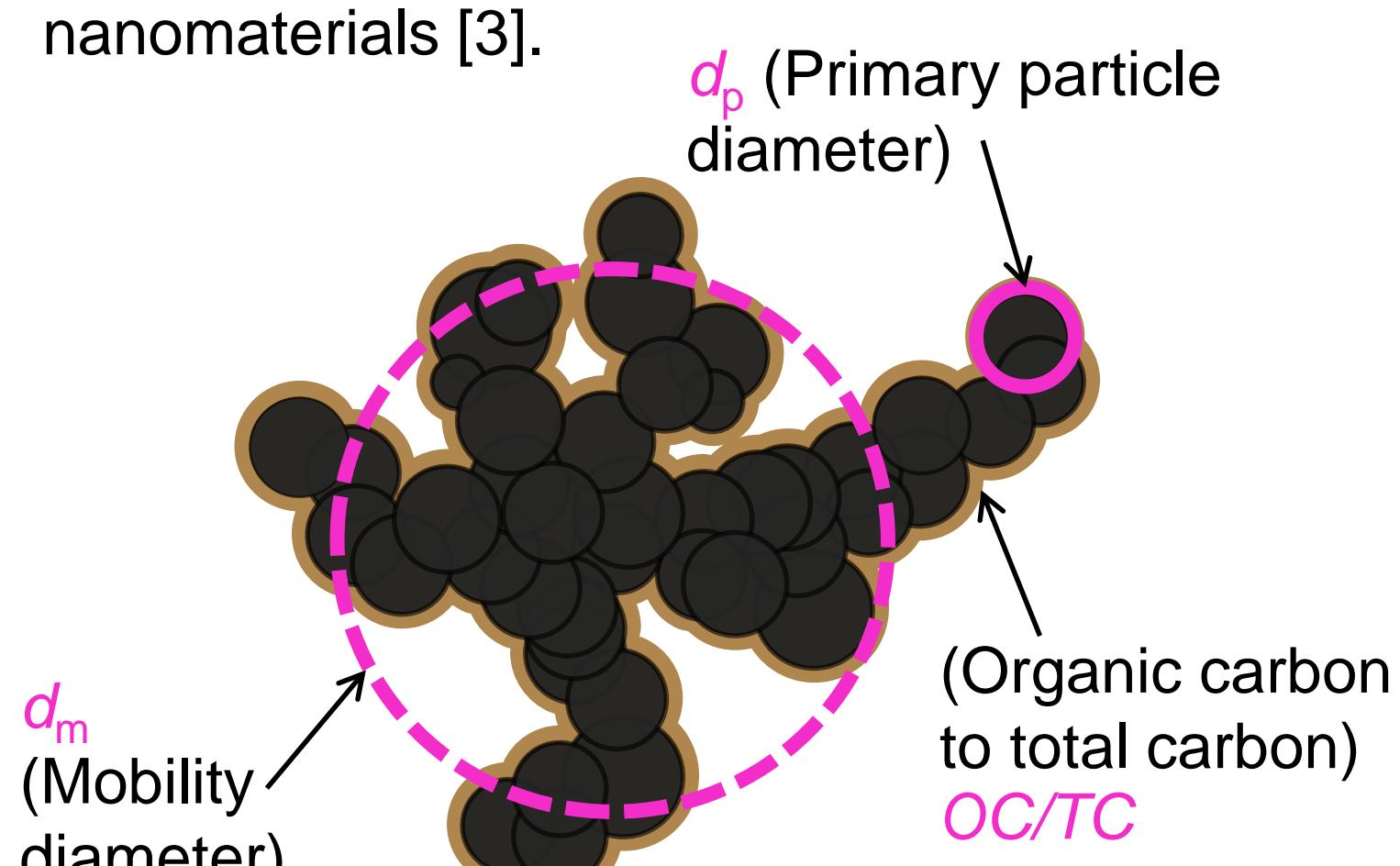
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## Motivation

