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**Nanotechnologies - Measurements of particle size and shape
distributions by transmission electron microscopy**

纳米技术 透射电子显微术测量纳米颗粒粒度及形状分布

(English Translation)

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Foreword

This document is in accordance with the provisions of GB/T 1.1-2020 "Guidelines for standardization work Part 1: Structure and drafting rules for standardization documents" Drafting.

This document is equivalent to ISO 21363:2020 "Nanotechnology - Measurement of nanoparticle size and shape distribution by transmission electron microscopy".

The following minimal editorial changes were made to this document.

---Added a note after Table 1;

---5.5 added notes;

--- The informative reference GB/T 21636-2021 replaces ISO 22309:2011;

- Change "Classification (see 9.1)" in 7.7 to "Classification (see 9.2)" to make the clause number and content correspond;
- Change "method (see 9.2)" in 9.2 to "method (see 9.4)" to make the clause number and content correspond;
- When there is no parallel item in the note, change Note 1 to Note.

Introduction

Typically, nanoparticle measurements include, but are not limited to, particle size, shape, surface structure (or texture), and surface chemistry.

This paper focuses on discrete, agglomerated and aggregated nano-objects (objects that have at least one dimension).

Transmission electron microscopy is a technique used to measure the morphological properties of particles. particle size and shape distribution.

A standard measurement tool at the nanoscale that provides a two-dimensional projection image of particles. Measure and evaluate particle size and shape distribution at the nanoscale General examples of sample preparation, instrument commissioning, image acquisition, particle analysis, data analysis, and reporting are presented in this document.

This paper reports on three discrete particle test samples.

The products are. spheres (gold nanospheres), bimodal mixtures of particle sizes (silica sol), and mixtures of particle shapes (gold nanorods and gold nanocubes).

The document reports two types of aggregates tested. amorphous alveolar aggregates (carbon black) and primary microcrystalline aggregates (titanium dioxide).

Methods for measuring low aspect ratio samples and nanoparticles with specific crystal orientations are given. Some of the case studies in this document are presented by New Materials and Interlaboratory Comparisons (ILCs) are provided under the guidance of the Versailles Association for Standardization (VAMAS) [47].

This document considers three types of particle size and shape parameters. Particle size parameters include those determined by linear or area measurements. Shape Parameters include extension parameters, such as the ratio of two length parameters, and roughness parameters, which represent surface irregularities.

The measurement approach in this document emphasizes that users should conduct both qualitative and quantitative analysis of data quality. Qualitative comparison of data sets involves determining the quality of individual parameters.

Quantitative comparison of data sets is based on the similarity or difference between the reference model parameters of the fitted parametric distribution.

The definition of a parametric distribution requires at least two parameters (mean and spread) and their uncertainties.

In some cases, two quantitative parameters and their uncertainties may not be sufficient to characterize the size and shape distribution. Data visualization techniques such as residuals and quantile plots can be used to Data correlation techniques such as paired size and shape parameters or fractal analysis can provide additional methods to evaluate and differentiate test samples.

In short, qualitative and quantitative quality measures coupled with visualization and correlation tools allow users to develop plan.

Nanotechnology Transmission electron microscopy measures nanometers Particle size and shape distribution

1 Scope

This document specifies the acquisition, measurement and analysis of transmission electron microscope (TEM) images to obtain nanoparticle size and shape.

Distribution method.

This document is applicable to nano-objects and particles larger than 100 nm. The specific scope of application depends on the required uncertainty and transmission.

Electron microscope performance.

2 Normative references

The contents of the following documents constitute the essential clauses of this document through normative references in this document.

For referenced documents without a date, only the version corresponding to that date applies to this document; for referenced documents without a date, the latest version (including all amendments) applies to this document.

ISO 9276-3 Representation of particle size analysis results Part 3: Adjustment of experimental curves to a reference model
ISO 9276-6 Expression of results of particle size analysis Part 6: Qualitative and quantitative expression of particle shape and morphology
Note. GB/T 15445.6-2014 Expression of particle size analysis results Part 6: Qualitative and quantitative expression of particle shape and morphology (ISO/T S9276-6.

2008, IDT)

ISO 29301 Method for calibration of image magnification using periodic structure reference materials in microbeam analysis transmission electron microscopy (Mi-Note. GB/T 34002-2017 Method for calibrating image magnification using periodic structure reference