Agglomeration with Polydisperse Primary Particles in the Transition Regime

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Motivation

Agglomeration dynamics of polydisperse soot primary particles (PPs) are taking place in combustion engines and flames. The resulting mature soot structure and size distribution affect its environmental impact and need to be determined accurately.

Here, Brownian coagulation of fractal-like agglomerates consisting of polydisperse PPs is investigated by Discrete Element Modeling (DEM) from the free molecular to transition regime.
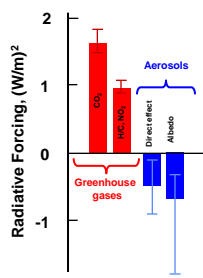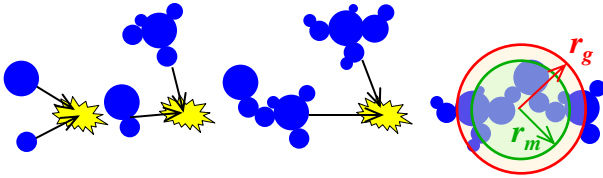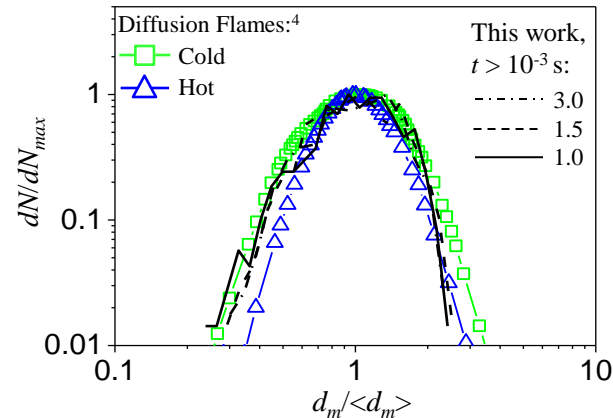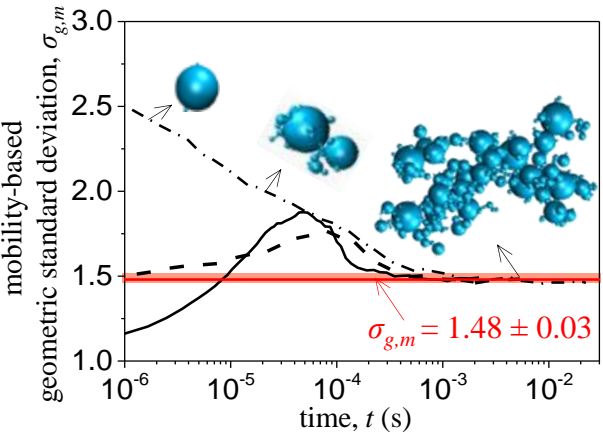

Method[1,2]