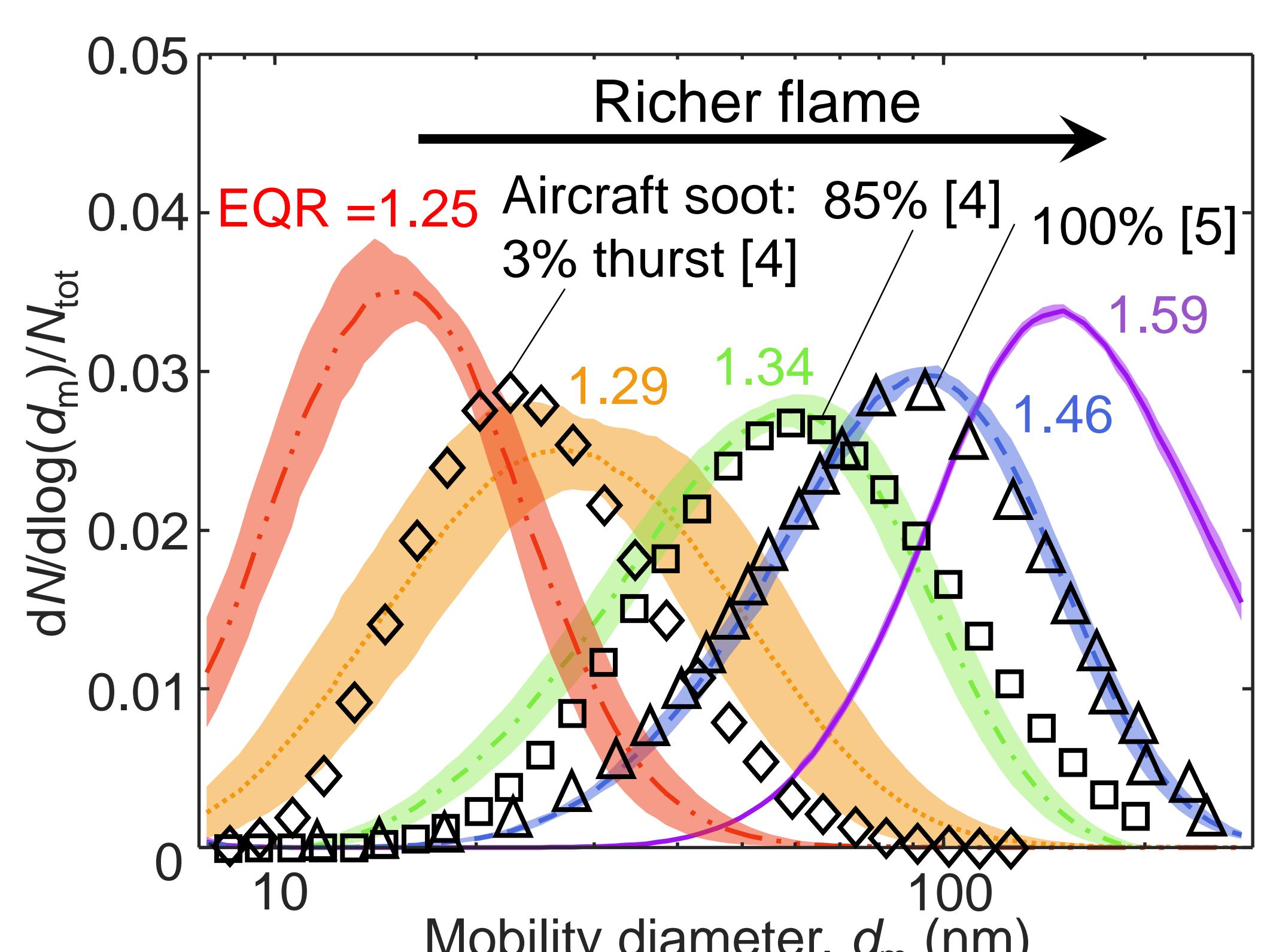
High-throughput, laboratory units for generation of aircraft-like soot are needed to quantify and understand the impact of such emissions on public health and climate change due to the high costs and limited access to aircraft engines.

Enclosed spray combustion of jet fuel [1] is used to generate high soot concentrations, up to  $255 \text{ mg/m}^3$ , three orders of magnitude higher than those typically obtained by widely-used (i.e. miniCAST) soot generators [2].

