NANOMATERIALS AND NANOTECHNOLOGIES-APPLICATIONS IN DIFFERENT FIELDS OF ACTIVITY

ADINA TĂTAR - *University "Constantin Brâncuşi", Tg-Jiu, ROMANIA*

Abstract: *Nanomaterials are chemicals / materials manufactured and used on a very small scale (up to 10,000 times smaller than the diameter of a human hair). The evolution of knowledge in nanostructured materials and nanotechnology has a huge impact in many areas, such as energy technologies and biomedical applications. These include solar cells, energy storage, environmental control, tissue engineering, bioprobing, biomarking, cancer diagnosis, cancer therapy and drug delivery. Nanotechnology is not only a tool for producing material structures that mimic biological ones, but is also a provider of efficient delivery systems.*

Key words: *Nanomaterials, biomedical, technologies, nanotechnology*

1. INTRODUCTION

Nanomaterials have the potential to improve the quality of life and contribute to industrial competitiveness in Europe. However, new materials can also present risks to the environment and raise a number of health and safety issues.

Although nanomaterials are not dangerous in themselves, there is still scientific uncertainty about the safety of nanomaterials in several respects and therefore the safety assessment of substances must be done on a case-by-case basis.

Different nanomaterials can be developed from the same chemical by manipulating the physical characteristics or surface particles of the nanoscale material. Sometimes these different nanomaterials are called "nanoforms" of the same substance, in analogy with most classical forms of substance for example, gas, liquid, powder.

Nanomaterials are developed to present new characteristics (increased strength, chemical reactivity or conductivity) compared to the same material without nanomatic-scale characteristics.

The increasing use of nanostructured materials requires an understanding of how these new materials influence biointerface interactions including the adsorption (the phenomenon of retention of molecules of a fluid substance (called adsorbate) on the surface of a liquid or solid body (adsorbent)) of proteins and subsequent cellular responses.

Due to its small thickness, this surface (called the surface layer) can be considered homogeneous and has specific properties, different from those of the separate phases.

A lot of nano-scale material properties influence these interactions and the toxicity of the material. Many products containing nanomaterials are already used (batteries, coatings, anti-bacterial clothing, etc.).

Analysts expect markets to grow significantly in the near future.

Nano-innovation will be seen in many sectors, including public health, employment and occupational safety and health, the information society, industry, innovation, the environment, energy, transport, security and space.

2. Characteristics of nanomaterials

Metal nanoparticles are a distinct class of advanced materials, applicable in a wide range of fields, from construction to transportation, communications, information technology or biomedical applications.

The application of nanotechnology to regenerative medicine is a matter of great interest. Regenerative medicine is an emerging multidisciplinary field that aims to restore, maintain or improve tissues and organ functions. Depending on the technology used and the synthesis parameters, several architectures regarding the structural and compositional homogeneity of bimetallic nanoparticles are possible: core-shell architecture (core + outer shell), bilobar architecture (dumbbell) or alloy structure.

Highlighting these nanometer-scale structural varieties requires microstructural and compositional characterization techniques of high spectral sensitivity and spatial resolution.

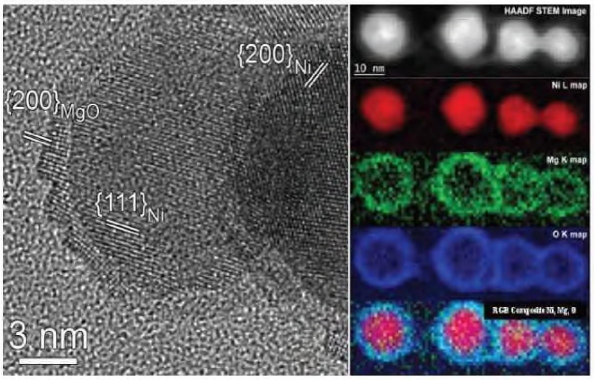

Fig.1.Characterization of core-shell bimetallic nanoparticles based on Mg and Ni by HRTEM (high resolution transmission electron microscopy) and STEM-EELS (scanning transmission electron microscopy (STEM) coupled with electron energy loss spectroscopy (EELS)

The image illustrates the potential of analytical transmission electron microscopy in the investigation of bimetallic nanoparticles using both conventional imaging and microstructural techniques, and especially the possibilities offered by sphericity aberration correction in ultra-high resolution electron microscopes.

An additional aspect of understanding how size defines a nano-object or nanomaterial is the size distribution around a median or average.

