Influence of soot aggregate structure on particle sizing using laser-induced incandescence

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Soot aggregates formed in combustion processes can be described as random fractal structures. For theoretical studies of the physical properties of such aggregates, they have often been modelled as spherical primary particles in point contact. However, transmission electron microscopy (TEM) images show that the primary particles in general are more connected than in a single point; there is a certain amount of bridging between the primary particles. The results of particle sizing using laser-induced incandescence (LII) is crucially dependent on the heat conduction rate from the aggregate, which, in turn, depends on the amount of bridging.

In this work, aggregates with bridging are modelled using overlapping spheres, see Fig. 1, and it is shown how such aggregates can be built with specific fractal parameters. Aggregates with and without bridging are constructed, and it is investigated how the bridging influences the heat conduction rate in the free-molecular regime. It is shown that bridging has a significant influence on the shielding parameters that are inferred from the heat conduction results, Fig. 2. These results are used together with an LII model to show how LII particle sizing is affected by the difference in bridging.

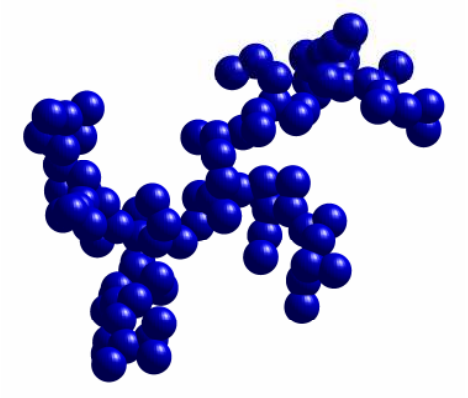

Figure 1. Example aggregate with 100 primary particles and 25 % bridging (k_f = 2.3 and D_f = 1.8).

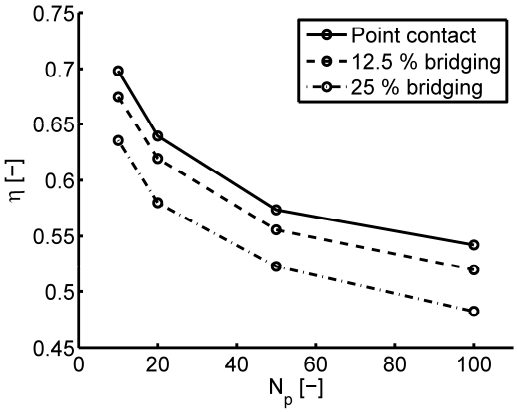

Figure 2. Example of shielding values, η, for aggregates with point contact and with bridging. N_p denotes the number of primary particles per aggregate and the heat accommodation coefficient is here set to α_T = 1.0.