North America Self-Healing Material Market, By Form (Extrinsic and Intrinsic), By Material Type (Polymers, Concrete, Coatings, Others), By End Use (Building & Construction, Mobile Devices, Transportation, Others), By Country and Competition, Forecast & Opportunities, 2018-2028F

Market Report (3 business days) | 2023-10-03 | 140 pages | TechSci Research

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Report description:

The North America Self-Healing Material Market was valued at USD 431.27 Million in 2022 and is anticipated to project robust growth in the forecast period with a CAGR of 9.85% and is expected to reach USD 743.91 Million by 2028. Self-healing materials are man-made or synthetically engineered substances endowed with an inherent capability to autonomously mend damage without the need for external diagnosis or human intervention. These materials emulate the innate capacity of living organisms to heal injuries and reinstate functionality. Self-healing materials offer a multitude of prospective applications across diverse domains, including aerospace, automotive, civil engineering, biomedical, and electronics. Examples of self-healing materials encompass polymers, metals, ceramics, concrete, and coatings. Consequently, the escalating utilization of self-healing materials plays a pivotal role in fostering growth within the North America Self-Healing Material Market throughout the forecast period.
Key Market Drivers
Growing Demand from Building & Construction Industry
The building and construction sector is undergoing a significant transformation with the adoption of innovative materials and technologies that promise durability, sustainability, and cost-efficiency. One such technological advancement garnering increasing attention is the development and application of self-healing materials. These materials have the remarkable ability to repair themselves when subjected to damage, offering a solution to some of the sector's most persistent challenges. The building and construction sector plays a pivotal role in the global economy and has a substantial impact on resource consumption and environmental sustainability. However, it faces inherent challenges, such as the need for ongoing maintenance, repairs, and the eventual deterioration of structures due to various factors, including weathering, environmental stresses, and physical damage. These challenges often lead to costly repairs, safety concerns, and significant environmental repercussions. In response to these

challenges, researchers and engineers have turned to self-healing materials as a potential game-changer. These materials possess the ability to autonomously repair damage, extending the lifespan of structures, reducing maintenance costs, and minimizing waste generated from construction and demolition activities. As a result, the demand for self-healing materials in the building and construction sector has been steadily growing. Additionally, self-healing material concrete has emerged as a game-changer, particularly in high-stress environments such as bridges, highways, and critical infrastructure. From residential to commercial structures, self-healing materials can enhance the durability and longevity of walls, floors, and foundations. In addition, self-healing materials align with green building principles, reducing the environmental impact of construction and promoting sustainable practices.

Moreover, the concept of self-healing materials draws inspiration from nature, where living organisms possess the innate ability to regenerate and repair. In materials science, this concept has been adapted and applied to create innovative construction materials. The fundamental principle behind self-healing materials is the incorporation of microcapsules, vascular networks, or other mechanisms that release healing agents when damage occurs. These healing agents can be in the form of adhesives, sealants, or even bacteria that produce minerals to repair cracks. One common approach involves microcapsules filled with a healing agent embedded within the construction material. When a crack forms, these capsules rupture, releasing the healing agent into the damaged area. The agent then reacts with the surrounding material to seal the crack. This process mimics the way our body's immune system responds to injuries, making it a fascinating and efficient solution for structural repair.

Furthermore, self-healing concrete is one of the most notable applications. Cracks in concrete are a common issue, leading to structural instability and degradation. Self-healing concrete addresses this problem by automatically repairing cracks when they form, ensuring the integrity and longevity of the structure. It is especially valuable in infrastructure projects such as bridges, roads, and buildings. Self-healing coatings and sealants are used to protect surfaces from damage and corrosion. These materials are applied to structures like steel bridges and buildings to provide an additional layer of protection. When damage occurs, the coatings and sealants release healing agents, preventing further deterioration. Self-healing polymers and composite materials are used in various structural components, such as beams and columns. These materials can recover their mechanical properties when subjected to damage, maintaining the overall structural integrity. Therefore, increasing demand of self-healing materials led to the growth of North America Self-Healing Material Market.

Supportive Government Policies and Initiatives

In the pursuit of sustainable and innovative solutions, the government has recognized the transformative potential of self-healing materials in various sectors, including construction, transportation, and infrastructure. Through supportive policies and initiatives, the government is paving the way for the widespread adoption of these materials, fostering resilience, efficiency, and environmental stewardship. The U.S. government acknowledges that self-healing materials can significantly impact sustainability, durability, and economic growth. As such, it has initiated various measures to promote research, development, and deployment of these advanced materials. For example, government agencies, such as the National Science Foundation (NSF) and the Department of Energy (DOE), provide funding for research and innovation related to self-healing materials. Grants support academic institutions, research organizations, and industry partnerships, fostering breakthroughs that drive technology forward. Along with this, government funding for infrastructure projects often prioritizes sustainability and resilience. The use of self-healing materials aligns with these goals, making projects more durable and reducing the need for frequent repairs. Furthermore, government agencies, like the Advanced Research Projects Agency-Energy (ARPA-E), offer programs that promote transformative technologies. Self-healing materials, due to their potential impact on energy efficiency and environmental sustainability, can qualify for such initiatives. Thus, the large number of initiatives by government regarding self-healing material is anticipated to drive the demand of North America Self-Healing Material Market in the forecast period.

Growing Demand of Self-healing Material in Transportation Sector

The transportation sector, encompassing automobiles, aircraft, ships, and infrastructure, has been a cornerstone of modern society, providing essential connectivity and mobility. However, it faces formidable challenges such as wear and tear, corrosion, and structural damage over time, leading to maintenance costs, safety concerns, and environmental impacts. The transportation sector is characterized by continuous movement, exposure to harsh environmental conditions, and high levels of stress on materials. These factors contribute to wear and deterioration, necessitating frequent maintenance, repairs, and replacements. Such maintenance not only incurs substantial costs but also results in downtime, reduced efficiency, and increased environmental

impact due to resource consumption and waste generation. As a solution to these challenges, self-healing materials have emerged as a groundbreaking innovation that can transform the transportation industry. Self-healing materials possess the remarkable ability to autonomously repair damage, mitigating the impact of wear and structural deterioration. They offer the potential to extend the lifespan of transportation infrastructure and vehicles, reduce maintenance costs, enhance safety, and promote sustainability. As a result, the demand for self-healing materials in the transportation sector is experiencing significant growth.

Moreover, self-healing materials find applications in vehicle exteriors, such as self-repairing coatings that protect against scratches and minor damage. These coatings can maintain a vehicle's appearance and reduce the need for cosmetic repairs. In aviation, self-healing composites can enhance the structural integrity of aircraft components. These materials are designed to repair themselves when subjected to stress or damage, reducing the risk of structural failures. Along with this, self-healing coatings are used to protect the hulls of ships from corrosion caused by saltwater exposure. These coatings can autonomously repair small breaches, preventing water intrusion and extending the life of the vessel. In transportation infrastructure, such as bridges and roads, self-healing concrete can repair cracks and fissures caused by environmental factors and wear. This technology enhances the durability of critical infrastructure components. Self-healing materials can be applied to rail tracks and components to extend their lifespan and reduce maintenance requirements. This is especially valuable in high-speed rail systems where maintenance can disrupt service. Thus, these factors dominate the growth of North America Self-Healing Material Market in the forecast period.

Key Market Challenges

High Cost of Self-Healing Material

In the field of material science, the advancement of self-healing materials signifies a significant step toward enhancing durability and sustainability. Nevertheless, the issue of exorbitant expenses associated with these groundbreaking materials has presented a substantial obstacle. As industries endeavor to harness the advantages of self-healing capabilities, it becomes crucial to address cost-related concerns while preserving the transformative potential that these materials hold. The elevated costs linked to self-healing materials can be attributed to various factors, including the pioneering nature of self-healing technologies, which entails extensive research, experimentation, and refinement, thereby contributing to the initial high costs. Additionally, many self-healing materials necessitate specialized additives, nanoparticles, or polymers, which can be costly to procure or synthesize. Furthermore, the intricate processes required to manufacture self-healing materials with precise properties often result in heightened production expenses. Moreover, the challenge of scaling up production to meet demand can introduce complexities and further amplify costs.

Scalability of Self-Healing Material

The potential offered by self-healing materials to transform various industries by enhancing durability and sustainability is undeniably significant. However, the intricate task of transitioning these materials from laboratory settings to practical real-world applications is a multifaceted challenge that demands careful consideration of numerous factors. As industries aspire to leverage the advantages of self-healing materials on a broader scale, they must navigate a series of hurdles pertaining to production, cost-effectiveness, performance, and feasible implementation. The shift from laboratory-scale prototypes to the mass production of self-healing materials presents a range of challenges. It is imperative to maintain consistent material properties and self-healing capabilities across extensive production batches to ensure dependable performance. Furthermore, scaling up production can potentially impact material costs, potentially affecting the overall economic feasibility of self-healing solutions. Some self-healing materials necessitate intricate manufacturing processes that may be challenging to replicate on a larger scale. Moreover, ensuring that self-healing properties remain effective throughout the entire lifespan of products is of paramount importance for practical real-world applications. These complexities and challenges may present hurdles for the growth of the North America Self-Healing Material market in the projected period.