A hypothetical particle size distribution highlights that a substance with an average particle size greater than 100 nm may still have a portion of particle volume interpretations, and very few particulate matter below 100 nm are "monodisperse" (ie with a standard geometric deviation of 10% by weight).

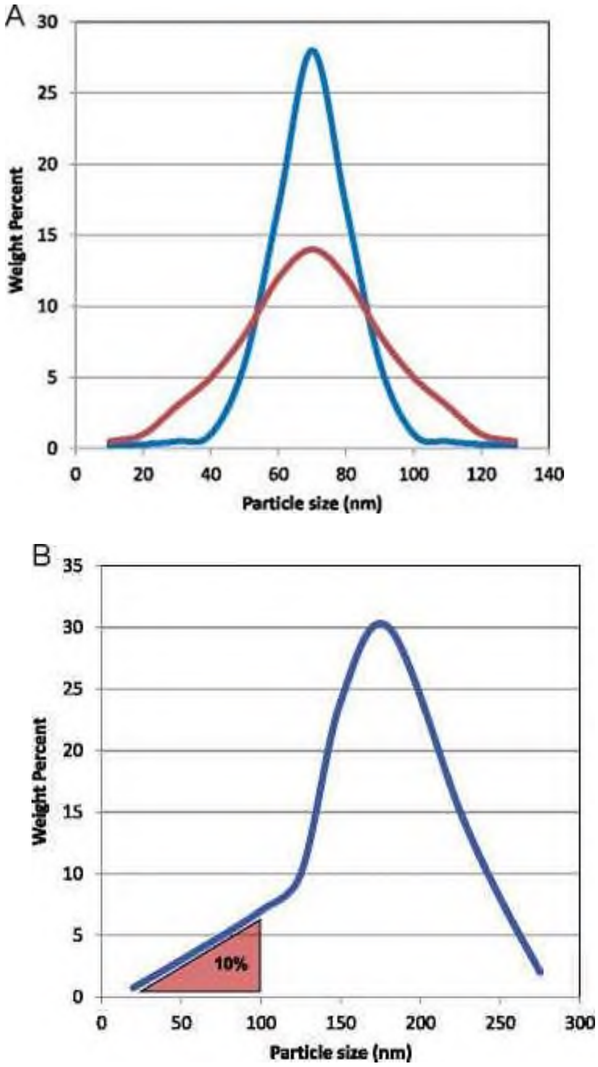

Fig. 2. Particle size distribution. (A) The size distribution of two simple particle populations with the same average particle size but different distributions of the overall size. (B) Particle size distribution with an average size greater than 100 nm;

Laboratory instruments used to measure the mass or volume of particles often use mathematical conversions to obtain information about the number of particles and for these instruments, a 1% error in the ability of a method to accurately describe a mass or volume distribution at the nano- scale could result in an error of more than 50% in a numerical distribution (Linsinger et al., 2012; Brown et al., 2013).

Manufacturing processes can have a significant impact on the shape of particles and how particles can associate with each other. Nanomaterials are produced by either "top-down" or "bottom-up" manufacturing approaches (Luther, 2004).

Most conventional nanomaterial manufacturing processes are "top-down" in which a larger material is ground or ground to smaller particle sizes (graphene, pigments). Depending on the amount of energy applied in the process, the final material can vary in size, from microscale to nanoscale.

Nanomaterials produced by bottom-up processes are synthesized from atomic or molecular species by chemical reactions, allowing the precursor particles to increase in size. Solegel chemistry is an example of this approach in which solid nanoparticles dispersed in a liquid agglomerate (a solution or soil) to form a three-dimensional continuous network that extends throughout the liquid (a gel, Thin films, xerogels) (Young, 2002).

Another type of "top-up" nanomaterial manufacturing involves the burning of chemical raw materials at high temperatures to produce air molecules that immediately collide to form solid nuclei.

During this process, coagulation rates are very fast, the nuclei sintering or coalescing into primary spherical particles (also called "nodules"). In milliseconds, the primary particles combine (sinter) into larger particles, called aggregates.

As the manufacturing process continues, the aggregates collide, resulting in secondary structures, known as agglomerates (Donnet et al., 1993). Industrial aggregates (titanium dioxide, carbon black and some forms of synthetic amorphous silica) are examples of nanostructured materials produced by thermal combustion processes. Aggregates and agglomerates illustrate the production of aggregates and agglomerates manufactured by a bottom-up combustion process at high temperature. The manufacturing processes described above can produce three different forms of particles that can exist on a nanomatic scale: discrete, aggregated and agglomerated primary particles.

