

Bulk Metallic Glass Market - Global Industry Size, Share, Trends, Opportunity, and Forecast, Segmented By Technology (Casting, Thermoplastic Forming, 3D Printing), By End User (Consumer Electronics and Wearables, Sporting Equipment, Biomedical, Aerospace/Defence, Others), By Region and Competition, 2019-2029F

<https://marketpublishers.com/r/BE16CBBCFB81EN.html>

Date: May 2024

Pages: 185

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

ID: BE16CBBCFB81EN

Abstracts

Global Bulk Metallic Glass Market was valued at USD 50.36 million in 2023 and is anticipated to project robust growth in the forecast period with a CAGR of 3.56% through 2029. The worldwide bulk metallic glass (BMG) market has seen a significant uptick in demand and innovation due to its distinctive characteristics and broad applications spanning various industries. BMGs, also referred to as amorphous metals, boast outstanding strength, resistance to corrosion, and elasticity, making them an appealing option across sectors where traditional metals fall short.

A key catalyst behind the market's expansion is its integration into manufacturing operations. BMGs are extensively utilized in crafting precise components for consumer electronics, aerospace, and medical equipment. Their capacity to be shaped into intricate forms with precision, coupled with their durability against wear and tear, positions them favorably for producing resilient and lightweight parts in smartphones, laptops, aircraft components, and medical implants.

The automotive sector has acknowledged the potential of BMGs in bolstering vehicle performance and fuel efficiency. As there's a growing focus on lightweight materials to enhance fuel economy and curb emissions, automotive manufacturers are exploring BMGs as viable alternatives to conventional materials like steel and aluminum. BMGs

offer the promise of sturdier, lighter components capable of withstanding harsh operational conditions, thereby improving vehicle efficiency and durability.

The BMG market is experiencing growth in emerging domains such as additive manufacturing (3D printing). Leveraging BMGs in additive manufacturing facilitates the creation of intricate geometries with superior mechanical properties, unlocking new avenues in aerospace, defense, and biomedical engineering.

The global BMG market encounters challenges, including elevated production expenses and restricted access to raw materials. Ongoing research and development endeavors aimed at refining manufacturing processes and exploring novel alloy compositions are anticipated to mitigate these obstacles and propel further market growth.

Key Market Drivers

Growing Demand of Bulk Metallic Glass in Electronic Industry

In the electronic industry, a key force pushing the demand for BMG is the continual drive towards making electronic devices smaller and more efficient. As gadgets shrink in size, the necessity for materials that can endure this miniaturization process while maintaining performance becomes critical. BMGs, with their impressive strength-to-weight ratio and capacity to be shaped into intricate forms accurately, effectively meet this demand.

BMGs demonstrate excellent electrical conductivity, making them well-suited for use in electronic circuits' components and connectors. Unlike conventional metals, which may experience electrical losses and heat generation, BMGs offer reduced resistivity and enhanced signal integrity, thereby improving the effectiveness and dependability of electronic systems. This characteristic proves especially advantageous in applications where signal integrity is paramount, such as high-frequency scenarios.

The increasing utilization of advanced manufacturing methods like additive manufacturing and injection molding has made mass production of BMG components feasible at a competitive price. This scalability has further accelerated the incorporation of BMGs into various electronic applications, spanning from smartphone casings to high-performance connectors in aerospace electronics.

The electronic industry's dependence on BMGs is expected to grow as emerging technologies such as 5G connectivity, Internet of Things (IoT), and artificial intelligence

(AI) fuel the demand for high-performance electronic components. BMGs, with their distinctive blend of properties, present a compelling solution to meet the evolving requirements of these transformative technologies.

Growing Demand of Bulk Metallic Glass in Medical Industry

In the medical sector, a primary driver behind the demand for BMGs stems from their superior mechanical attributes compared to conventional materials like stainless steel and titanium. BMGs showcase outstanding strength and elasticity, allowing for the manufacture of medical devices and implants capable of enduring the demands of surgical procedures and the biomechanical stresses within the human body. This advantageous strength-to-weight ratio proves particularly beneficial in orthopedic implants, where the preference lies in lightweight materials capable of supporting substantial loads.

