

Nanoscale Chemicals and Materials Market - Global Industry Size, Share, Trends, Opportunity, and Forecast, Segmented By Grade (Industrial Grade Nanoscale Chemicals, Pharma Grade Nanoscale Chemicals), By Type (Nanoparticles, Nanocomposites, Nanotubes, Nanofilms, Nanofibers, Others), By End User (Healthcare & Pharmaceuticals, Electronics & Semiconductor, Automotive, Aerospace & Defense, Energy, Others), By Region and Competition, 2019-2029F

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Abstracts

Global Nanoscale Chemicals and Materials Market was valued at USD 680.34 Million in 2023 and is anticipated to project steady growth in the forecast period with a CAGR of 7.24% through 2029. Nanoscale materials encompass a diverse group of substances characterized by dimensions smaller than 100 nanometers, exhibiting unique optical, magnetic, or electrical properties. Examples include ultrafine particulate matter found in environmental settings. Manufacturers can customize nanoscale materials by controlling their size, shape, composition, and surface features, enabling tailored functionalities for various applications. Due to their high surface area-to-volume ratio and quantum effects, nanomaterials often display enhanced mechanical strength, catalytic activity, conductivity, and optical characteristics compared to larger-scale equivalents.

In electronics, nanoscale materials are valued for improved conductivity, enhanced thermal properties, and the ability to facilitate miniaturization. They are employed in applications such as nanoscale transistors, memory devices, and conductive coatings.

In healthcare, nanoscale materials are utilized in drug delivery systems, diagnostics, and medical devices for precise targeting, enhanced bioavailability, and improved therapeutic outcomes.

Nanoscale materials significantly enhance energy technologies, improving both storage (batteries, capacitors) and conversion (solar cells, fuel cells). They contribute to increased efficiency, reduced weight, and enhanced durability in these applications. In environmental fields, they play a vital role in water treatment with nanofiltration membranes, air purification using nanoparticle-based filters, and remediation technologies employing nanoparticle catalysts for pollutant degradation. Additionally, nanoscale materials are integral to industries like cosmetics, textiles, coatings for self-cleaning surfaces, and electronics, such as scratch-resistant screens.

Despite their promising potential, nanoscale materials present challenges related to safety, environmental impact, and regulatory considerations. As research advances and applications expand, nanoscale materials are anticipated to play an increasingly pivotal role in shaping technology, healthcare, and sustainability in the future.

Key Market Drivers

Growing Demand for Electric Vehicles

The automotive industry's expansion as a catalyst for the adoption of nanoscale chemicals and materials underscores its dedication to innovation, efficiency, and sustainability. Automakers are increasingly prioritizing the reduction of vehicle weight to enhance fuel efficiency and lower emissions. Nanomaterials like carbon nanotubes, graphene, and nanostructured metals offer superior strength-to-weight ratios, enabling the creation of lightweight components without compromising safety or performance. For example, BMW's i3 electric vehicle extensively incorporates CFRP body panels reinforced with nanoscale materials, significantly reducing overall vehicle weight.

Advanced materials also optimize engine performance by reducing frictional losses through nanomaterial-based lubricants and coatings, thereby enhancing fuel efficiency and prolonging service life. Integration of nanoscale materials in automotive electronics and sensors facilitates the development of smart systems for autonomous driving, driver assistance, and connectivity, enhancing sensor miniaturization, sensitivity, and responsiveness.

Global emissions regulations are driving the adoption of nanotechnology in automotive

catalysis, where nanoscale catalysts improve the efficiency of exhaust gas treatment systems, reducing emissions of pollutants such as nitrogen oxides (NO_x) and particulate matter.

Furthermore, advancements in battery technology leverage nanomaterials like silicon nanoparticles in anodes or nanostructured cathode materials to enhance energy density, charge-discharge rates, and cycle life. Improved battery performance extends the driving range and accelerates charging times, bolstering the broader adoption of electric vehicles (EVs). For instance, Mercedes-Benz plans to adopt silicon anode batteries in its EQG model from 2024, increasing the recharge range by 20%.

According to IBEF, the global EV market was valued at approximately US\$ 250 billion in 2021 and is projected to grow fivefold to US\$ 1,318 billion by 2028. In April 2024 alone, global production figures for passenger vehicles, three-wheelers, two-wheelers, and quadricycles totaled 2,358,041 units.

As the automotive industry continues to innovate, nanotechnology plays a pivotal role in shaping the future of mobility towards more sustainable and technologically advanced vehicles.

Growth of Electronics Sector

The expansion of the consumer electronics sector is a significant driver behind the growing demand for nanoscale chemicals and materials. This growth stimulates innovation, enhances device capabilities, and aligns with the evolving preferences of tech-savvy consumers worldwide. Manufacturers continuously strive to miniaturize devices, reduce weight, and increase power, objectives facilitated by nanoscale materials that enable the development of smaller components with superior performance characteristics such as enhanced conductivity, improved thermal management, and greater durability.

An example of this can be observed in the adoption of nanoscale materials like quantum dots in display technologies such as QLED and OLED. This technological progression drives their integration across a broad spectrum of consumer electronic devices, meeting consumers' expectations for vivid and energy-efficient screens.

In 2023, Canon introduced the FPA-1200NZ2C Nano-imprint Lithography (NIL) semiconductor equipment, showcasing how nanotechnology revolutionizes semiconductor manufacturing. This equipment enables the creation of intricate 2D or 3D

circuit patterns with a single imprint, potentially paving the way to produce 2nm chips and beyond.

The increasing popularity of wearable devices such as smartwatches and fitness trackers underscore the necessity for flexible, lightweight, and durable materials. Nanomaterials are essential in developing components such as sensors, conductive textiles, and flexible electronics that are integral to the functionality and comfort of wearable technology.

As Internet of Things (IoT) devices proliferate, there is a rising demand for compact yet powerful sensors, actuators, and communication modules. Nanoscale materials facilitate the integration of IoT functionalities into everyday objects, driving the expansion of interconnected devices and augmenting their capabilities. An industry example illustrating this trend is the collaboration between Arduino and Espressif in 2023 to launch the Nano ESP32 Dev Board. Across displays, semiconductor manufacturing, wearable technology, and IoT devices, nanoscale materials play a critical role in advancing technological innovation and meeting the evolving expectations of consumers for more efficient and capable electronic devices.

Key Market Challenges

Cost of Production and Scaling

The nanoscale chemicals and materials market face significant challenges related to production costs and scaling. Manufacturing nanoscale materials often demands specialized equipment and processes, which are expensive to procure and maintain. The initial investment and ongoing operational expenses can be particularly burdensome for smaller companies and startups.

The complexity of synthesis and purification processes further drives up operational costs, making large-scale production of items like quantum dots economically challenging. Achieving economies of scale poses additional hurdles due to the need for precise control over particle size, shape, and purity requirements that are more difficult to consistently meet at higher production volumes. This necessitates advanced process engineering and optimization to ensure uniformity and quality across batches.

Scaling up production of materials such as carbon nanotubes presents specific challenges, as maintaining consistent parameters like diameter, length, and purity becomes increasingly complex at larger volumes. Process optimization and advanced

manufacturing techniques are crucial to achieving economies of scale while preserving material performance.

Despite the exceptional properties of graphene, its production remains costly. Techniques like chemical vapor deposition (CVD) or exfoliation from graphite involve expensive equipment and require meticulous control over deposition conditions. These factors contribute to the high production costs associated with graphene. Managing uncertainties in raw material prices, regulatory requirements, and fluctuations in demand adds further complexity to cost management and necessitates robust risk mitigation strategies.

Regulatory Concerns

Nanomaterials can exhibit distinct properties from their larger-scale counterparts, potentially posing risks to human health and the environment. Regulatory bodies are focused on understanding and addressing these risks through appropriate testing and regulation. However, uncertainties persist regarding the physicochemical properties, environmental behavior, and toxicological effects of nanomaterials. Testing often occurs early in the product development stage, and the final product can behave differently. Nanomaterials possess unique characteristics that necessitate novel approaches to risk assessment. Regulatory agencies encounter challenges in evaluating these risks due to limited data on long-term effects. In the European Union (EU), an increasingly significant strategy for nano safety is the concept of safe-by-design, ensuring the safety of nanomaterial-based products throughout their lifecycle, from production to disposal or recycling. This concept, originally developed within the EU NANoREG flagship project, aligns with established principles of safe-by-design in industrial innovation.

Several Canadian departments and agencies, such as Health Canada, Environment and Climate Change Canada, Agriculture and Agri-Food Canada, and the Canadian Food Inspection Agency, conduct risk assessments of nano plastics. Their regulatory focus includes mitigating risks, compiling an inventory of nanomaterial-containing products on the market, and assessing the biological impacts of specific nanomaterials. Regulatory frameworks for nanomaterials vary significantly across countries and regions globally. The lack of international harmonization presents barriers to market entry and increases compliance costs for businesses operating internationally. The rapid evolution of nanotechnologies often surpasses existing regulatory frameworks, causing uncertainty for manufacturers and investors. This uncertainty, exacerbated by ambiguous guidelines, can impede innovation and hinder market growth.

Key Market Trends

Growing Use in Environmental Remediation

The adoption of nanoscale chemicals and materials in environmental remediation reflects a global shift towards more effective, sustainable, and technologically advanced methods to combat environmental pollution and preserve natural resources.

Nanomaterials are versatile, being applied across diverse environmental contexts such as soil, groundwater, sediments, and wastewater, offering flexible solutions to various contamination challenges. This trend is fueled by increasingly stringent regulatory standards worldwide, pushing industries towards innovative technologies like nanotechnology to achieve cleaner and safer remediation practices.

For instance, ASUS introduced the VU series monitors in 2024, featuring integrated nano-ion air purification technology. This advancement not only improves air quality by removing particles and inhibiting pathogens like viruses and bacteria but also incorporates sustainable elements such as halogen-free PCB boards and casings made from 85% recycled plastic. These monitors exemplify how nanotechnology is being leveraged to enhance everyday products with environmental benefits.

Amida Cleantech, based in New Delhi, has developed a pioneering filter less air purification system. This technology, nearing US patent approval in 2023, targets large-scale outdoor, semi-outdoor, and indoor environments. It underscores the importance of nanotechnology in creating scalable solutions for air quality improvement, as evidenced by its global patent filings and publication in scientific journals like the Journal of Sol-Gel Science and Technology.

In another breakthrough, scientists at the Materials Research Centre (MRC) of the Indian Institute of Science (IISc) have engineered a novel enzyme mimetic capable of degrading toxic chemicals in industrial wastewater when exposed to sunlight. This innovation showcases nanotechnology's role in developing advanced materials that enhance environmental sustainability through efficient pollutant removal.

Iran's creation of the world's largest ozone reactor for drinking water treatment in 2024 illustrates the application of nanotechnology on a large scale. This reactor generates ozone nanobubbles, demonstrating how nanomaterials can be pivotal in developing cutting-edge technologies for water purification and environmental protection.

These examples highlight ongoing advancements in nanotechnology research and

development, emphasizing its pivotal role in advancing environmental remediation strategies worldwide. As research progresses, nanomaterials continue to evolve, promising even greater efficacy, stability, and safety in addressing environmental challenges and driving their widespread adoption across various industries.

Segmental Insights

Type Insights

Based on Type, the Nanoparticles emerged as the dominant segment in the global market of Nanoscale Chemicals and Materials in 2023. This dominance arises from their remarkable adaptability, distinctive characteristics, wide-ranging utility, continuous technological progress, economic feasibility, and regulatory approval. For example, in the medical field, nanoparticles play a crucial role in targeted drug delivery systems, leveraging their small size to effectively infiltrate cells for therapeutic applications. In electronics, nanoparticles are integral to cutting-edge materials like conductive inks and quantum dots, boosting the performance of electronic devices and displays. Additionally, their high ratio of surface area to volume and heightened reactivity are essential in catalysis, environmental cleanup initiatives, and sensing innovations. Ongoing advancements in research and development further refine nanoparticle manufacturing and functionalization methods, bolstering their adoption and commercial success.

