Chemical characterization of engineered nanoparticles

Michael R. Winchester · Ralph E. Sturgeon ·
José Manuel Costa-Fernández

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Nanoparticles, particles having all three dimensions on the nanoscale (1–100 nm), are not new. They have been around since the dawn of the universe. However, interest in nanoparticles has increased explosively over the past two decades. This is especially the case for “engineered” nanoparticles, which can be defined as nanoparticles that are prepared to have certain characteristics so that they can be used for specific purposes. Though technically not nanoparticles, nanotubes and nanorods having only two dimensions on the nanoscale are often categorized and discussed together with true nanoparticles.

Engineered nanoparticles are currently being used, or investigated and developed for use, in a wide range of applications spanning an array of technology sectors. Exciting examples can be found in medicine, where nanoparticles show great promise for cancer diagnosis and treatment, as well as for early detection of Alzheimer’s disease. In materials science, adding nanoparticles to plastics can make them lighter, while enhancing strength and durability. Nanoparticles are being utilized to produce self-cleaning windows, paints and coatings that resist abrasions and graffiti, as well as scratch-proof eyeglasses. In the area of

environmental technologies, silver nanoparticles, known to have antimicrobial properties, are being investigated for remediation of chemical pollution. And in the area of water purification, nanoparticles are being studied for their potential to remove water contaminants selectively.

The integration of nanoparticles into consumer products continues to skyrocket. However, the enormous application potential of nanoparticles is accompanied by both real and perceived risks to the environment and public health and safety. Consequently, in addition to the broad studies being conducted to find new uses for nanoparticles, research into the environmental, health, and safety (EHS) aspects of nanoparticles is being undertaken in many laboratories around the globe. At present, little is actually known concerning these EHS aspects and a very large body of knowledge remains to be discovered.

Finding new uses for nanoparticles and understanding their EHS aspects require reliable methods for nanoparticle characterization. Of the types of characterization that are needed, perhaps none is more challenging than chemical characterization. In some senses, chemical characterization of nanoparticles has been performed for many years, though the terminology was different prior to the introduction of the new terms that include the prefix “nano.” For instance, researchers have been publishing papers on chemical analysis of colloidal suspensions and ultrafine particles for decades. However, somewhat different analytical problems have arisen with the advent of nanotechnology. Probably the most important example is the necessity to determine the surface compositions of engineered nanoparticles. A related example is found in the need to determine quantitatively the amount of a specific chemical component attached to the surfaces of nanoparticles relative to the amount of that same component dissolved in the solution phase of a suspension.

This special issue of *Analytical and Bioanalytical Chemistry* is focused on chemical characterization of engi-

M. R. Winchester (✉)
Analytical Chemistry Division,
National Institute of Standards and Technology,
Gaithersburg, MD 20899, USA
e-mail: mwinchester@nist.gov

R. E. Sturgeon
Institute for National Measurement Standards,
National Research Council Canada,
Ottawa, ON K1A 0R6, Canada

J. M. Costa-Fernández
Department of Physical and Analytical Chemistry,
University of Oviedo,
33006 Oviedo, Spain

neered nanoparticles. We, the guest editors, have been privileged to have had the opportunity to assemble a group of excellent authors, all significant contributors to their areas of nanoparticle science, to contribute to this special issue. Herein, the reader will find a trends paper, several critical reviews, and a feature article that examine aspects of nanoparticle chemical metrology in broad context. These are followed by original papers describing cutting-edge research using a variety of analytical methods applied to a range of engineered nanoparticles. Taken as a whole, this special issue should provide a useful snapshot of some of the important advancements being made in this field. We would like to express our deep appreciation to all of the authors who contributed to this special issue, the referees for their thorough and timely reviews, and the journal staff for their guidance and assistance. We now invite the reader to sit back and enjoy the mind-expanding process of reading, learning, and contemplating.

Michael R. Winchester

is a research chemist in the Analytical Chemistry Division of the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland, USA. His current research interests include the development of atomic spectroscopic and chromatographic methods of exceptionally high accuracy and precision and analytical methods for chemical analysis of nanoparticles. He is responsible for approximately 75 NIST Standard Reference

Materials, including the 3100 series of single-element standard solutions and the 3180 series of anion standard solutions.

Ralph Sturgeon

is currently a principal research officer and group leader for Chemical Metrology at the Institute for National Measurement Standards, National Research Council Canada. His interests lie in inorganic analytical chemistry, comprising trace element analysis, vapor generation, instrument development, organometallic speciation, and production of certified reference materials with a focus on atomic and mass-spectrometric detection.

José Manuel Costa-Fernández

is an associate professor of analytical chemistry in the Department of Physical and Analytical Chemistry at the University of Oviedo (Spain), and is Vice-Dean of the Chemistry Faculty. His scientific interests include development of functionalized photoluminescent nanomaterials (e.g., quantum dots) for biolabeling and sensing applications and the use of plasma-based elemental mass spectrometry for direct analysis of solids and chemical speciation studies.