The corrosion resistance of BMGs renders them an appealing option for long-lasting implantable medical devices. Unlike traditional metallic materials prone to corrosion over time, BMGs offer heightened durability and longevity, diminishing the likelihood of implant failure and the necessity for replacement surgeries. This aspect holds significant importance in applications like cardiovascular implants and dental prosthetics, where sustained biocompatibility is crucial for patient well-being and comfort.

Another influential factor driving the demand for BMGs in the medical realm is their biocompatibility. BMGs have demonstrated excellent biocompatibility, indicating their ability to be safely implanted into the human body without eliciting adverse reactions or immune responses. This quality positions BMGs as suitable candidates for a broad array of medical implants, including orthopedic screws, dental implants, and cardiovascular stents.

The versatility of BMGs enables the fabrication of intricate and personalized medical devices through advanced manufacturing techniques such as additive manufacturing (3D printing). Utilizing BMGs in additive manufacturing facilitates the production of implants tailored to individual patients, boasting intricate geometries and customized mechanical properties. This customization enhances the fit and performance of medical devices while reducing surgical complications and recovery durations.

With the escalating demand for minimally invasive surgical procedures, the medical industry increasingly relies on BMGs for the development of innovative surgical instruments and tools. BMGs can be fashioned into sharp, resilient, and precise cutting

instruments, along with endoscopic devices characterized by superior maneuverability and flexibility. These advancements bolster the efficiency and efficacy of minimally invasive surgeries, meeting the evolving needs of medical practitioners and patients alike.

Key Market Challenges

Brittleness and Fracture Toughness

Bulk metallic glass (BMG) has attracted considerable attention in recent times due to its distinctive blend of characteristics, encompassing high strength, superb corrosion resistance, and exceptional magnetic properties. Despite its array of advantages, BMGs encounter certain challenges. One of the primary hurdles confronting the global bulk metallic glass market is brittleness and fracture toughness.

In contrast to conventional crystalline metals, which demonstrate ductile behavior and can undergo plastic deformation prior to failure, BMGs are inherently brittle substances. This brittleness stems from their amorphous atomic arrangement, lacking the ordered structure found in crystalline materials. BMGs are susceptible to abrupt failure under tensile stress, resulting in fracture without significant plastic deformation. This characteristic presents obstacles in applications where resilience to mechanical failure and fracture toughness are paramount, such as structural elements within aerospace or automotive systems.

Fracture toughness, which measures a material's ability to resist crack propagation and endure fracture under applied stress, serves as a pivotal property determining the reliability and longevity of engineering materials. BMGs exhibit limited fracture toughness, constraining their suitability for certain demanding applications. The absence of ductility and mechanisms for energy absorption in BMGs renders them vulnerable to sudden and catastrophic failure when subjected to impact or cyclic loading, thereby posing challenges in ensuring the structural integrity of components crafted from these materials.

Key Market Trends

Surge in Environmental and Sustainability Considerations

The growing emphasis on environmental considerations within the BMG market is significantly influenced by the recyclability of BMG materials. Unlike conventional

metals, which often degrade in quality during recycling, BMGs can undergo multiple recycling cycles without compromising their distinctive properties. This inherent recyclability diminishes the dependence on virgin raw materials, preserves natural resources, and reduces waste generation, rendering BMGs an appealing option for eco-conscious industries.

The production process of BMGs offers environmental benefits over traditional metal manufacturing methods. BMGs can be produced using relatively low-energy techniques such as rapid solidification, consuming less energy and emitting fewer greenhouse gases compared to conventional metal casting and forging processes. The absence of crystalline grain boundaries in BMGs decreases the energy needed for processing and enhances material efficiency, further bolstering environmental sustainability.

