NANOPARTICLE AEROSOL TECHNOLOGY: An Enabling Discipline

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Nanoparticle aerosols are gaseous suspensions of particles smaller than about 100nm. Nanoparticle aerosol technology consists of (1) a tested set of integro-differential equations that describe the dynamics of nanoparticle aerosols, (2) sophisticated measurement systems that include instruments capable of on-line measurements of particle size distributions and the chemical composition of single particles and (3) computer simulation methods for solving the fundamental equations and predicting size distributions and chemical compositions.

Nanoparticle aerosol technology is an enabling discipline with many applications including the industrial synthesis of nanoparticles used in nanocomposite materials (elastomers) and as catalysts, the fabrication of optical fibers, the characterization and control of diesel emissions, the analysis of the effects of atmospheric aerosols on global climate, the characterization of emissions from fossil fuel fired power plants and from incinerators and, finally, particle formation when meteors enter Earth's atmosphere. This new discipline can be expected to play a major role in assessing the consequences of important sectors of the field of nanotechnology itself!

We will discuss highlights in the development of nanoparticle aerosol technology, beginning with nucleation theory (C.T.R. Wilson at the end of the 19th century), Smoluchowski's theory of coagulation and Whytlaw-Gray's demonstration of its applicability to fine particles in gases. Langmuir's theory of aerosol filtration by diffusion, developed during World War II, led to more efficient gas mask filters and serves as a basis for modern clean room design.

The discovery in the 1960's of asymptotic aerosol particle size distributions resulting from coagulation, and their experimental verification, helped establish aerosol reaction engineering as the key design methodology for nanoparticle synthesis in several important industry sectors. Our overview concludes with a discussion of modern developments that include nanoparticle aggregate dynamics, the collision-coalescence process that determines primary particle size and the molecular dynamics of nanoparticle interactions.

For further information, see the report of the Workshop (June 27-28, 2003) on *"Emerging Issues in Nanoparticle Aerosol Science and Technology"* sponsored by NSF and EPA:
http://www.chemeng.ucla.edu/SFriedlander/index.html