

Platinum Nanoparticles Market - Global Industry Size, Share, Trends, Opportunity, and Forecast, Segmented By Product Type (Spherical, Baton, Cube, Square), By End User (Automotive, Healthcare, Chemicals, Textiles, Others), By Region and Competition, 2019-2029F

<https://marketpublishers.com/r/P2CD7E59DD50EN.html>

Date: July 2024

Pages: 185

Price: US\$ 4,900.00 (Single User License)

ID: P2CD7E59DD50EN

Abstracts

Global Platinum Nanoparticles Market was valued at USD 283.78 Million in 2023 and is anticipated to project steady growth in the forecast period with a CAGR of 4.17% through 2029. Platinum nanoparticles are ultra-small particles of platinum, typically sized between 1 and 100 nanometers. They possess distinct physical and chemical properties that differentiate them from bulk platinum, rendering them highly valuable across various applications. Their minute size results in an exceptionally high surface area to volume ratio, which significantly boosts their catalytic effectiveness. Retaining the superb electrical conductivity of bulk platinum, these nanoparticles are indispensable in electronics and electrochemical devices. Depending on their dimensions and configuration, platinum nanoparticles can exhibit unique optical traits, including plasmonic effects within visible and infrared spectrums.

Primarily employed in catalytic roles, platinum nanoparticles serve as catalysts in diverse chemical reactions, notably vital in the automotive industry for catalytic converters that convert harmful pollutants into less detrimental substances, aligning with stringent global environmental standards. They are equally essential in industrial operations such as refining petroleum, manufacturing pharmaceuticals, and synthesizing chemicals, leveraging their extensive surface area and catalytic efficiency.

Within the electronics sector, platinum nanoparticles find utility in fuel cells, batteries,

and sensors due to their exceptional electrical conductivity and stability. They enhance device performance and durability, playing a pivotal role as catalysts in fuel cells for efficient chemical-to-electrical energy conversion.

In biomedical applications, platinum nanoparticles are gaining prominence due to their biocompatibility and potential for precise drug delivery and medical imaging. They are explored for targeted therapies in cancer treatment, enabling drugs to selectively target tumor sites while minimizing harm to healthy tissues.

Despite their widespread applications and promising advantages, challenges such as the high production costs linked to platinum and intricate regulatory frameworks surrounding nanomaterials remain significant hurdles. However, ongoing advancements in nanoparticle synthesis technologies, concerted efforts to mitigate production expenses, and strategic collaborations among industry players and research institutions are anticipated to uncover new prospects and propel further growth within the market for platinum nanoparticles.

Key Market Drivers

Growing Demand of Automotive Catalysts

The rising demand for platinum nanoparticles in automotive catalysts is a key driver in the global platinum nanoparticles industry. Governments worldwide are enforcing stricter vehicle emission regulations to combat air pollution and adhere to environmental standards. Platinum nanoparticles are crucial elements in catalytic converters, essential for reducing harmful emissions from gasoline or diesel engines by catalyzing reactions that convert pollutants like carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NOx) into less harmful substances such as carbon dioxide (CO₂), nitrogen (N₂), and water vapor. These nanoparticles are renowned for their durability, maintaining catalytic efficiency despite exposure to high temperatures and corrosive exhaust gases, ensuring the longevity of catalytic converters over a vehicle's lifespan. As fuel efficiency standards become more stringent, automakers increasingly adopt advanced catalytic converter technologies utilizing platinum nanoparticles.

The World Platinum Investment Council (WPIC) forecasted a 12% rise in automotive platinum demand from 2021 to 2022, followed by an 11% increase from 2022 to 2023. Major automakers such as BMW and Renault are investing in hydrogen projects alongside battery electric vehicles (BEVs), seeing hydrogen technology as a sustainable option. BMW has initiated small-series production of the iX5 hydrogen model, with a test

fleet scheduled for release in spring 2023.

The automotive industry is expanding globally due to growing consumer demand, economic growth, and urbanization, directly boosting demand for platinum nanoparticles used in catalytic converters installed in new vehicles. The global trend towards decarbonization in the automotive sector is expected to further drive growth and innovation in the global platinum nanoparticles market in the years ahead.

Rising Demand of Electronics and Sensors

The demand for platinum nanoparticles in electronics and sensors is fueled by their distinctive blend of electrical, catalytic, and biocompatible characteristics. As electronic devices increasingly shrink in size while demanding higher performance, platinum nanoparticles play a crucial role. Their unique electrical and thermal properties make them suitable for a variety of applications, such as conductive pastes, printable electronics, and high-performance interconnects. These nanoparticles are utilized in conductive inks and pastes to print electronic circuits on diverse substrates, including flexible and transparent materials. This capability enables the production of flexible electronics like bendable displays, wearable sensors, and smart textiles. The high conductivity of platinum nanoparticles ensures dependable electrical connections and supports intricate circuit designs.