The lightweight characteristics of BMGs present opportunities for curbing energy consumption and carbon emissions in transportation and aerospace sectors. By substituting heavier materials with BMGs in automotive components, aircraft structures, and spacecraft parts, manufacturers can enhance fuel efficiency, lower emissions, and reduce the environmental footprint of transportation systems. This trend aligns with global initiatives to transition towards greener and more sustainable modes of transportation to address climate change and mitigate air pollution.

As the world moves towards a circular economy model and strives to achieve sustainable development goals, the adoption of environmentally friendly materials like BMGs is anticipated to continue growing across various industries. With their unique combination of exceptional mechanical properties, recyclability, and energy efficiency, BMGs are well-equipped to meet the escalating demand for sustainable materials and foster positive environmental outcomes in the global market.

Segmental Insights

Technology Insights

Based on the technology, the casting emerged as the fastest growing segment in the global market for bulk metallic glass in 2023. Casting presents a versatile approach to shaping and molding BMGs into a diverse array of intricate geometries, encompassing complex shapes and thin-walled structures.

Casting methods, including injection molding and die casting, frequently offer cost advantages over alternative manufacturing techniques such as powder metallurgy or

machining. The capability to manufacture substantial quantities of BMG components while minimizing material waste leads to cost efficiencies in production.

End User Insights

The consumer electronics and wearables segment is projected to experience rapid growth during the forecast period. Bulk metallic glasses (BMGs) are instrumental in improving heat dissipation and thermal management in consumer electronics and wearables. Their inherent thermal conductivity enables the swift removal of heat from critical components like processors, memory modules, and batteries. This efficient heat dispersion ensures stable operating temperatures, thereby prolonging the lifespan and reliability of electronic devices.

BMGs' thermal stability makes them well-suited for applications with frequent temperature fluctuations, such as automotive electronics or outdoor wearable devices. BMGs maintain consistent thermal performance across diverse operating conditions, ensuring the reliability and resilience of electronic systems even in demanding environments.

Regional Insights

Asia Pacific emerged as the dominant player in the Global Bulk Metallic Glass Market in 2023, holding the largest market share in terms of value. Asia Pacific, particularly nations such as China, Japan, South Korea, and Taiwan, possesses a robust manufacturing infrastructure that facilitates the production of BMGs. These countries boast well-established industrial sectors equipped with advanced manufacturing capabilities, including proficiency in materials science, precision engineering, and metallurgy, all crucial for crafting BMG components.

The Asia Pacific region leads in technological progress and innovation in BMG research and development. Institutions, universities, and enterprises in countries like Japan and South Korea have made significant advancements in BMG technology, spanning alloy design, processing methodologies, and applications across diverse industries. This technological acumen provides manufacturers in Asia Pacific with a competitive advantage in the global BMG market.

Key Market Players

Orbray Co., Ltd.

RS ACCIAI S.r.l.

Heraeus Holding GmbH

Eutectix LLC

Hitachi, Ltd.

Liquidmetal Technologies, Inc.

Amorphology, Inc.

Glassimetal Technology, Inc.

PX Limited

Epson Atmix Corp.

Report Scope:

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

Bulk Metallic Glass Market, By Technology:

- o Casting

- o Thermoplastic Forming

- o 3D Printing

Bulk Metallic Glass Market, By End User:

- o Consumer Electronics and Wearables

- o Sporting Equipment
- o Biomedical
- o Aerospace/Defence
- o Others

Bulk Metallic Glass Market, By Region:

- o North America
 - ? United States
 - ? Canada
 - ? Mexico
- o Europe
 - ? France
 - ? United Kingdom
 - ? Italy
 - ? Germany
 - ? Spain
- o Asia Pacific
 - ? China
 - ? India
 - ? Japan

? Australia

? South Korea

o South America

? Brazil

? Argentina

? Colombia

o Middle East & Africa

? South Africa

? Saudi Arabia

? UAE

Competitive Landscape

Company Profiles: Detailed analysis of the major companies present in the Global Bulk Metallic Glass Market.

Available Customizations:

Global Bulk Metallic Glass 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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