Key Market Trends

Nanocomposite Self-healing Materials

In the field of materials science, a groundbreaking innovation is capturing the attention of researchers, engineers, and industries alike: nanocomposite self-healing materials. These extraordinary materials have the potential to transform various sectors by bolstering durability, reducing waste, and promoting sustainability through their unique capacity to autonomously mend damage.

As we venture further into the realm of nanocomposite self-healing materials, a world of possibilities unfolds, heralding a future where products and structures can recover from wear and tear. This not only diminishes the environmental impact but also extends the lifespan of materials. Nanocomposite self-healing materials amalgamate the exceptional properties of nanomaterials with the concept of self-repair. These materials are meticulously engineered to respond to damage by mending themselves autonomously, emulating the processes of natural healing. They achieve this feat by incorporating nanoparticles, polymers, or other components that can interact and reform bonds when exposed to specific stimuli, such as heat, light, or pressure.
Furthermore, nanocomposite self-healing materials possess the remarkable capability to significantly prolong the lifespan of products and structures. This reduction in the need for frequent replacements conserves valuable resources and minimizes waste generation, aligning seamlessly with principles of the circular economy. Moreover, by empowering materials to rebound from minor damages, these materials contribute to environmental friendliness. In addition to these benefits, nanocomposite self-healing materials find diverse applications across various industries. For instance, they can enhance the durability of vehicle components, aircraft structures, and even tires, thereby reducing maintenance requirements and enhancing safety. In the realm of construction, self-healing concrete and other building materials can diminish the occurrence of cracks and extend the longevity of structures, making significant contributions to sustainable infrastructure development. These remarkable materials also have potential applications in the realm of electronics, where they can be integrated into devices to repair minor damages, prolonging the functional life of gadgets, and reducing electronic waste. In the fashion industry, self-healing fabrics could lead to longer-lasting clothing, thereby mitigating the environmental impact associated with fast fashion practices.
Moreover, the versatility of self-healing materials extends to the field of healthcare. They could potentially find applications in medical devices, implants, and drug delivery systems, enhancing their reliability and safety. Additionally, nanocomposite self-healing materials constitute a unique category of materials capable of improving their mechanical strength and healing ability after sustaining damage, thanks to the integration of nanoscale components. Materials with an interwoven network exhibit exceptional tensile strength, high toughness, impressive stretchability, and remarkable healing efficiency.
Rising Demand of Bio-Based Self-Healing Material
In an era characterized by a heightened environmental consciousness and a strong drive toward sustainable solutions, there is a growing and robust demand for bio-based self-healing materials. These innovative materials represent a harmonious convergence of nature's inherent brilliance and human ingenuity, offering the potential to revolutionize various industries while aligning seamlessly with the global push for sustainability. As this demand continues to gather momentum, bio-based self-healing materials are poised to usher in a new era of product longevity, waste reduction, and substantial contributions to a more sustainable future. Bio-based self-healing materials represent a union between components derived from the biological realm and advanced engineering principles. They possess an extraordinary capacity to autonomously mend damage, mimicking the regenerative abilities found in living organisms. This pioneering approach holds immense promise across a multitude of applications, spanning industries from construction and automotive to electronics and consumer goods.
Furthermore, the escalating demand for bio-based self-healing materials can be attributed to several compelling factors. Firstly, there is a growing concern about the environmental repercussions associated with traditional materials, driving an increased need for sustainable alternatives that can effectively mitigate carbon footprints and reduce dependence on finite resources. Bio-based self-healing materials align seamlessly with the principles of the circular economy, wherein materials are intentionally designed for reuse, remanufacturing, and recycling, thereby minimizing waste and extending the lifecycles of products. These materials also embody the concept of regenerative design, promoting the creation of products that have the innate ability to "heal" themselves over time, consequently necessitating fewer replacements and repairs. Industries seeking materials that offer both resilience and cost-effectiveness are turning to bio-based self-healing solutions to enhance product performance and curtail maintenance expenses.
Moreover, the versatile applications of bio-based self-healing materials span various sectors. For instance, these materials can be seamlessly integrated into concrete formulations, effectively reducing the occurrence of cracks and significantly extending the lifespan of structures. In the realm of automotive engineering, bio-based self-healing materials bolster the durability of vehicle components, ultimately reducing the frequency of replacements and minimizing the volume of automotive waste generated. Furthermore, the incorporation of self-healing materials into electronic devices has the transformative potential to extend their functional life, thereby reducing the overall amount of electronic waste produced. Additionally, bio-based self-healing materials