The primary particles are considered the smallest discrete entity. They can exist at the nanoscale and are considered to be an indivisible entity. Aggregates may consist of primary constituent particles ranging in size from nanoscale to more than 100 nm and, depending on the size and number of primary particles, the aggregates may vary in size from nanoscale to microscale.

The size and shape of aggregates have a fundamental influence on the properties of nanomaterial (Donnet et al., 1993). Importantly, aggregates are robust structures, essentially indivisible, similar to primary particles, in the sense that they cannot be broken down by external forces commonly encountered during subsequent handling and processing (Gray and Muranko, 2006).

Instead, an "agglomerate" is a collection of weakly bound particles, or aggregates or mixtures of the two, and for which the resulting outer surface is similar to the sum of the surfaces of the individual components (ISO, 2008).

Agglomerates are held together by relatively weak forces, such as van der Waals forces or by simple physical entanglement. Therefore, unlike aggregates, agglomerates can decompose into their constituent entities with sufficient external energy (Donnet, 1993; Gray and Muranko, 2006). The agglomerates themselves may vary in size, but are usually greater than 100 nm.

Nanoparticles have been ubiquitous since the formation of the earth until now and we are constantly surrounded by them. For example, the air we breathe contains tens of thousands of nanoparticles per cubic centimeter (Buzea et al., 2007; Hochella et al. 2008; Slezakova et al. 2013).

Some of these nanoparticles are accidental particles of artificial origin (products from the combustion of coal and petroleum products, abrasion residues and even baking). Others are of natural origin, coming from the atmosphere, volcanic dust, spraying, forest fires.

The volume of natural nanomaterials far exceeds the volume of those produced from artificial sources (Buzea et al., 2007). Some very small particles can cause health problems due to their composition and / or concentration in the air.

A designed nanomaterial is designed for specific purposes / functions. In each case, the intention of the manufacturers is to take advantage of the properties offered by the nanomaterial, size-dependent properties may have little or no relevance for hazard identification (eg melting point, color), while others may be extremely relevant (eg surface activity, solubility).

For example, surface reactivity is frequently mentioned as an important factor contributing to the (eco) toxicity of nanomaterials, and yet there is no consensus on the most appropriate methods for measuring surface reactivity, and available methods may be prone to artifacts and misinterpretations (Horst et al., 2013; Petersen et al., 2014)

3. CONCLUSIONS

Nanotechnologies are currently being used to create new consumer products. There are a large number of "nano-characteristics" that could be included in a consumer product, such as a coating (thin coating and nanometer layers, either applied to the material or formed after use) or a nanomaterial. (for example: nanotubes, nanoparticles).

Nano silver is the most frequently mentioned material in product descriptions, followed by carbon (which includes fullerenes), titanium (including titanium dioxide), silicon dioxide, zinc (including zinc oxide) and gold.

Nanomaterials are currently being introduced in several commercial drugs, and some drugs are now in a clinical stage. Gold nanoparticles are often used in miniaturized immunogenic diagnostic devices (pregnancy tests or NOVAmed putties (such as AdenoStick) that detect the presence of intestinal viruses).

Nano-gold coatings and metal nanoparticles are under investigation for targeted drug therapy, and various implants are now being improved with nanotechnologies.

Silver nanoparticles are mainly used to make textiles that have antibacterial properties, such as dressings and bandages. Silver nanoparticles have a stronger antibacterial activity than conventional silver, being transparent, they are currently used in many composites for different applications.

Some nanomaterials, such as liposome collagens, have been used in cosmetics for decades, and in recent years, new nanomaterials have been used to improve performance or change their color.

At the nano scale, titanium oxide (TiO2) and zinc oxide (ZnO) in some creams, nanomaterials can improve the absorption of the "active" ingredient in the skin, and in raw form (macro) are widely used in many industrial products (toothpaste, sunscreen, paint, etc.).

Improving the performance of some materials is a priority in sports equipment and fitness equipment, such as: bicycles, tennis rackets, swimsuits, tennis balls, shoes, climbing equipment, etc.

Silver nanoparticles are also used in the coating of household appliances, such as refrigerators and washing machines.

The nano coating is also used to improve the performance of some products and ensures a better temperature and higher scratch resistance.

Nanofibers and nano-absorbers are currently used in some water filtration systems, which allow the filtration of water by contaminants, such as: bacteria, arsenic and other heavy metals.

Silver-based nanotechnology is used in many children's products, various household items, to provide antibacterial properties.

There are many examples in the product inventory, such as teddy bears whose fibers are impregnated with silver nanoparticles; bottles made of a silver-plastic composite; toothbrushes and others.

An example is the Nano-San® Antibacterial mattress for changing diapers

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