End User Insights

Based on end user, the Healthcare & Pharmaceuticals segment emerged as the dominant in the global market of Nanoscale Chemicals and Materials in 2023. This can be attributed to their capacity to significantly enhance treatment outcomes, accuracy in diagnostics, and overall patient care through groundbreaking nanotechnology solutions. Ongoing advancements in nanotechnology research and development are driving continuous innovation in drug delivery systems, diagnostics, and personalized medicine. Cornell University researchers developed nanofiber-coated cotton bandages infused with lawsone, known for its antioxidant and antibacterial properties, to combat infections and accelerate wound healing. At Sahmyook University, scientists pioneered a novel drug delivery system for skin cancer treatment using nanofibers layered with thermosensitive and poly-ionic coatings alongside gold nanorods, precisely targeting cancer cells. In 2024, Nanoform Finland advanced medicine with trials evaluating the bioavailability of their nanocrystalline-enabled alternative to Xtandi's conventional formulation, aiming to enhance prostate cancer treatment efficacy. Avery

Pharmaceuticals, under Arrow Greentech, commenced commercial production of pharmaceutical and nutraceutical products, including innovative nanotechnological formulations like sublingual films and Nanofilms. These advancements underscore nanotechnology's pivotal role in revolutionizing medical treatments, enhancing drug delivery systems, and driving significant innovations in healthcare globally. Significant investments from pharmaceutical firms and academic institutions play a crucial role in supporting these developments. Moreover, regulatory frameworks are increasingly accommodating the safe integration of nanotechnology into medical applications, which further contributes to its expanding influence and dominance in the market.

Regional Insights

Based on Region, Asia-Pacific emerged as the fastest growing region in the global market of Nanoscale Chemicals and Materials in the forecast period. This growth can be attributed to dynamic economic expansion, significant investments in technology, and supportive government policies in the Asia-Pacific region. Countries such as China, India, and South Korea are experiencing rapid industrialization, which fuels demand for advanced materials and technologies, including nanoscale chemicals and materials. The increasing middle-class population and rising disposable incomes in China and India are driving consumer demand for nanotechnology-based products, further stimulating market growth. Governments across Asia-Pacific actively promote nanotechnology through funding initiatives and supportive policies like India's Mission on Nano Science and Technology (Nano Mission), which fosters a conducive environment for market expansion. In 2024, Huawei introduced the Pura 70 smartphone featuring a new 7-nanometer HiSilicon chip manufactured by Semiconductor Manufacturing International Corp (SMIC), showcasing advancements in nanotechnology adoption. Additionally, collaborative efforts between NY CREATES and the National Nano Fab Center in Korea aim to establish a shared hub for joint semiconductor research, technology services, and workforce development, bolstering high-tech ecosystems in both nations. Fawoo Nanotech Co. stands out as the sole company worldwide capable of creating and commercializing ultrafine bubbles, known as nano bubbles, in water, offering innovative solutions for gas absorption and water treatment applications. These developments underscore partnerships between academia, industry, and government that drive growth and innovation in the nanoscale chemicals and materials market.

Key Market Players

American Elements

Quantum Materials Corporation

Evonik Industries AG

Strem Chemicals, Inc.

SkySpring Nanomaterials, Inc.

Nanoshel LLC

Arkema

BASF SE

US Research Nanomaterials, Inc.

Advanced Nano Products Co Ltd

Report Scope:

In this report, the Global Nanoscale Chemicals and Materials Market has been segmented into the following categories, in addition to the industry trends which have also been detailed below:

Nanoscale Chemicals and Materials Market, By Grade:

Industrial Grade Nanoscale Chemicals

Pharma Grade Nanoscale Chemicals

Nanoscale Chemicals and Materials Market, By Type:

Nanoparticles

Nanocomposites

Nanotubes

Nanofilms

Nanofibers

Others

Nanoscale Chemicals and Materials Market, By End User:

Healthcare & Pharmaceuticals

Electronics & Semiconductor

Automotive

Aerospace & Defense

Energy

Others

Nanoscale Chemicals and Materials Market, By Region:

North America

United States

Canada

Mexico

Europe

France

United Kingdom

Italy

Germany

Spain

Asia Pacific

China

India

Japan

Australia

South Korea

South America

Brazil

Argentina

Colombia

Middle East & Africa

South Africa

Saudi Arabia

UAE

Competitive Landscape

Company Profiles: Detailed analysis of the major companies presents in the Global Nanoscale Chemicals and Materials Market.

Available Customizations:

Nanoscale Chemicals and Materials Market - Global Industry Size, Share, Trends, Opportunity, and Forecast, Seg...

Global Nanoscale Chemicals and Materials Market report with the given market data, Tech Sci Research offers customizations according to a company's specific needs. The following customization options are available for the report:

Company Information

Detailed analysis and profiling of additional market players (up to five).

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