Agglomerate Morphology [2]
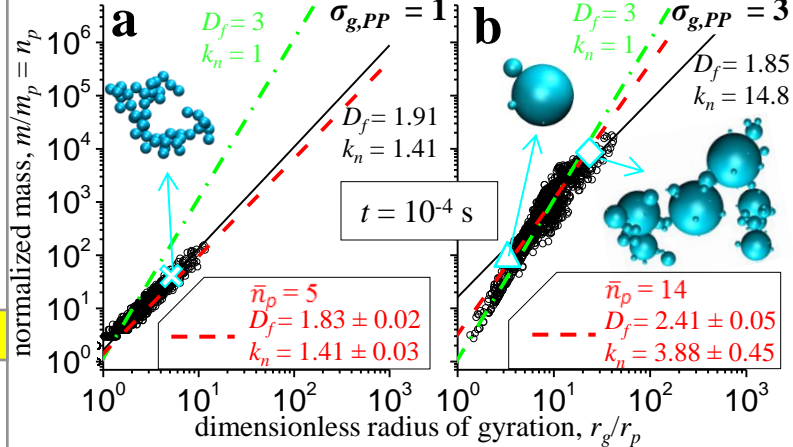
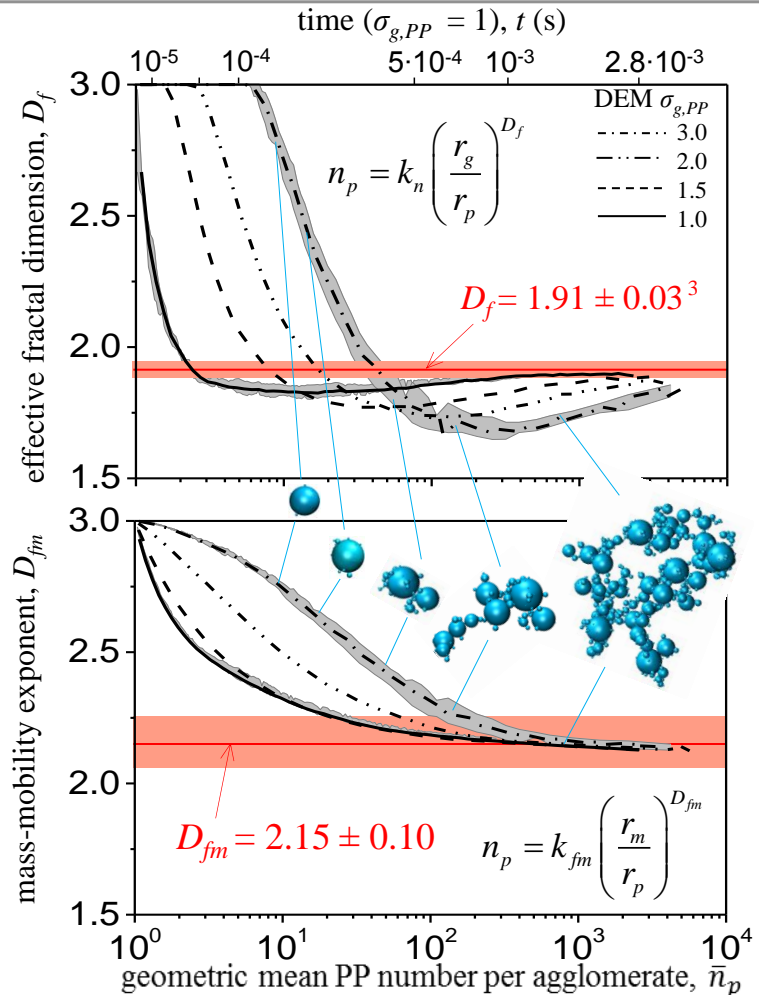Evolution of agglomerate structure by coagulation in dimensionless mass-radius of gyration, r_g, space.

Attainment of quasi-SPSD

$\sigma_{g,m} = 1.48 \pm 0.03$

Evolution of $\sigma_{g,m}$ during agglomeration of polydisperse PPs (lines). The normalized quasi-self-preserving size distribution (SPSD) in the transition regime is compared to soot aggregates measured in diffusion flames (symbols).

$$n_p = k_n \left(\frac{r_g}{r_p}\right)^{D_f}$$

$D_f = 1.91 \pm 0.03$ [3]

$$n_p = k_{fm} \left(\frac{r_m}{r_p}\right)^{D_{fm}}$$

$D_{fm} = 2.15 \pm 0.10$

Evolution of D_f and D_{fm} during agglomeration of polydisperse PPs with $\sigma_{g,PP} = 1 - 3$.

References

[1] Goudeli E, Eggersdorfer ML, Pratsinis SE. (2015) *Langmuir* **31**, 1320
[2] Goudeli E, Eggersdorfer ML, Pratsinis SE. (2016) *Langmuir* **32**, 9276
[3] Ball RC, Jullien R. (1984) *J. Phys. Lett.* **45**, L1031
[4] Rissler J, Messing ME, Malik AI, Nilsson PT, Nordin EZ, Bohgard M, Sanati M, Pagels JH. (2013) *Aerosol Sci. Technol.* **47** 792

Conclusions

1. The primary particle (PP) polydispersity ($\sigma_{g,PP}$) delays the attainment of asymptotic D_f, D_{fm} and quasi-SPSD.
2. Agglomerate dynamics are not affected by $\sigma_{g,PP}$ once agglomerates reach their asymptotic D_f.
3. The normalized quasi-SPSD of agglomerates in the transition regime is independent of $\sigma_{g,PP}$ and in excellent with measurements of soot in diffusion flames.