



Standard Guide for Measurement of Particle Size Distribution of Nanomaterials in Suspension by Photon Correlation Spectroscopy (PCS)¹

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1. Scope

1.1 This guide deals with the measurement of particle size distribution of suspended particles, which are solely or predominantly sub-100 nm, using the photon correlation (PCS) technique. It does not provide a complete measurement methodology for any specific nanomaterial, but provides a general overview and guide as to the methodology that should be followed for good practice, along with potential pitfalls.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E1617 Practice for Reporting Particle Size Characterization Data

F1877 Practice for Characterization of Particles

2.2 ISO Standards:

ISO 13320-1 Particle Size Analysis—Laser Diffraction Methods—Part 1: General Principles³

ISO 14488 Particulate Materials—Sampling and Sample Splitting for the Determination of Particulate Properties³

ISO 13321 Particle Size Analysis—Photon Correlation Spectroscopy³

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 Some of the definitions in 3.1 will differ slightly from those used within other (non-particle sizing) standards (for example, repeatability, reproducibility). For the purposes of this Guide only, we utilize the stated definitions, as they enable the isolation of possible errors or differences in the measurement to be assigned to instrumental, dispersion or sampling variation.

3.1.2 *correlation coefficient, n* —measure of the correlation (or similarity/comparison) between 2 signals or a signal and itself at another point in time.

3.1.2.1 *Discussion*—If there is perfect correlation (the signals are identical), then this takes the value 1.00; with no correlation then the value is zero.

3.1.3 *correlogram or correlation function, n* —graphical representation of the correlation coefficient over time.

3.1.3.1 *Discussion*—This is typically an exponential decay.

3.1.4 *cumulants analysis, n* —mathematical fitting of the correlation function as a polynomial expansion that produces some estimate of the width of the particle size distribution.

3.1.5 *diffusion coefficient (self or collective), n* —a measure of the Brownian motion movement of a particle(s) in a medium.

3.1.5.1 *Discussion*—After measurement, the value is be inputted into in the Stokes-Einstein equation (Eq 1, see 7.2.1.2(4)). Diffusion coefficient units in photon correlation spectroscopy (PCS) measurements are typically $\mu\text{m}^2/\text{s}$.

3.1.6 *Mie region, n* —in this region (typically where the size of the particle is greater than half the wavelength of incident light), the light scattering behavior is complex and can only be interpreted with a more rigorous and exact (and all-encompassing) theory.

3.1.6.1 *Discussion*—This more exact theory can be used instead of the Rayleigh and Rayleigh-Gans-Debye approximations described in 3.1.8 and 3.1.9. The differences between the approximations and exact theory are typically small in the size range considered by this standard. Mie theory is needed in order to convert an intensity distribution to one based on volume or mass.