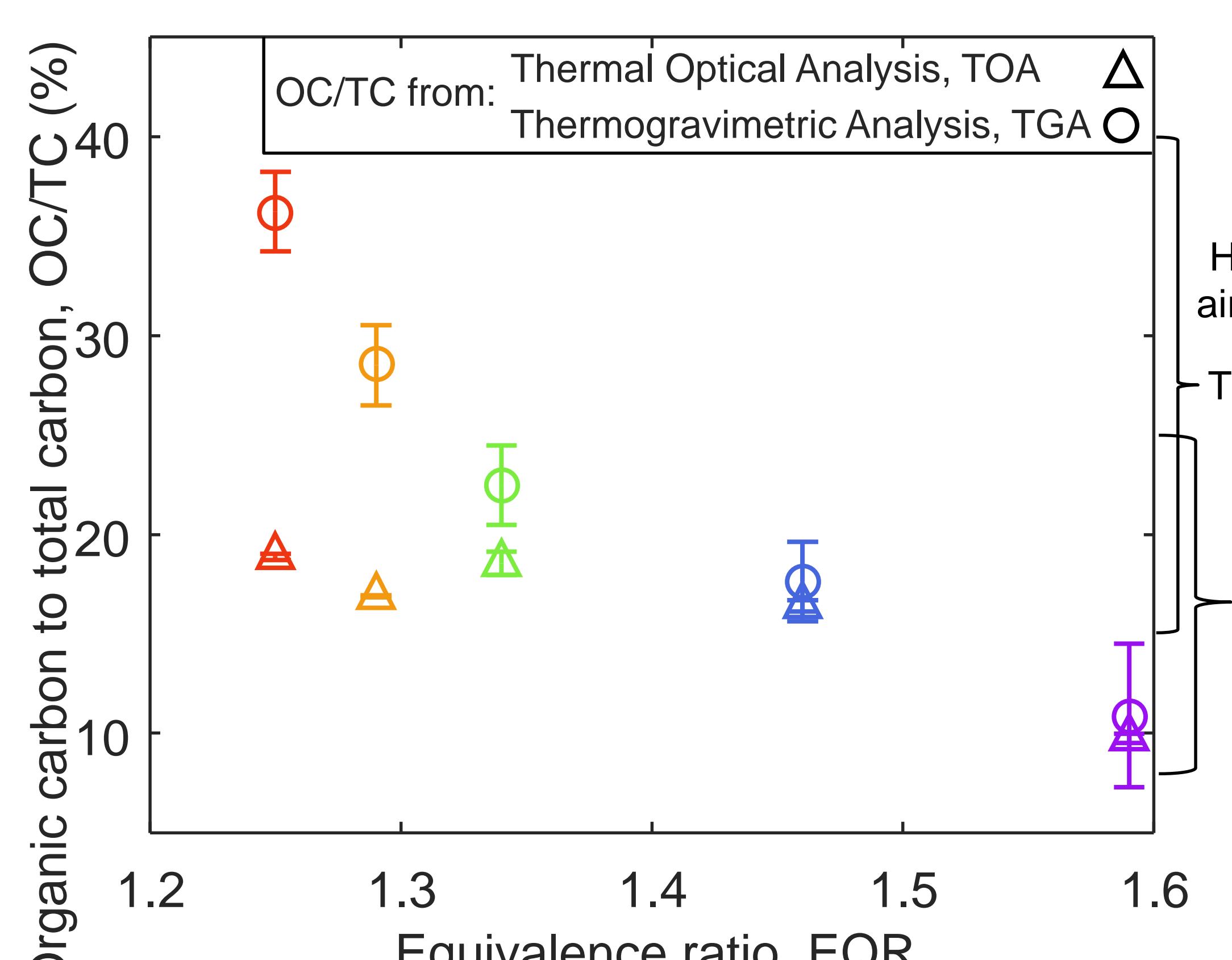
Varying the equivalence ratio (EQR) of the flame enables large variability of the soot mobility diameter ( $d_m$ ), specific surface area (SSA) and pore size distribution (PSD) measured by  $\text{N}_2$  adsorption that are of prime importance also for assessing the toxicity of nanomaterials [3].



