Module 11: Nano-Particle Characterization

- What are the basic steps involved in vapor-phase synthesis of nano-particles? Write the general dynamic equation for aerosol formation and transport in a gas-phase reactor.
- What are some possible mechanisms contributing to enhanced thermal conductivity in nano-fluid suspensions? Show the "hyperbolic thermal wave" effect on Fourier's law of thermal conductivity.
- Describe a typical "top-down" method for fabrication of nano-particles. How would you make this process compatible with blending and processing downstream?
- Name two instruments commonly used in characterization of nano-particles, and state their principles of operation.
- You are asked to develop and implement a process to synthesize silica (SiO_2) particles in the 20-70 nm size range.
    - Outline one bottom-up and one top-down method suitable for this application.
    - You are asked to model the synthesis processes to enable prediction of mean size and variance of the particle population. Describe how you would do so in each case.

- You are required to measure particle size distribution. Define one technique that you could use for single particles, and one for agglomerates.
- Define two ratio-based methods to quantify the shape of the particle. What are such techniques limited by in the nanosize-range?
- You are asked to characterize the crystal structure of single particles, and the composite structure of the product powder. Outline the analytical techniques you would use in each case.
- Name some surface characteristics of nano-particles that are distinctly different from larger particles. What is the underlying cause for the difference?
- You are asked to use an AFM to characterize the 3D morphology of the particle. What are the different modes of operation? Illustrate using the 6-12 potential curve.
- You are asked to assess the chemical purity of the silica powder. How would you proceed?