In the realm of printed electronics, platinum nanoparticles function as conductive components in inkjet and screen printing processes. They facilitate the creation of thin, lightweight, and cost-effective electronic components, such as RFID antennas, touch sensors, and flexible electrodes for medical devices. This application harnesses the scalability and precision of printing technologies to meet the increasing demand for integrated and interconnected electronic systems.

Research published in ACS Publications in 2023 by Annelies Sels and Vivek Subramanian detailed the development of a stable platinum nanoparticle-based ink for drop-on-demand inkjet printing and the fabrication of metallic platinum thin films. A resistive platinum heater was successfully printed as a demonstration of the ink's integration capabilities. Consequently, the platinum nanoink developed in this study holds promise for applications in biology, chemistry, and printed electronics.

Platinum nanoparticles also demonstrate outstanding catalytic activity, making them highly suitable for gas sensors and biosensors. They enhance sensitivity and selectivity in detecting gases and biomolecules, thereby advancing healthcare diagnostics,

environmental monitoring, and industrial safety. As technological advancements continue to progress, platinum nanoparticles are positioned to play a pivotal role in enabling next-generation electronic devices, smart sensor networks, and sustainable energy solutions.

Key Market Challenges

Cost-effectiveness

Cost-effectiveness presents a significant hurdle for the platinum nanoparticles market, impacting their adoption across various industries. Platinum, a rare and precious metal primarily mined in countries like South Africa, Russia, and Zimbabwe, is scarce with limited global reserves, contributing to its high market price.

With tighter regulations increasing demand for Platinum Group Metals (PGMs), the World Platinum Investment Council (WPIC) anticipated a deficit in platinum for vehicle exhaust systems. It projected a 303koz (approximately 8.5 tonnes) deficit in 2023, as global platinum demand is forecasted to rise by 19% annually, while supply is expected to increase by just 2%. The WPIC highlighted that power disruptions and mine maintenance in South Africa, the leading platinum-producing country globally, could constrain supply.

The price of platinum is volatile due to factors such as geopolitical instability, mining strikes, demand fluctuations, and currency changes. This volatility complicates long-term planning and budgeting for manufacturers and users of platinum nanoparticles.

The synthesis of platinum nanoparticles involves advanced techniques such as chemical reduction, sol-gel methods, or electrochemical deposition, which are energy-intensive and require specialized equipment and expertise. These factors contribute to higher production costs.

Achieving cost-effectiveness at scale is challenging for platinum nanoparticles. While small-scale production in laboratories can show promising results, scaling up to industrial levels necessitates significant investments in infrastructure, optimizing processes, and implementing stringent quality controls. Ensuring consistent quality and yield rates during scale-up can be demanding and costly, as variations in particle size, shape, and dispersion impact catalytic performance and overall product quality.

Competitive alternatives

Competitive alternatives pose a significant challenge for the global platinum nanoparticles market, impacting market dynamics such as pricing, performance evaluations, and customer preferences. Other nanoparticle types made from materials such as gold, silver, and palladium directly compete with platinum nanoparticles, often sharing similar properties like catalytic activity, electrical conductivity, and stability. For example, gold nanoparticles are recognized for their effective catalytic properties, silver nanoparticles for their antimicrobial capabilities, and palladium nanoparticles for their catalytic uses in hydrogenation reactions. These materials may offer comparable performance to platinum nanoparticles but potentially at lower costs.

Substitutes like carbon nanotubes (CNTs) and graphene-based materials present another layer of competition. Carbon nanotubes, known for their exceptional mechanical strength and electrical conductivity, are suitable for diverse applications from electronics to composite materials. These materials possess distinctive functionalities that can either rival or complement the attributes of platinum nanoparticles in specific applications.

While platinum is a precious and relatively rare metal, alternatives such as gold, silver, and carbon-based materials are often more abundant or easier to produce, leading to reduced manufacturing expenses. This cost advantage holds significant sway over market dynamics, particularly in industries or applications where cost-effectiveness is crucial.

Key Market Trends

Rising Demand of Fuel Cells

Platinum nanoparticles act as catalysts in fuel cells, facilitating electrochemical reactions that directly convert chemical energy (such as from hydrogen or methanol) into electrical energy. Their high surface area to volume ratio enhances catalytic activity, thereby improving the efficiency of energy conversion. The rising demand for fuel cells spans various sectors, including automotive (particularly for hydrogen fuel cell vehicles), stationary power generation, and portable devices. This demand underscores the necessity for efficient catalysts like platinum nanoparticles.

Fuel cells are renowned for their status as clean energy technology, generating electricity with only water and heat as byproducts, without emitting pollutants such as greenhouse gases or particulate matter. This quality makes them highly attractive for

applications prioritizing environmental sustainability.

Platinum-enabled fuel cell electric vehicles (FCEVs) are poised to play a crucial role in global zero-emission transport. For instance, Anglo American Platinum collaborates with BMW Group and Sasol to test a prototype iX5 SUV on South African roads. Meanwhile, scientists at Sweden's Chalmers University of Technology in May 2024 have modeled low-platinum fuel cells for potential use in hydrogen vehicles. Their research suggests that these cells, when scaled up, could achieve efficiencies similar to or higher than those of current commercial fuel cells, bridging the gap between material science advancements and vehicle implementation.