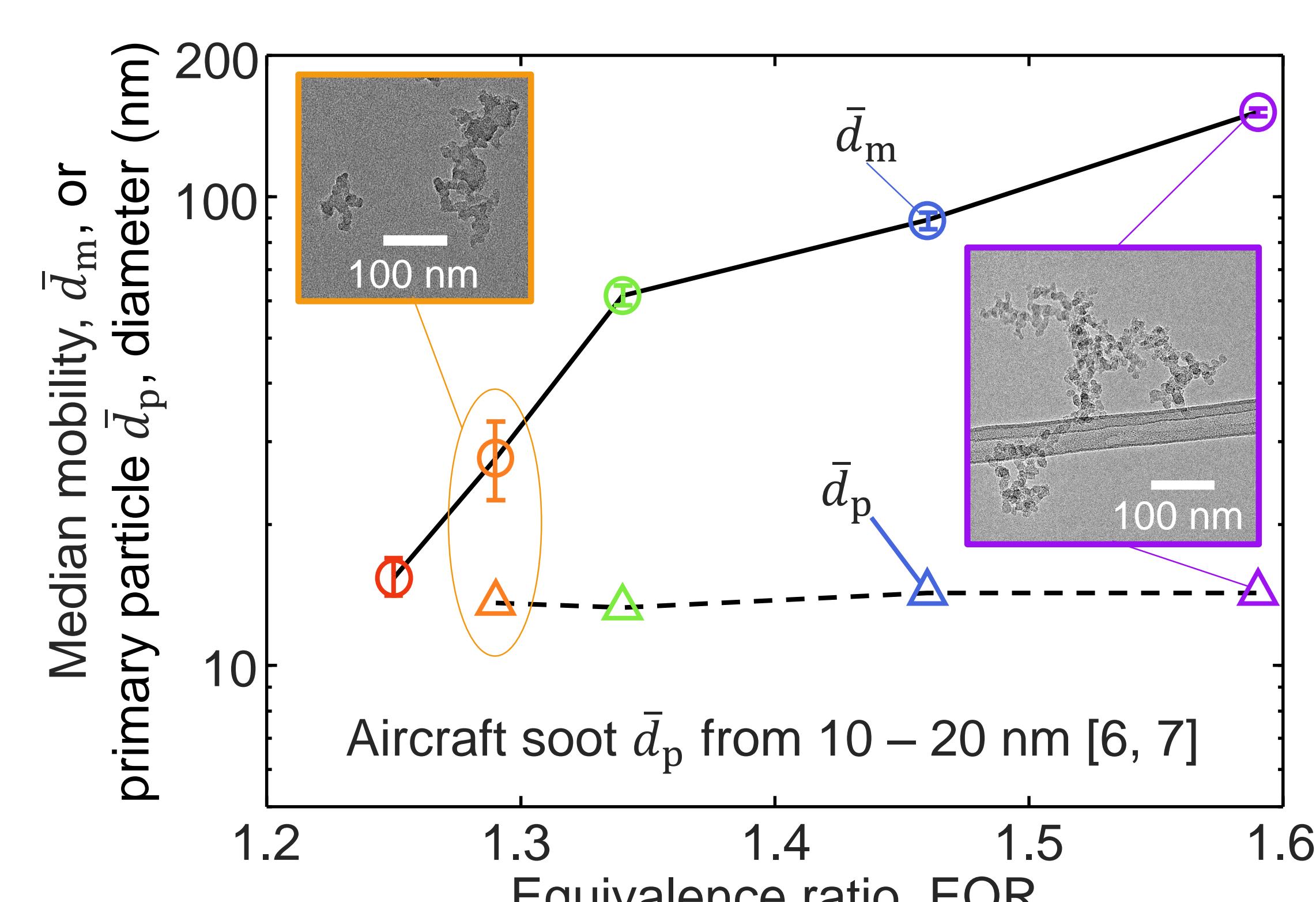
## Variation of soot $d_m$ , $d_p$ , OC/TC and nanostructure with EQR



