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Particle dynamics simulation of nanoparticle formation in a flame reactor using a polydispersed submicron-sized solid precursor

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Abstract

Formation of nanoparticles from polydispersed, non-spherical submicron-sized particles via a gas-phase route in a flame reactor was investigated using tungsten oxide particles as a model material. Nanoparticles were formed by the evaporation of non-spherical powder, followed by nucleation, coagulation and surface condensation. The effects of both the flame temperature profile and the carrier gas flow rate on particles formation were studied numerically, and the results were validated by experimental data. The simulation was initiated by the use of computational fluid dynamics (CFD) to obtain the temperature distribution in the flame reactor. Then, evaporation of the feed material was modeled, taking into account both the polydispersity and the shape of the non-spherical particles. A nodal method was selected to solve the general dynamics equation (GDE), which included nucleation, coagulation, and surface condensation terms, for the prediction of particle dynamics. Results of the simulation were consistent with the experimental data, indicating that the selected model adequately predicts the final particle size distribution.

Keywords

Tungsten oxide; Evaporation; A gas-phase route; Non-spherical particles

Figures and tables from this article: