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Role of nenotechnology in modern life: literature review

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Abstract:

Over the past decade or so, nanotechnology has seamlessly integrated into the fabric of human daily existence. Nanoparticles have found applications across diverse industries, spanning food production, pharmacology, healthcare, and cosmetics, and are integral components of commonly used dietary supplements, hygiene products, and packaging materials. Nanotechnology, with its remarkable capacity to manipulate matter at the atomic scale, represents a paradigm shift in human technological capabilities, poised to usher in unprecedented advancements. In this article, we delve into the myriad applications of nanotechnology in our everyday lives and underscore its significance in shaping the modern

Keywords:

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1. Introduction:

Nanotechnology, emerging in the latter part of the 20th century, is experiencing rapid development, with groundbreaking projects announced almost monthly. What once seemed like science fiction is now becoming reality. Nanotechnology represents a manufacturing approach focused on producing devices and substances with precise atomic structures, operating at the scale of individual atoms. This sets it apart from traditional "volumetric" bulk technologies, which manipulate macroscopic objects.

It's worth noting that "nano" denotes a scale of 10^{-9} , highlighting the minuscule dimensions involved. For example, eight oxygen atoms can span a one-nanometer length. Nanoparticles, such as metal nanoparticles, typically exhibit physical and chemical properties distinct from larger objects made of the same material or individual atoms. For instance, the melting temperature of gold particles measuring 5-10 nm is significantly lower than that of a 1 cm^3 piece of gold.

Research conducted at the nanoscale intersects various scientific disciplines, with advances in materials science influencing fields like biotechnology, solid-state physics, and electronics. Renowned nanomedicine scientist Robert Freitas emphasizes the complexity of future nanomachines, which will comprise billions of atoms. Designing and building these nanorobots will require the collaborative efforts of multiple research teams, akin to the multinational collaboration involved in designing and constructing aircraft like the Boeing 777.

2. What makes nanoparticles truly exceptional and distinct?

Nanoparticles boast an incredibly high surface area to volume ratio, a stark contrast to macroscopic objects where this ratio is significantly lower. This unique characteristic gives rise to novel properties, most notably their remarkable penetrating ability. Nanoparticles can infiltrate cells through the larger pores of cell membranes, employing various mechanisms such as endocytosis. This includes phagocytosis, the process of cell nutrition, and pinocytosis, the uptake of fluid by the cell. Additionally, cell membrane receptors can bind to ligand substances, triggering a conformational transition akin to a "key-lock" mechanism. This facilitates the entry of substances into the intracellular space. Such mechanisms have evolved to supply cells with essential nutrients for development. Consequently, nanoparticles can enter cells in a highly specific manner, traversing organs via the bloodstream, surmounting natural

bodily barriers, and penetrating tissue cells with remarkable precision.

3. What can Nanotechnology do?

Nanotechnology holds the potential to revolutionize both inorganic and organic matter at the atomic level, thereby reshaping societal structures and business paradigms. It has the capacity to introduce novel business models, design tools, and manufacturing strategies that are not only cost-effective but also highly efficient.

If nanotechnology progresses to achieve critical mass, ushering in groundbreaking advancements like automatic self-assembly, virtually every industry will experience significant transformation. Industrial and post-industrial supply chains will undergo profound changes.

Consider the implications if drug development and manufacturing costs were slashed by 70%, or if power generation no longer relied on fossil fuels. Imagine the impact of reducing manufacturing costs for computers by 50%. Furthermore, envision the potential of nanotechnology to decrease the costs of essential goods and services, thereby enhancing quality of life, health, habitat, and transportation.

Such developments would undoubtedly have a dramatic effect on lifestyles, disrupting traditional value chains, support systems, alliances, and distribution networks. Financial services, educational institutions, and production processes would undergo reform.

Picture a future where a nanochip possesses the computing power of ten supercomputers, yet is priced lower than a quartz watch or keychain. Envision the emergence of super-strong, inexpensive materials capable of replacing steel and metal in engineering applications. As the global economy continues its trajectory of technological transformation, a fierce competition will emerge for capabilities, intellectual property, capital, and technological expertise.

