Material Informatics Market - Global Industry Size, Share, Trends, Opportunity, and Forecast, Segmented By Application (Chemical and Pharmaceuticals, Material Science, Manufacturing, Food Science, Energy, Others), By Material Type (Elements, Chemicals, Others), By Technique (Digital Annealer, Deep Tensor, Statistical Analysis, Genetic Algorithm), By Region and Competition, 2019-2029F

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Abstracts

Global Material Informatics Market was valued at USD 127.98 Million in 2023 and is anticipated to project impressive growth in the forecast period with a CAGR of 12.48% through 2029. The Global Material Informatics Market is experiencing rapid growth, driven by the increasing demand for advanced materials across various industries, such as aerospace, automotive, healthcare, and electronics. Material informatics leverages data science, machine learning, and artificial intelligence to accelerate the discovery, development, and deployment of new materials. This interdisciplinary field integrates materials science with informatics to analyze and predict material properties, leading to more efficient and cost-effective production processes. One of the primary factors propelling the market is the rising need for innovative materials that offer superior performance, sustainability, and reduced environmental impact. As industries seek to develop lightweight, stronger, and more durable materials, the adoption of material informatics is becoming essential.

Key players in the market are investing heavily in research and development to harness the potential of big data and computational tools for materials innovation. Companies are also forming strategic partnerships with academic institutions and technology

providers to stay at the forefront of advancements in this field. Government initiatives and funding aimed at promoting advanced manufacturing technologies are bolstering market growth. For instance, various national laboratories and research organizations are collaborating to create extensive materials databases that can be accessed by industries for accelerated innovation.

Key Market Drivers

Technological Advancements in Data Science and AI

The integration of data science, machine learning (ML), and artificial intelligence (AI) into materials science is revolutionizing the field, driving unprecedented advancements and efficiency. Traditionally, the discovery and development of new materials relied heavily on experimental trials and a trial-and-error approach, which were both time-consuming and costly. However, with the advent of advanced computational techniques, this paradigm is shifting towards a more data-driven and predictive methodology.

AI and ML algorithms have the capability to analyze vast amounts of data swiftly, identifying patterns and correlations that are often imperceptible to human researchers. These technologies can process and interpret complex datasets derived from various sources, including experimental results, theoretical calculations, and historical data. By doing so, they can predict material properties, such as strength, conductivity, and thermal stability, with high accuracy. This predictive power is crucial in screening potential materials before they undergo expensive and time-consuming experimental validation.

One of the most transformative applications of AI and ML in materials science is molecular-level simulation and modeling. Researchers can create detailed virtual models of materials, allowing them to simulate and observe behaviors under different conditions. This capability enables the exploration of a wide range of material compositions and structures, accelerating the discovery of optimal materials for specific applications. For instance, in the pharmaceutical industry, such simulations can predict how new compounds interact with biological systems, speeding up the drug discovery process.

The computational approach provided by data science and AI drastically reduces the time required for material discovery and development. Traditional experimental methods can take years or even decades to bring new materials to market. In contrast, AI-driven

methods can reduce this timeframe to months or even weeks. The cost savings are substantial, as fewer resources are spent on physical experiments. This efficiency not only accelerates innovation but also makes the development of advanced materials more economically viable.

Rise in Sustainability and Environmental Concerns

The growing awareness of environmental issues and the pressing need for sustainable practices are significantly influencing the materials science field. Industries across the globe are increasingly prioritizing eco-friendly materials with lower carbon footprints to address climate change and resource depletion. This shift towards sustainability is driven by both regulatory pressures and consumer demand for greener products. Material informatics plays a crucial role in the discovery and development of sustainable materials. By leveraging data science, machine learning (ML), and artificial intelligence (AI), researchers can analyze extensive datasets to identify materials with desirable environmental properties. This approach enables the exploration of a broader range of materials, including those that might have been overlooked using traditional methods. The ability to predict and optimize material properties through computational models accelerates the identification of sustainable alternatives.

One of the key benefits of material informatics is its ability to optimize materials for specific environmental criteria. Researchers can model the lifecycle impacts of materials, including their energy consumption, greenhouse gas emissions, and recyclability. This comprehensive analysis helps in developing materials that not only meet performance requirements but also minimize environmental harm. For example, in the packaging industry, material informatics can lead to the creation of biodegradable plastics or materials with reduced dependency on fossil fuels.

