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***In situ* X-ray Scattering: An Ideal Tool to Observe the Fundamental Chemistry and Physics of the Nucleation and Growth of Carbonaceous Particles.** J.P. Hessler, R.S. Tranter, S. Vajda, N. Van Wermeskerken, Chemistry Div., Argonne National Laboratory, Argonne, IL 60439 USA.

Third-generation x-ray sources allow us to perform *in situ* small-angle x-ray scattering on nucleating carbonaceous systems. The particle size distribution functions, which are common to both theory and experiment, of incipient carbonaceous particles (1-2 nm), primary particles ($6 < D(nm) < 15$), and their aggregates were measured in a laminar premixed flame of 15.7% ethylene, 19.2% oxygen, and 65.1% argon with small-angle x-ray scattering (SAXS). The scattering apparatus was calibrated with C_4F_8. Two distribution functions, the Schultz for incipient particles and the log-normal for primary particles were extracted at ten different distances from the flame front. Particle agglomeration, which was observed at all but the lowest distance, was modeled with Beaucage's unified equation. In the region of mature particles the mean diameter of the primary carbonaceous particles agrees with Transmission Electron Microscopic and Scanning Mobility Particle Sizer (SMPS) measurements. In addition, an alternate distribution function, which more closely reflects the chemistry of particle formation, and its use with the maximum-entropy method for extracting distribution functions directly from SAXS profiles will be presented.

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