Theoretical and experimental analysis of droplet-to-particle formation during aerosol processing of colloidal TiO_2 nanoparticles

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Theoretical and experimental investigation of the particle formation during processing of colloidal nanoparticles in aerosol laminar flow reactor is presented. Simple analytical model taking into consideration all important process parameters, such as physico-chemical properties of the colloidal solution, initial droplet size, residence time and temperature, is developed in order to predict the final particle morphology. The formation of spherical, hierarchically organized, ~450 nm sized TiO_2 particles has been followed at 150^0C starting from colloidal TiO_2 nanoparticle (~4.5 nm) solution as precursor. It has been shown that the final particle morphology is formed in the evaporation/drying stage through the self assembly processes of colloidal nanoparticles collision and aggregation. The dimensionless numbers Re, Nu, Pr and Bi, were used in modeling to briefly describe the transport properties in dispersed system and heat and mass transport phenomena. The predicted particle size and morphology is confirmed by using scanning electron microscopy (SEM/FESEM) and laser diffraction particle size analyzer (LPS). Additionally, closer morphological investigation is performed with transmission electron microscopy (TEM) and nanotomography. Correspondingly, theoretical analysis under this study presents a simple procedure to predict the final morphology and mean particle size during aerosol processing.

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