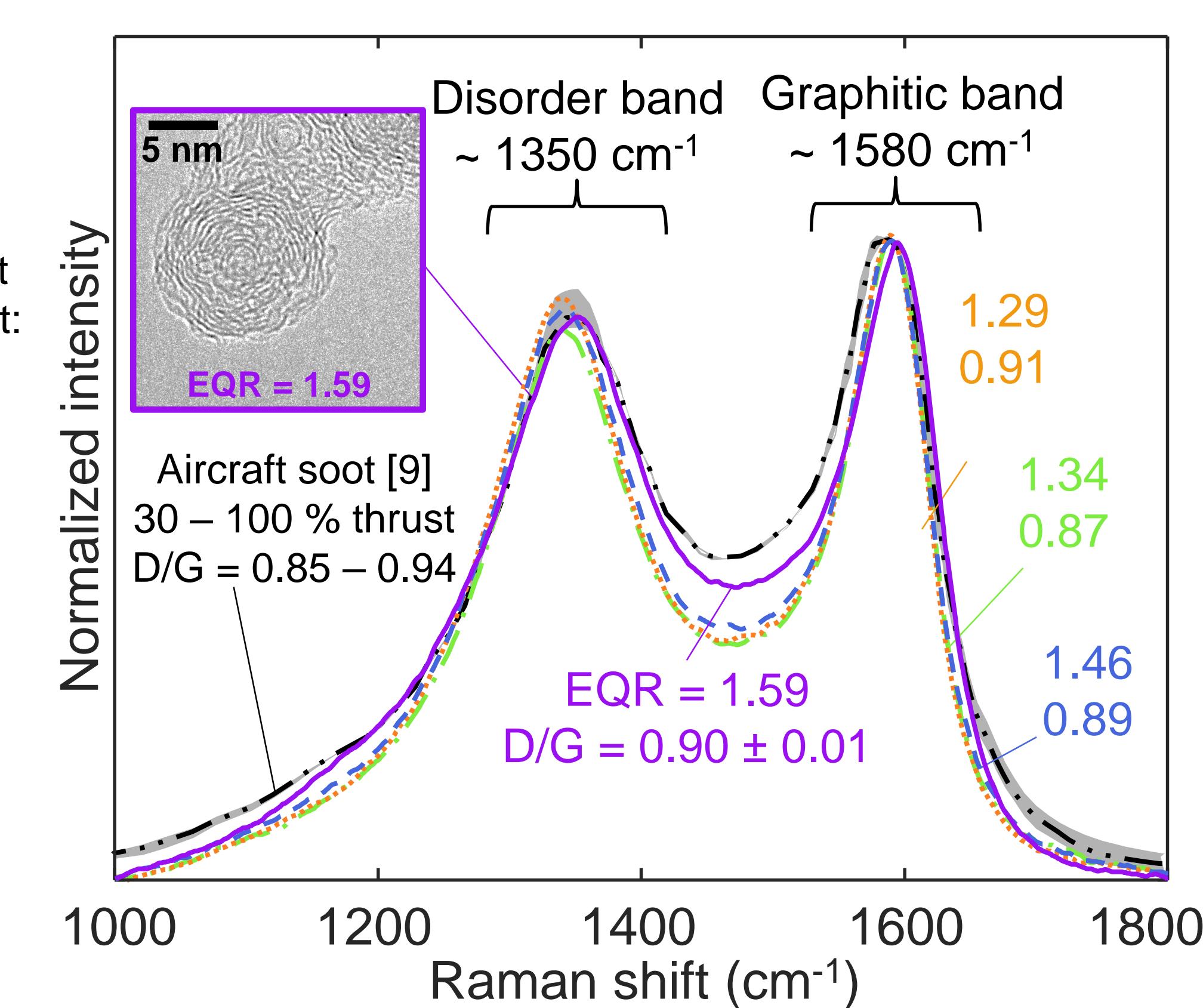
Normalized soot number concentration,  $dN/d\log(d_m)/N_{\text{tot}}$ , as a function of mobility diameter,  $d_m$ , at various equivalence ratios (EQR). The shaded areas represent one standard deviation between, at least, 9 measurements.



The present OC/TC of soot from TGA (circles) and TOA (triangles) as a function of EQR.

