Probing nascent particles in flames: sensitivity of experimental techniques and influence of probe artifacts

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The formation of soot in combustion is a complex process involving gas-phase chemical kinetics, heterogeneous reactions on the particle surface and particle dynamics. Modeling of these processes in combustion environments has received great attention in recent years and models, today, simulate the concentration, size distributions of particles and, in some cases, particle morphology and internal structure.

Models have been developed based on experimental evidences mainly obtained by interfering with the flame aerosol by laser sources or by withdrawing particles from the combustion system and characterizing them with advanced chemical and physical diagnostics which interfere with the probed material.

Sampling induces perturbations and modifies the probed material. This may be particular serious when nascent particles are under investigation but often sensitivity of the experimental techniques and influence of probe artifacts are not taken into account when model results are compared with experimental data.

In this study, the effect of laser irradiation, of temperature perturbation induced by the sampling probe and of the chemical and physical manipulation of the probed material is analyzed. Our results demonstrate that chemical functionality of soot surfaces, particle size distributions, particle concentrations and morphology, and particle internal structure are highly dependent on the modality of particle detection and possibly sampling conditions.