OPEN ACCESS Freely available online

ISSN: 2090-4568
Journal of Advanced Chemical Engineering

Perspective

Nanotechnology: Introduction and Applications

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DESCRIPTION

The term "nanotechnology" refers to atomic, molecular, and macromolecular size research and technology development that enables the controlled manipulation and study of structures and devices with length scales between one and one hundred nanometers. The features and functions of objects at this scale, such "nanoparticles," are unique and very different from those of objects at a larger scale. For biologists, the nanoparticles tiny size, surface tailorability, increased solubility, and multifunctionality present a wide range of new study opportunities. Innovating at the scale of biomolecules, nanoparticles unique characteristics enable innovative interactions with intricate biological processes.

New science and technology are frequently the result of human dreams and creativity. These aspirations gave rise to the 21st century frontier of nanotechnology.

Understanding and manipulating matter at dimensions between 1 nm and 100 nm, where special phenomena allow for fresh applications, is referred to as nanotechnology. Although there have always been nanoparticles around, the industrial revolution saw a sharp rise in this exposure. Nanoparticle research is not brand-new. Richard Zsigmondy, the 1925 winner of the Nobel Prize in chemistry, was the first to put out the idea of a "nanometer." He was the first to use a microscope to measure the size of particles like gold colloids, and he also invented the term nanometer specifically to describe particle size.

Although the commercial potential of nanotechnology is strong, it will take time and effort to translate fundamental findings into products that can be sold. Throughout the past ten years, nanotechnology has been featured and reviewed a number of times, each time hinting at the possibility of a revolutionary, all-pervasive technology.

One must comprehend the surface chemistry of the particles in order to properly comprehend the strong applications of nanotechnology and nanoparticles in particular. A wide range of chemical, molecular, and biological entities can be covalently or otherwise linked to the nanoparticle through modification of its outer layer. The particle gains beneficial features by manipulation of its corona, including improved solubility and biocompatibility. When employed for *in vivo* applications, hydrophilic polymers like Poly Ethylene Glycol (PEG) can be added to the surface to significantly increase the hydration (i.e., solubility) of the nanoparticles and shield connected proteins from enzyme degradation.

Applications of nanotechnology

Gold nanoshells can function as molecularly tailored contrast agents for optical imaging when they are coated with ligands that are unique to cancer cells. The nanoshells have been designed to target three distinct markers overexpressed on cancer cells: the epidermal growth factor receptor, matrix metalloproteases, and oncoproteins linked to human papillomavirus infection, the main cause of cervical cancer. These markers have been targeted using a variety of ligands, including mAb and aptamers. The inherent low cost of optical imaging compared to more complex imaging modalities like Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) has drawn increasing interest from cancer researchers, especially with the development of affordable, fiber-optic, confocal imaging systems capable of being fed through ducts and capillaries, despite the limitations of optical imaging due to tissue absorption and reflection of light.

Four factors, which should be evaluated differently for nanoparticles than for conventional materials, according to Walker and Bucher. Surface properties have an impact on dosimetry because they change the toxicokinetics of materials of similar size and shape, new routes of exposure arise when a nanomaterial is small enough to enter new cellular portals, new commercial applications may result in unexpected toxicities, new biological interactions and assessment of relative risk using dose expressed in terms of mass may result in false results because some nanomaterials dosimetry.

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Received: 03-Feb-2023, Manuscript No. ACE-23-20635; **Editor assigned:** 06-Feb-2023, Pre QC No. ACE -23-20635 (PQ); **Reviewed:** 21-Feb-2023, QC No. ACE -23-20635; **Revised:** 28-Feb-2023, Manuscript No. ACE-23-20635 (R); **Published:** 07-Mar-2023, DOI: 10. 35248/ 2090-4568.23.13.271.

Citation: Anderson T (2023) Nanotechnology: Introduction and Applications. Adv Chem Eng.13:271.