LASER TRANSMISSION SPECTROSCOPY: A DISCUSSION OF TECHNIQUE AND STUDIES OF BIOLOGICAL SYSTEMS

Abstract

by

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This thesis describes a new method for characterizing nanoparticles in suspension using laser transmission spectroscopy (LTS). This system combines a widely tunable laser with specialized optical and detection schemes in an apparatus that can measure light transmission as a function of wavelength with unprecedented precision and sensitivity. The measured transmittance as a function of wavelength is inverted using the Mie model for the extinction cross-section to obtain particle size and density distribution. The precision of LTS's measurements allows not only the determination of the particle size distribution, but also the absolute number of particles with diameters in the range of 5 nm to 3000 nm. Our method works well for nanoparticle densities ranging from ~10^3 particles/mL to ~10^{10} particles/mL. The usage of transmittance as a function of wavelength means both the information collected and signal to noise ratio is high, thus LTS can provide information not available with other nanoparticle sizing techniques. Furthermore, LTS has the capability to determine the geometry of particles, which is not available with any other current particle sizing technique.

This thesis shows the successful application of LTS to the studies of: (1) liposome aggregation and fusion, where we determined the geometry of the fused liposome particles as well as verify the behavior of liposome vesicles when exposed to different stimulus, (2) DNA (origami) protein folding, where folding of DNA origami rectangles into cylinders was observed, and (3) the time evolution of the geometry and growth rate of E. coli bacteria.