Material informatics supports industries in complying with stringent environmental regulations and achieving sustainability goals. Governments and regulatory bodies are increasingly imposing limits on emissions, waste, and the use of hazardous substances. By using material informatics, companies can ensure that their materials and products adhere to these regulations, avoiding potential fines and reputational damage. Adopting sustainable materials enhances corporate responsibility and aligns with the growing consumer preference for environmentally conscious brands. The push towards greener technologies is heavily reliant on the development of sustainable materials. Material informatics not only facilitates this development but also promotes innovation in various sectors, such as renewable energy, electric vehicles, and green building materials. For instance, the advancement of high-performance batteries for electric vehicles depends

on discovering materials that are both efficient and sustainable. Similarly, the construction industry benefits from new materials that reduce energy consumption and carbon emissions.

Key Market Challenges

Data Quality and Availability

One of the primary challenges in the material informatics market is the quality and availability of data. Material informatics relies heavily on large datasets to train machine learning (ML) algorithms and drive AI models. However, obtaining high-quality, comprehensive data can be difficult. Data from different sources often vary in format, completeness, and accuracy, making it challenging to integrate and analyze effectively. Proprietary data held by private companies is often inaccessible, limiting the scope of available information.

Incomplete or low-quality data can lead to inaccurate predictions and unreliable models, undermining the benefits of material informatics. For example, inconsistencies in experimental conditions, measurement techniques, or data recording practices can result in datasets that are difficult to reconcile. This fragmentation not only hampers the training of robust ML models but also reduces the overall confidence in the predictive capabilities of these models. Addressing this issue requires standardized data collection methods and improved data sharing practices across the industry. Standardization can ensure that data is collected uniformly, making it easier to combine and compare datasets from different sources. This could involve developing industry-wide protocols for data recording and reporting, as well as creating common formats for data storage and exchange.

Enhanced collaboration between academia, industry, and government can facilitate better data integration and quality. Collaborative efforts can lead to the creation of comprehensive, high-quality databases that are accessible to all stakeholders. For instance, public-private partnerships can help bridge the gap between proprietary data and publicly available information, enriching the datasets available for material informatics.

Interdisciplinary Skill Gaps

Material informatics represents a convergence of multiple disciplines, including materials science, data science, and computational modeling. However, the demand for

professionals with expertise in all these areas far outstrips the current supply, leading to significant interdisciplinary skill gaps in the workforce. Traditionally, materials scientists focused on experimental techniques for synthesizing and characterizing materials, while computational scientists primarily worked on data analysis and modeling. Bridging the gap between these disciplines requires individuals with a deep understanding of both material science concepts and advanced data analytics techniques.

The shortage of professionals with interdisciplinary skills poses several challenges to the effective implementation and utilization of material informatics technologies. Without adequate expertise, organizations may struggle to develop accurate predictive models or effectively interpret data insights. This can result in suboptimal material design and development processes, limiting the potential for innovation and advancement in the field.Addressing the interdisciplinary skill gap requires targeted educational and training programs that equip professionals with the necessary knowledge and expertise. Universities and training institutions can develop interdisciplinary curricula that integrate materials science, data science, and computational modeling courses. Industry-academic partnerships can provide hands-on training opportunities and real-world experience to aspiring material informatics professionals.

Key Market Trends

Emergence of Cloud-Based Platforms

The advent of cloud-based platforms and software solutions is profoundly transforming the material informatics landscape, enabling unprecedented efficiencies and capabilities. These platforms integrate seamlessly into existing workflows, enhancing the overall productivity and collaborative potential of research and development teams. By facilitating real-time data sharing, collaboration, and more accurate simulations, cloud-based solutions are revolutionizing how materials are discovered, developed, and optimized.

Cloud-based platforms allow for the smooth integration of material informatics into the workflows of research and development teams. This integration is crucial for enabling real-time data sharing and collaboration among geographically dispersed teams. Researchers can access and contribute to a centralized database, ensuring that data is consistently updated and available to all stakeholders. This real-time collaboration accelerates the pace of innovation, as insights and discoveries can be rapidly shared and built upon. One of the most significant advantages of cloud-based solutions is their scalability. Researchers and engineers can scale their computational resources up or

down based on the complexity and demands of their projects. This flexibility eliminates the need for extensive on-premises infrastructure, which can be costly and difficult to maintain. Cloud platforms provide access to high-performance computing resources, enabling the execution of complex simulations and analyses that would otherwise be impractical. This scalability ensures that material informatics can be applied to a wide range of projects, from small-scale studies to large-scale industrial applications.

Cloud-based platforms democratize access to advanced computational tools, making them available to a broader range of users, including small and medium-sized enterprises (SMEs) and academic institutions. This accessibility reduces barriers to entry and fosters a more inclusive innovation ecosystem. The pay-as-you-go model of cloud services is cost-efficient, allowing organizations to manage their budgets more effectively by only paying for the resources they use. This cost efficiency is particularly beneficial for startups and research institutions with limited funding.