As nanotechnology transitions from theory to practical application, its potential influence on society, business, and the economy will become increasingly apparent. This necessitates proactive measures to shape the strategic future of nanotechnology for our nations.

4. Nanotechnology in daily life:

Many of us benefit from advancements in nanotechnology without even realizing it. For instance, contemporary microelectronics has transcended the micro scale and entered the nano

realm: transistors used in today's chips typically measure up to 90 nm, with plans for further miniaturization to 60, 45, and even 30 nm.

Hewlett-Packard has announced plans to replace traditional transistors with nanostructures. One such innovation features three conductors, each several nanometers wide, arranged in parallel with one positioned perpendicular to the others. These conductors, resembling bridges, facilitate the flow of molecular chains from upper to lower layer when a voltage is applied, enabling data storage and logical operations akin to transistors.

This technology promises to shrink microcircuitry components to unprecedented scales, potentially below 10-15 nanometers, rendering traditional semiconductor transistors obsolete. It's conceivable that by the first half of the next decade, serial microcircuits integrating Nano elements will emerge, revolutionizing conventional silicon-based designs.

In 2004, Kodak introduced Ultima inkjet paper, featuring nine layers incorporating ceramic nanoparticles for enhanced thickness and sheen, 10 nm pigment nanoparticles to improve print quality, and polymer nanoparticles to expedite paint fixation.

We are witnessing the dawn of the nano revolution, with new computer chips, stain-resistant fabrics, and the integration of nanoparticles in medical diagnostics and cosmetics. Nanomaterials offer novel possibilities in cosmetics, paving the way for unconventional product formulations.

At the nanoscale, materials exhibit unique properties. For instance, while silver ions possess antiseptic properties, silver nanoparticles demonstrate significantly higher activity. Bandages treated with silver nanoparticle solutions accelerate wound healing and reduce inflammation more effectively than conventional antiseptics.

Innovations by the domestic concern "Nanoindustry" have yielded stable silver nanoparticles with broad-spectrum antimicrobial properties. These nanoparticles find applications in various sectors, from modifying existing materials and creating new coatings to producing disinfectants and detergents. Silver nanoparticle-infused coatings and materials serve as proactive antimicrobial solutions in diverse settings, including transportation, public venues, agriculture, medical facilities, and water purification systems.

Numerous sectors produce similar products, such as coatings featuring silver nanoparticles for treating chronic inflammation and open wounds.

4.1. Carbon nanotubes:

A distinct class of nanomaterials comprises carbon nanotubes, known for their exceptional strength and unique properties. These cylindrical polymer molecules boast a diameter of approximately half a nanometer and can extend up to several micrometers in length. Initially discovered less than a decade ago as by-products of C60 fullerene synthesis, carbon nanotubes are already being employed in the creation of electronic devices at the nanometer scale. Forecasts suggest that they will gradually supplant numerous components in electronic circuits across various devices, including contemporary computers.

However, the utility of nanotubes extends beyond electronics. For instance, tennis rackets reinforced with carbon nanotubes are already available in the market, enhancing rigidity to limit twisting and imparting greater power to each hit. Similarly, carbon nanotubes find application in select components of sports bicycles, contributing to their performance and durability.

5. Conclusion:

The rapid evolution of technology has laid the foundation for unprecedented innovation, driving exponential growth in various sectors. The advances in new technologies have surpassed our ability to accurately predict their impact on society, business, and the economy. Therefore, it is imperative to possess the necessary knowledge to adapt to this rapidly evolving landscape in real-time.

We are currently amidst a paradigm shift, where traditional sciences focused on understanding nature are being supplanted by integrated sciences and technologies aimed at transforming nature to address socioeconomic needs and sustain life on Earth.

Our civilization is experiencing the swiftest and most profound technological transformation in history. Nanotechnology possesses the capabilities required to redefine, reshape, and revolutionize global economies and societies. The manipulation of matter at the atomic level heralds a reevaluation of global markets, economies, and industries on an unprecedented scale. Nanotechnology, with its ubiquitous presence, serves as a fundamental science-technology with applications spanning various sectors including health, materials, electronics, robotics, photonics, and environmental preservation.

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