hold the potential to revolutionize packaging practices, offering a sustainable alternative that reduces the reliance on single-use items and aligns with environmentally conscious approaches to packaging design. These materials are poised to play a pivotal role in ushering in a more sustainable and environmentally responsible era, where products and structures exhibit greater resilience, reduced environmental impact, and extended lifecycles.

Segmental Insights

Form Insights

Based on the form, the extrinsic segment is expected to register the highest growth of 10.05% during the forecast period 2024-2028. The surge in popularity of extrinsic self-healing materials in North America can be attributed to their remarkable capacity to enhance the durability and lifespan of diverse infrastructure elements like roads, bridges, and buildings. This is of particular significance in North America, where the demand for sustainable and cost-effective approaches to upkeep and renovate aging infrastructure is on the rise. Furthermore, the flourishing aerospace and defense sector in the region is playing a pivotal role in propelling the growth of extrinsic self-healing materials. This, in turn, contributes to the expansion of the North America Self-Healing Material Market during the forecast period.

Material Type Insights

Based on the material type, the polymer segment is expected to register the highest growth of 10.33% during the forecast period 2024-2028. As polymer type self-healing materials significantly improve the durability of products and structures. They can autonomously repair damage, such as cracks and scratches, which helps extend the lifespan of the material and reduces the need for frequent replacements or repairs. This, in turn, contributes to the expansion of the North America Self-Healing Material Market during the forecast period.

End Use Insights

Based on the end use, the mobile devices segment is expected to register the highest growth of 10.14% during the forecast period, 2024-2028. This trend can be attributed to the increasing global demand for smart devices, including but not limited to smartphones, tablets, and laptops. As these mobile devices continue to permeate everyday life, there is a growing imperative for the integration of self-healing materials to enhance their durability and extend their operational lifespans. The mobile device sector stands out as a high-value market, where consumers are willing to invest in devices that offer superior durability and longer lifecycles. Consequently, this market presents an alluring prospect for companies operating within the self-healing materials industry. As a result, companies are consistently in search of innovative solutions to set themselves apart from their competitors. For instance, both Apple and Samsung have adopted these materials in their smart devices to elevate their products to a premium level, ultimately enhancing their profitability. These developments contribute significantly to the propulsion of the North America Self-Healing Material Market throughout the projected period.

Regional Insights

United States will witness fastest growth during the forecast period, 2024-2028. This can be attributed to the rising demand, supportive government policies, expanding research and development initiatives, significant market opportunities, and cost-effective advantages. Additionally, the production of aircraft, spacecraft, satellites, and similar advanced technologies necessitates the incorporation of materials and technologies like self-healing materials to augment product performance.

Key Market Players

Dow Inc.

Huntsman International LLC

NEI Corporation

High Impact Technology, LLC

Autonomic Materials Inc.

Applied Thin Films Inc.

Report Scope:

In this report, the North America Self-Healing Material Market has been segmented into the following categories, in addition to the industry trends which have also been detailed below:

- North America Self-Healing Material Market, By Form:
  - Extrinsic

o Intrinsic
North America Self-Healing Material Market, By Material Type:
o Polymers
o Concrete
o Coatings
o Others
North America Self-Healing Material Market, By End Use:
o Building & Construction
o Mobile Devices
o Transportation
o Others
North America Self-Healing Material Market, By Country:
o United States
o Mexico
o Canada

Competitive Landscape
Company Profiles: Detailed analysis of the major companies present in the North America Self-Healing Material Market.
Available Customizations:
The North America Self-Healing Material 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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North America Self-Healing Material Market, By Form (Extrinsic and Intrinsic), By Material Type (Polymers, Concrete, Coatings, Others), By End Use (Building & Construction, Mobile Devices, Transportation, Others), By Country and Competition, Forecast & Opportunities, 2018-2028F

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