Ongoing research aims to develop more cost-effective catalysts by reducing platinum usage or exploring alternative materials. This effort seeks to mitigate the high cost typically associated with platinum and enhance the scalability of fuel cell technology.

In May 2023, researchers from India's National Chemical Laboratory (CSIR-NCL) and the Centre for Nano and Soft Matter Sciences (CeNS) synthesized a trimetallic PtMnCo catalyst. This catalyst exhibited superior activity and high tolerance to CO compared to commercially available options, particularly in methanol oxidation reactions at the anode of direct methanol fuel cells (DMFCs). Such advancements underscore the significant market potential of platinum nanoparticles in fuel cells, driven by the expanding adoption of clean energy solutions globally.

Segmental Insights

Product Type Insights

Based on product type, the Spherical emerged as the dominant segment in the global market for Platinum Nanoparticles in 2023. This can be attributed to catalytic efficiency, superior electrochemical properties, and versatility in biomedical and environmental applications. Platinum's renowned catalytic capabilities are optimized in spherical nanoparticles due to their high surface area-to-volume ratio, enhancing the effectiveness of processes like hydrogenation, oxidation, and reduction. In fields such as fuel cells and electrochemical sensors, spherical platinum nanoparticles demonstrate superior electrocatalytic performance by providing an ideal geometry for electron transfer reactions on electrode surfaces.

These nanoparticles are extensively researched for biomedical use, particularly in precise drug delivery systems and advanced medical diagnostics. Their uniform size

and shape enable accurate control over drug release kinetics, while their ample surface area facilitates efficient binding of biomolecules for targeted therapies and imaging. Additionally, spherical platinum nanoparticles are recognized for their stability and durability across diverse environments. Their symmetrical shape minimizes defects and surface irregularities, thereby reducing the risk of particle aggregation and structural degradation over time. These attributes collectively underscore their prominence and utility in various cutting-edge applications.

End User Insights

Based on end user, the Healthcare segment emerged as the dominant in the global market for Platinum Nanoparticles in 2023. This can be attributed to critical role these nanoparticles play in advancing medical treatments, diagnostics, and healthcare delivery systems. Due to their high atomic number and strong X-ray absorption capabilities, platinum nanoparticles serve effectively as contrast agents in imaging technologies such as computed tomography (CT) scans. This enhances visibility of tissues and organs, contributing to more accurate disease diagnosis. Platinum nanoparticles are also integral components in biosensors used for detecting biomarkers and pathogens, facilitating early disease detection and monitoring.

Extensive research focuses on platinum nanoparticles for targeted cancer therapies, leveraging their ability to deliver anticancer drugs directly to tumor sites while minimizing systemic toxicity. Their capability to interact with biological molecules and traverse cellular barriers suggests promising advancements in cancer treatment methodologies. In 2023, Scientific Reports published a study detailing the use of a Pt@ZIF-8 nanocomposite-based electrochemical biosensor for the precise detection of tau protein in Alzheimer's disease patients. These nanoparticles are essential in advancing healthcare technologies due to their versatility, biocompatibility, and capacity to improve therapeutic outcomes.

Regional Insights

Based on Region, North America emerged as the dominant region in the Global Platinum Nanoparticles Market in 2023. This can be attributed to advanced technology expertise, robust healthcare infrastructure, supportive regulatory frameworks, strong market demand, and extensive research and development efforts. North America serves as a center for technological innovation and research, particularly in biotechnology, healthcare, and nanotechnology. This environment facilitates significant progress in synthesizing, applying, and commercializing platinum nanoparticles across

various industries. The region benefits from advanced healthcare infrastructure and a robust pharmaceutical sector, where platinum nanoparticles play a crucial role in biomedical applications such as drug delivery systems, diagnostics, and therapeutic treatments.

These nanoparticles are pivotal in the development of advanced catalytic converters aimed at improving emission reduction in automobiles and trucks. The increasing adoption of fuel cells in North America also drives market expansion. For example, in October 2023, Nikola Corporation marked the commercial launch of the Nikola Tre FCEV, a hydrogen fuel cell electric truck, at its manufacturing facility in Coolidge, Arizona. This underscores the region's growing emphasis on fuel cell vehicle development alongside advancements in the healthcare sector, collectively propelling market growth in North America.

Key Market Players

American Elements

Nano Research Elements LLC

TANAKA HOLDINGS Co., Ltd.

Strem Chemicals, Inc.

Merck KGaA

Nanoshel LLC

NanoComposix

Nanostructured & Amorphous Materials, Inc.

Fortis Life Sciences

Beijing Meliorum Technologies, Inc.

Report Scope:

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

Platinum Nanoparticles Market, By Product Type:

Spherical

Baton

Cube

Square

Platinum Nanoparticles Market, By End User:

Automotive

Healthcare

Chemicals

Textiles

Others

Platinum Nanoparticles 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 Platinum Nanoparticles Market.

Available Customizations:

Global Platinum Nanoparticles 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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