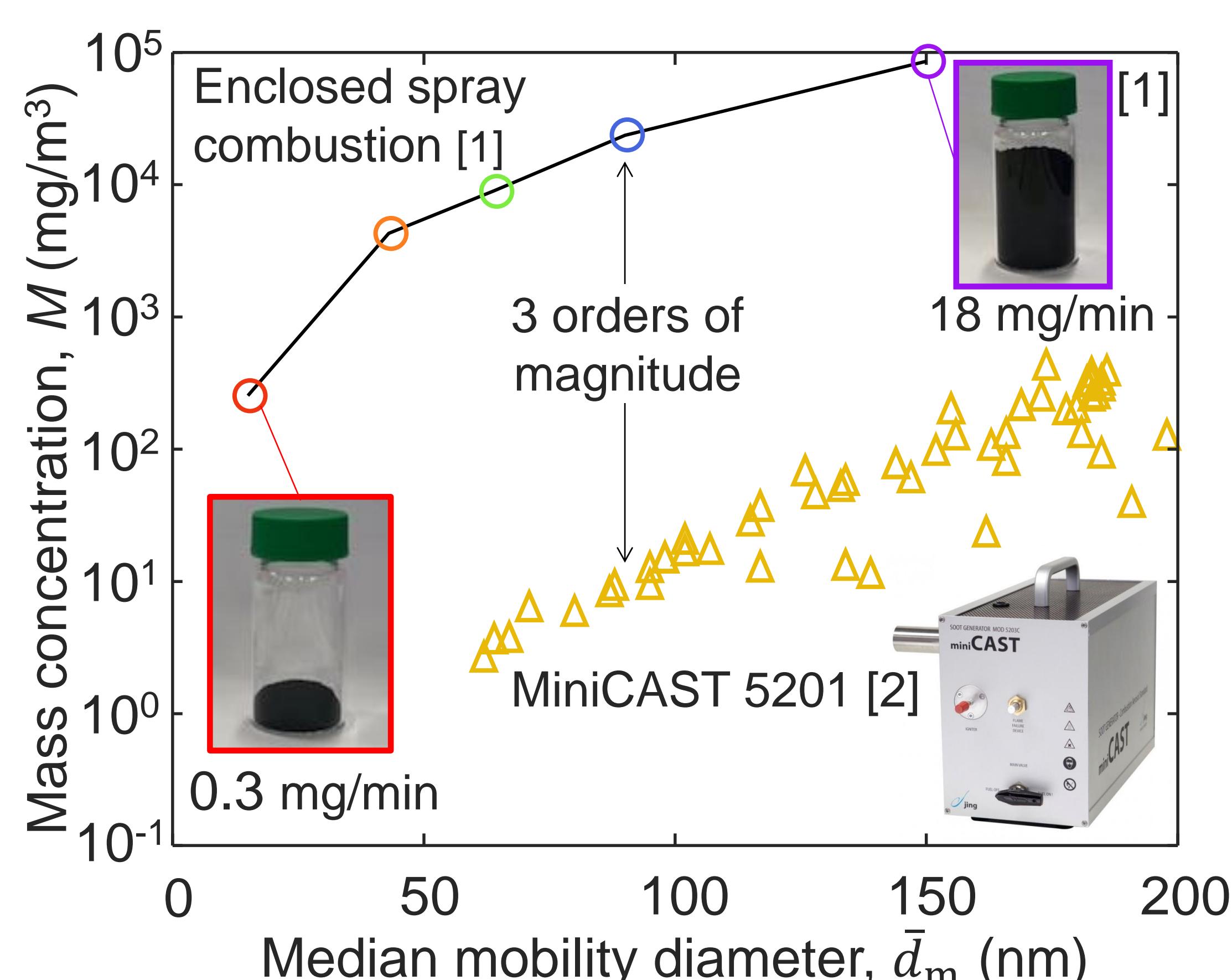


The median mobility,  $\bar{d}_m$  (circles), and primary particle diameter,  $\bar{d}_p$  (triangles) as a function of EQR.

