Research and Development

Extended Abstract

Nanomedicine 2017: Characterization of nanomaterials in liquid phase using particle tracking analysis method-Haruhisa Kato-National Institute of Advanced Industrial Science and Technology

Abstract

Recently, there has been an unprecedented increase in the number of studies related to nanomaterials technologies and nanomedicine area. Accurate determination of nanomaterial/nanomedicine size is crucial for developing such nanoscale technologies, because size governs many of the physical and chemical properties of these materials. In addition, focused on the regulation, the European Commission has declared that a nanomaterial is a natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50% or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm–100 nm. According to this definition, accurate size determination of nanomaterials in a liquid phase is an important factor for nanomedicine/nanotoxicity fields. In order to characterize size of nanomaterials in liquid phase, diffusion phenomena are used to determine the sizes of particles in the liquid phase by particle tracking analysis (PTA), pulsed field gradient nuclear magnetic resonance (PFG-NMR), and dynamic light scattering (DLS). In PTA, the sizes of particles in a suspension are determined by measuring the diffusion coefficients, and then calculating the sizes of the particles from these diffusion coefficients by the stokes-Einstein relation as well as the PFG-NMR and DLS methods. As the PTA, PFG-NMR and DLS methods are based on the observation of particle diffusion phenomena in the liquid phase, the particle interactions are mediated by the solvent and measured as a configuration-dependent system friction. This effect is expected to increase with higher particle concentrations. An accurate determination of the size of the PS latex particles in aqueous solution was performed after reducing the electrostatic interaction between the particles, varying the concentrations of the nanomaterials and the electrolyte in the aqueous solution. Measurement of zeta potential and evaluation by Derjaguin, Landau, Verwey and Overbeek provided a good indicator for reducing electrostatic interactions between particles in order to determine the exact size of the particles using the diffusion-based characterization method.

As the use and potential use of nanomaterials (NM) in food and food-related products is increasing, the need for well-defined and established methods for characterizing NM properties is necessary for product quality control and regulatory purposes. The potential introduction of NM into foods intentionally as an additional ingredient or accidentally during production or through contact with packaging material is an increasing problem as more and more NM is being tested for use in food-related

products. NM characterization is a complex process that involves the initial stages of identification, extraction, separation, and purification before using techniques to determine physical and chemical properties such as size, shape, chemical composition and surface coating. The full characterization of NM is even more complicated when they are included in a complex matrix, such as food. Thus, the identification and characterization of NM in food matrices is a complex task and requires the use of the most modern devices. This chapter discusses the application of various methods for determining the characteristics of NM in complex matrices, as well as problems and key factors that must be considered in the process of determining characteristics.

It is increasingly recognized that nanomaterials present a series of characterization challenges that have the potential to inhibit or delay the scientific and technological impact of nanoscience and nanotechnology. Incomplete characterization and underreporting of data necessary to reproduce and validate experimental findings1, 2, 3, 4, 5, 6 involving nanomaterials limit scientific understanding, delay the development of new technologies and hinder the reliable treatment of important issues, such as life product and relevant issues for the occupational and public health. Concerns about proper characterization of nanomaterials are not new, and numerous issues have been highlighted by numerous research groups, teams of researchers from multiple organizations, and the scientific press. or use it for biomedical, energy, or other applications, and for regulators who need to understand their impact on human health and the environment. Incomplete reports characterizing many materials are seen by some as a significant failure by the scientific community.Incomplete reports characterizing many materials are seen by some as a significant failure by the scientific community. We have developed an innovative method for determining the average size of nanoparticles under flow conditions, a method of tracking particle flow (FPT). The liquid particle counting method is commonly used to determine numbers based on flow conditions by converting the light scattering intensity of individual particles into a size using the relationship between the size and light scattering intensity of a standard size material. However, the size determined depends a lot on the type of standard size material. On the contrary, the developed FPT method can safely determine the average size of the nanoparticles under flow conditions according to the Stokes-Einstein assumption, observing the Brownian motion of the individual particles; therefore, this method does not require a calibration step using a size standard and can be applied to any type of material.

In order to reliably determine the particle size under flow conditions, we determined the profile of the flow velocity in the sample cell, extracting only the flow velocity from the particle motion. After determining the self-diffusion coefficient of each particle and subtracting the influence of the flow velocity, we successfully obtained a reliable average size. The developed method can promote the use of microchannel reaction / synthesis devices using nanomaterials. Advances in nanomaterials have opened a new era in various fields such as industrial, medical, commercial, and consumer products owing to their unique and novel physical and chemical properties. A wide variety of techniques can be used to analyze and characterize nanoparticles depending on the application of interest. Characteristics refer to the study of material characteristics such as composition, structure and various properties such as physical, chemical, electrical, magnetic etc. This chapter summarizes the techniques commonly used to study the size, shape, surface properties, composition, purity and stability of nanomaterials. , along with their pros and cons. Various characterization techniques such as optical (imaging), electron probe, photon probe, ion particle probe, and thermodynamic techniques are discussed briefly in this article.

Environmental risk assessments of engineered nanoparticles require in-depth characterization of the nanoparticles and their aggregates. In addition, quantitative analytical methods are needed to determine environmental concentrations and allow for both assessment of effects and exposure.

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