The ease of access and enhanced computational power provided by cloud-based platforms are driving the adoption of material informatics across various industries. Sectors such as aerospace, automotive, healthcare, and electronics are leveraging these platforms to accelerate the development of advanced materials. For instance, the aerospace industry uses cloud-based simulations to design lightweight yet durable materials for aircraft, while the healthcare sector explores new biomaterials for medical applications. The broad applicability of cloud-based material informatics underscores its transformative potential across multiple fields.

Increasing Demand for Advanced Materials

Industries such as aerospace, automotive, electronics, and healthcare are continuously seeking advanced materials that provide superior performance, durability, and sustainability. These advanced materials are crucial for driving innovation and maintaining competitive advantage in increasingly demanding markets. Material informatics is pivotal in addressing these needs by facilitating the rapid development of materials with specific, optimized properties. In the aerospace industry, there is a constant demand for materials that are lightweight yet incredibly strong and heat-resistant. Such materials are essential for improving fuel efficiency, reducing emissions, and enhancing the overall performance and safety of aircraft. Material informatics helps researchers discover and optimize alloys and composites that meet these stringent requirements. By leveraging data science and AI, the aerospace industry can develop materials that withstand extreme conditions while minimizing weight.

The automotive sector is also heavily focused on advanced materials to enhance fuel efficiency and reduce vehicle weight. Lightweight materials, such as advanced high-strength steels, aluminum alloys, and carbon fiber composites, are critical for achieving these goals. Material informatics accelerates the identification and development of such materials by predicting their properties and performance through computational models. This capability allows automotive manufacturers to innovate faster, bringing more efficient and environmentally friendly vehicles to market.

In the electronics industry, the demand for materials with high thermal conductivity and electrical insulation properties is paramount. These materials are vital for the development of smaller, faster, and more reliable electronic devices. Material informatics enables the exploration of new materials that can dissipate heat effectively while maintaining electrical insulation, thereby supporting the miniaturization and performance enhancement of electronic components. The healthcare sector seeks advanced materials for medical devices, implants, and drug delivery systems that are biocompatible, durable, and capable of functioning in complex biological environments. Material informatics aids in the discovery of biomaterials that meet these criteria, facilitating innovations in medical technology and improving patient outcomes. For instance, researchers can use computational models to design materials for prosthetics that are both lightweight and highly durable.

One of the primary advantages of material informatics is its ability to accelerate the development and customization of materials. Traditional methods of material discovery are often slow and resource-intensive, involving extensive trial and error. In contrast, material informatics uses advanced algorithms and data analysis to predict the properties and performance of new materials quickly. This predictive capability significantly reduces development time and costs, allowing industries to respond swiftly to changing market demands and technological advancements.

Segmental Insights

Application Insights

Based on the Application, in 2023, the Energy segment emerged as the dominant segment in the Global Material Informatics Market. This dominance can be attributed to several factors driving the demand for advanced materials and the adoption of material informatics within the energy sector. The push towards renewable energy sources, such as solar and wind power, has fueled the need for materials with enhanced performance characteristics. Advanced materials are crucial for improving the efficiency and

durability of renewable energy technologies, such as photovoltaic cells and wind turbine blades. Material informatics enables researchers to discover and optimize materials that can withstand harsh environmental conditions, leading to more reliable and cost-effective renewable energy systems.

The transition towards electric vehicles (EVs) has spurred innovation in battery technology. Lithium-ion batteries, the primary energy storage technology used in EVs, require materials with high energy density, fast charging capabilities, and long-term stability. Material informatics facilitates the development of new battery materials by predicting their electrochemical properties and optimizing their performance through computational modeling. The quest for sustainable energy solutions has prompted research into alternative energy sources, such as hydrogen fuel cells and advanced nuclear reactors. These technologies rely on materials that can efficiently catalyze chemical reactions, withstand high temperatures and pressures, and minimize environmental impacts. Material informatics accelerates the discovery of such materials by providing insights into their structure-property relationships and guiding experimental efforts towards the most promising candidates.

Material Type Insights

Based on the Material Type, in 2023, the Chemicals segment emerged as the dominant segment in the Global Material Informatics Market. The chemicals sector encompasses a wide range of industries, including pharmaceuticals, cosmetics, agrochemicals, and specialty chemicals. Each of these industries relies heavily on advanced materials to develop innovative products with enhanced performance characteristics. Material informatics enables researchers to discover and optimize materials that meet specific requirements, such as chemical stability, solubility, and toxicity profile, leading to the development of safer, more effective, and environmentally friendly products.

