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Cleanrooms and associated controlled environments —

Part 12: Specifications for monitoring air cleanliness by nanoscale particle concentration

Salles propres et environnements maîtrisés apparentés —

Partie 12: Spécification de la propreté de l'air en fonction de la concentration des nanoparticules

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Foreword

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This document was prepared by Technical Committee ISO/TC 209, *Cleanrooms and associated controlled environments*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 14644 series can be found on the ISO website.

Introduction

Cleanrooms and associated controlled environments provide the control of contamination to levels appropriate for accomplishing contamination-sensitive activities. Products and processes that benefit from the control of contamination include those in such industries as aerospace, microelectronics, pharmaceuticals, medical devices, healthcare and food.

The normative requirements in the first editions of ISO 14644-1 and ISO 14644-3 were limited to classification of particles greater than 100 nm. However, informative material was included in both documents for airborne particles smaller than 100 nm. At the time these documents were written; particles smaller than 100 nm were called ultrafine particles rather than the more recent term, nanoparticles.

In the second editions of ISO 14644-1 and ISO 14644-3[1)], sections on ultrafine particles have been removed and these are incorporated, in modified form, in this document. Supporting information has also been drawn from documents developed elsewhere, for example by ISO/TC 229, *Nanotechnologies*.

Nanotechnology typically deals with material in the size range of approximately 1 nm to 100 nm. As part of the long-term trend of manufacturing products with ever smaller feature size to improve performance, many industries utilizing cleanrooms (such as microelectronics and those related to health) now have products in the nanoscale.

Nanoparticles are man-made. Other particles in the nanoscale size range can originate as incidental by-product emissions from industrial process or additionally as naturally occurring particles. A cleanroom with a nanotechnology-based process can contain nanoscale particles from all three sources.

Nanoparticles or ultrafine particles differ from sub-micron and macro-particles in origin, chemical properties and transport behaviour. Most sub-micron and macro particles in cleanrooms can be related to human activity. Nanoparticles are generated by electrostatic discharge, chemical reactions, such as oxidation, and gas phase nucleation. Material properties of nanoparticles are expected to differ from bulk properties with potentially greater reactivity and sometimes enhanced toxicity. Transport of nanoparticles is dominated by air flow, just like sub-micron particles. However, diffusion of nanoparticles and mobility in electrical fields increases rapidly with decreasing size. As a consequence, nanoparticles have higher coagulation rates in the air and deposition rates on surfaces are higher than larger sized particles. Therefore, it is not expected that the classification curves as described in ISO 14644-1 can be simply extrapolated to smaller particles than the stated lower limit.

Ultra Low Particulate Air (ULPA) filters remove nanoparticles with high efficiency, preventing penetration from the atmosphere and recirculated air. Therefore, the majority of the nanoparticles in cleanrooms are process related. For many cleanrooms, the composition of sub-micron and macro particles is comparable. For nanoparticles, each cleanroom has nanoparticles corresponding to the specific process. Therefore, measurement of the nanoparticle concentration is only suitable when the cleanroom is in an “operational” state. In the “as-built” or “at-rest” state, the lack of process related particles leads to data that do not correlate to the realistic conditions.

See Bibliography references [1] to [18] for background information on particle size characteristics/properties.

1) Under preparation. (Stage at the time of publication: ISO/DIS 14644-3.)