287k Particle Dynamics in Flame Synthesis of Materials

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Particle formation by flame spray pyrolysis is investigated theoretically and compared with particle size distribution data of ZrO_2 production at 100 to 300 g/h. Spray droplet size distributions as well as droplet and gas velocities are measured by Phase Doppler Anemometry (PDA) along the axis and radius of the solid cone type spray. Air entrainment and the radial spread of the expanding jet are determined from the gas velocities in horizontal planes across the spray cone at different heights above the nozzle. The isotropy of the turbulence is investigated using measured axial and radial velocity fluctuations. The turbulent flow is characterized by the integral time and Kolmogorov scales as well as the average shear rates acting on droplets and particles. Multi-component droplet combustion is simulated accounting for droplet polydispersity, transport and evaporation. The dynamics of the product particle size distributions are investigated accounting for coagulation and sintering by population balance equations. The effect of initial droplet size and liquid feed rate on the evolution of product particle size and polydispersity is analyzed.