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On the formation and early evolution of soot in turbulent nonpremixed flames F. BISETTI, King Abdullah University of Science and Technology, G. BLANQUART, California Institute of Technology, M.E. MUELLER, Stanford University, H. PITSCH, RTWH Aachen — A direct numerical simulation of soot formation in a turbulent nonpremixed flame has been performed to investigate unsteady hydrodynamic strain effects on soot growth processes and transport immediately following nucleation. For the first time in a DNS, polycyclic aromatic hydrocarbon (PAH) species are included in the chemical kinetics mechanism to describe soot inception. A novel statistical representation of soot aggregates based on the Hybrid Method of Moments (HMOM) is employed. In agreement with previous experimental studies in laminar flames, Damköhler number effects are significant, and soot nucleation and growth are locally inhibited by high scalar dissipation rate. Upon formation on the rich side of the flame, soot is displaced relative to curved mixture fraction iso-surfaces due to differential diffusion effects. Soot traveling towards the flame is oxidized, and aggregates displaced away from the flame grow by condensation of PAH species on the surface of soot aggregates. In contrast to previous DNS studies employing simplified models, we find that soot-flame interaction plays a limited role in soot growth. Nucleation and condensation processes occurring in the fuel stream are responsible for the greatest generation of soot mass.

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