The chemicals industry faces increasing regulatory pressure to minimize environmental impact and reduce the use of hazardous substances. Material informatics plays a crucial role in addressing these challenges by facilitating the development of sustainable materials and processes. Researchers can use computational modeling and data analytics to design materials with lower carbon footprints, improved recyclability, and reduced waste generation, aligning with global sustainability goals. The chemicals sector is highly competitive, with companies constantly seeking to differentiate their products through innovation. Material informatics provides a competitive advantage by accelerating the pace of materials discovery and development, enabling companies to bring new products to market faster and more cost-effectively.

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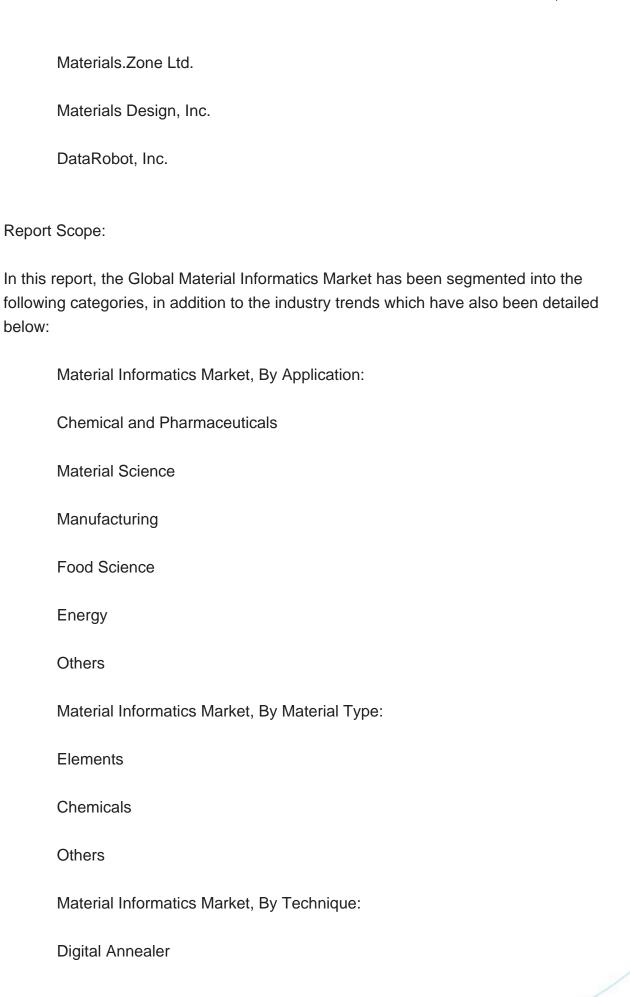
Regional Insights

In 2023, North America emerged as the dominant region in the Global Material Informatics Market, holding the largest market share. North America boasts a strong presence of key players and leading technology hubs in the field of material informatics. The region is home to prominent companies, research institutions, and universities that are at the forefront of developing advanced materials and leveraging data-driven approaches for materials discovery and development. These entities drive innovation and technological advancements in material informatics, attracting investments and fostering a thriving ecosystem for research and development.

North America benefits from robust infrastructure and advanced technology adoption, which provide a conducive environment for the growth of the material informatics market. The region has access to high-performance computing resources, data analytics platforms, and state-of-the-art laboratories, enabling researchers and companies to conduct cutting-edge research and experimentation in material science. North America has a diverse industrial landscape with a high demand for advanced materials across various sectors, including aerospace, automotive, electronics, healthcare, and energy. The region's strong manufacturing base and emphasis on innovation drive the adoption of material informatics technologies to improve product performance, reduce costs, and enhance competitiveness in global markets.

Key Market Players

AI Materia Inc.

ALPINE ELECTRONICS, Inc.

Citrine Informatics

Dassault Syst?mes S.E.

Exabyte Inc.

Hitachi High-Tech Corporation

Kebotix, Inc.

Materials.Zone Ltd.

Materials Design, Inc.

DataRobot, Inc.

Report Scope:

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

Material Informatics Market, By Application:

Chemical and Pharmaceuticals

Material Science

Manufacturing

Food Science

Energy

Others

Material Informatics Market, By Material Type:

Elements

Chemicals

Others

Material Informatics Market, By Technique:

Digital Annealer

Deep Tensor

Statistical Analysis

Genetic Algorithm

Material Informatics 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 present in the Global Material Informatics Market.

Available Customizations:

Global Material Informatics market report with the given market data, TechSci 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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