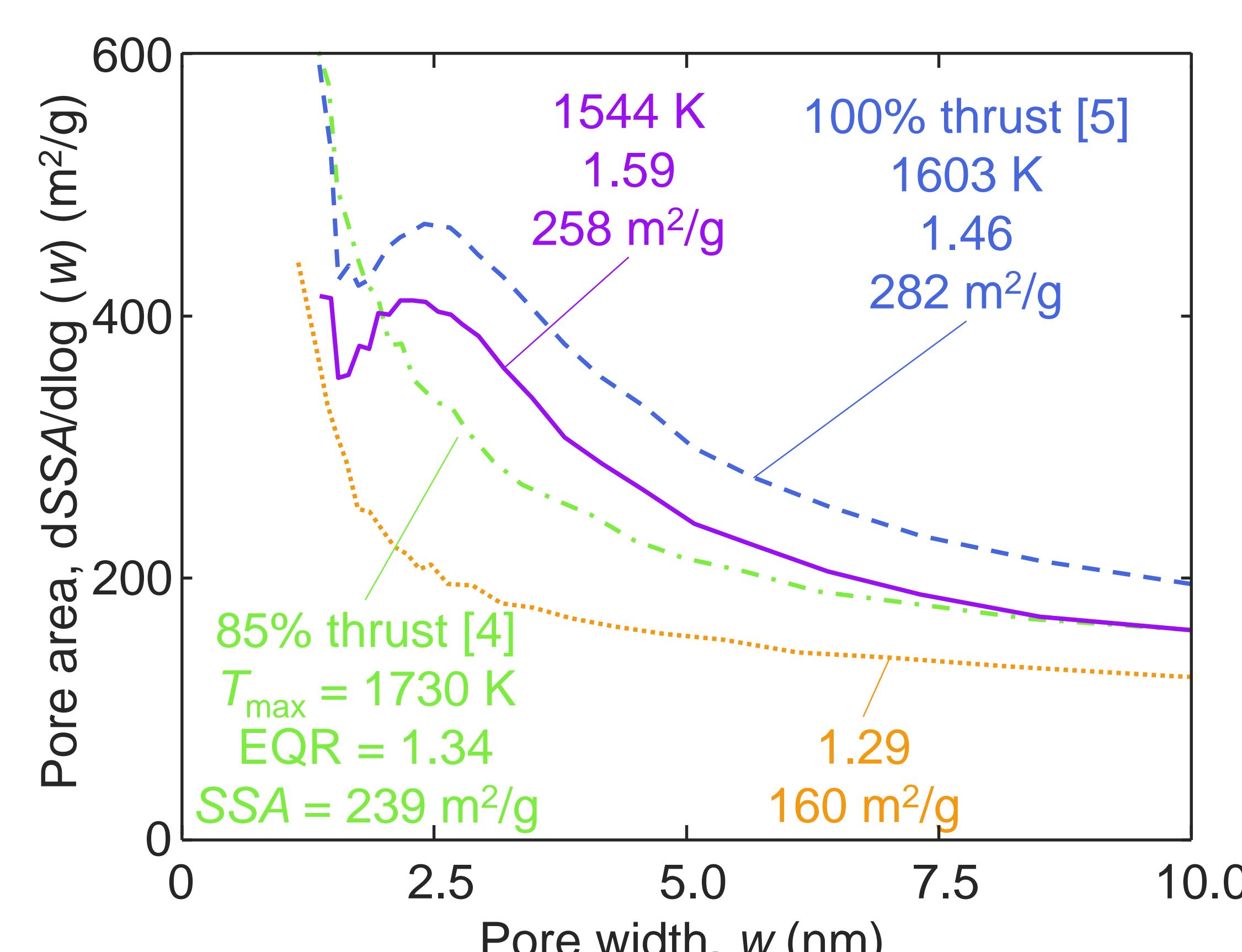


Raman spectra of soot from enclosed spray combustion at EQR = 1.29 (dotted line), 1.34 (dot-dashed line), 1.46 (broken line) and 1.59 (solid line) compared to aircraft soot (double dot-dashed line) between 30 – 100% thrust [9].

## Large soot mass enables characterization of soot SSA and porosity



The mass concentration,  $M$ , of soot from enclosed spray combustion (circles) and a 5201 miniCAST (triangles) [2] (corrected with a MAC that accounts for the soot OC/TC [10]) as a function of  $\bar{d}_m$ .



Specific pore surface area concentration,  $dSSA/d\log(w)$ , as a function of pore width,  $w$ , of soot made at EQR = 1.59 (solid line), 1.46 (broken line), 1.34 (dot-dashed line) and 1.29 (dotted line).

## References

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## Conclusions

1. Aircraft-like soot is generated by enclosed spray combustion at EQR = 1.59 - 1.29.
2. The present reactor can produce up to 3 orders of magnitude larger soot mass concentrations than existing soot generators.
3. Soot made at  $EQR \leq 1.34$  has mainly small pores ( $< 2 \text{ nm}$ ) and similar nanostructure, OC/TC,  $d_m$  and  $d_p$  distributions with those from high-thrust aircraft emissions [1].