

Global Carbon Nanotubes (CNT) Market: Analysis By Technology (Arc Discharge, Laser Ablation, CVD, Catalytic CVD, High Pressure Carbon Monoxide, CoMoCAT, Floating Catalyst, and Others), By Type (Single Walled and Multi Walled), By Application (Semiconductor & Electronics, Energy & Storage, Structural Composites, Chemical & Materials, Medical & Pharmacy, and Others), By Region Size and Trends with Impact of COVID-19 and Forecast up to 2028

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Abstracts

Carbon Nanotubes (CNT) are one dimensional allotropes of carbon made by rolled-up sheets of single-layer carbon atoms (graphene). Carbon nanotubes are composed of carbon atoms linked in hexagonal shapes, with each carbon atom covalently bonded to three other carbon atoms. The properties and applications of carbon nanotubes can vary depending on their type, diameter, length, and functionalization. The global carbon nanotube (CNT) market was valued at US\$5.72 billion in 2022. The market value is forecasted to grow to US\$13.32 billion by 2028.

Rising global energy demand, ongoing advancements in material science and manufacturing technologies, increasing use of CNTs as conductive fillers in ESD materials, EMI Shielding, & electronics packaging, favourable government initiatives to reduce greenhouse emissions and promote renewable energy sources, etc., have been positively contributing towards increased demand for carbon nanotubes. Other significant factor is ongoing technological advancements and innovations in the market by CNT manufacturing companies to remain competitive in the market and strengthen their current portfolios, while attracting new customers. The market is anticipated to

grow at a CAGR of approx. 15% during the forecasted period of 2023-2028.

Market Segmentation Analysis:

By Technology: The report provides the bifurcation of the market into eight segments based on technology: chemical vapor deposition (CVD), arc discharge, laser ablation, floating catalyst, CoMoCAT, catalytic CVD, high pressure carbon monoxide, and others. CVD carbon nanotubes market is the largest segment of global CNT market, owing to commercial adoption of CVD by key players, rapidly expanding end user industries, rising demand from emerging application in areas such as plastic additives, medical implants, carrier tapes, coatings, elastomers, etc., and added advantages offered by CVD process in the form of scalability and control, versatile substrate compatibility, vertical alignment capability, etc.

By Type: The report provides the bifurcation of the market into two segments based on type: single walled and multi walled. Multi walled carbon nanotubes market is both the largest and the fastest growing segment of global CNT market, owing to rising adoption of electric vehicles, growing demand for advanced materials with improved performance & efficiency, increased advancements in material science, ongoing improvements in product quality and wide application of MWCNT in various end-use industries, such as medical & healthcare, electronics, automotive, aviation etc. SWCNT is currently used as a conductive additive for anode when applying silicon anode material. As such, SWCNT is a must in silicon anode materials. It is expected that growth potential of SWCNT conductive additive to stand out from 2023, as more vehicle types adopt silicon anode materials. SWCNT requires more advanced technology than MWCNT.

By Application: The report provides the bifurcation of the market into six segments based on application: semiconductor and electronics, structural composites, energy and storage, chemical and materials, medical and pharmacy, and others. Semiconductor and electronics carbon nanotubes market is the largest segment of global CNT market owing to increasing demand from various manufacturing industries, rising consumer awareness, growing demand of consumer electronics, digitalization, rising popularity of electric vehicles and increasing number of new startups & businesses in major emerging economies.

By Region: The report provides insight into the carbon nanotube market based on the regions namely, Asia Pacific, North America, Europe, and rest of the world. North America carbon nanotubes market holds the largest share of global carbon nanotubes market, owing to the presence of a large number of end user industries, ever-increasing

demand for faster and newer electronic products from consumers, rapidly expanding healthcare sector, rising number of regulations imposed by government to promote green energy, and increasing use of CNTs in touchscreens and input devices such as robots, displays, and other electronic consumer goods, etc. North America carbon nanotubes market is divided into three regions on the basis of geographical operations, namely, the US, Canada and Mexico, where the US carbon nanotubes market is both the largest and fastest growing region of North America CNT market, owing to rising health awareness, increasing environmental and sustainability concerns, growing demand of CNTs from automotive, medical and energy sectors and increasing focus of carbon nanotubes companies on product innovations, collaborations and acquisitions for expanding consumer base and gaining larger market share.

Market Dynamics:

Growth Drivers: The global CNT market has been growing over the past few years, due to factors such as rising demand in electrical, electronics & semiconductor applications, increasing application in energy storage, growing demand of CNTs in other end user industries, increasing demand of CNTs in renewable energy and water treatment, etc. Carbon nanotubes are increasingly demanded for energy storage applications, particularly in the development of high-performance batteries, supercapacitors, and fuel cells, due to their large surface area, excellent electrical conductivity, and mechanical strength, which allows for improved energy storage and conversion capabilities. CNTs are mainly used in battery electrodes as conductive additives or coating material to improve electrode's charge transfer kinetics & stability and facilitate effective charge transfer, hence improving battery's energy storage capacity, cycling stability, and overall efficiency. Therefore, rising demand for carbon nanotubes that are increasingly used for efficient and high-capacity energy storage batteries and systems, will continue to accelerate the growth of global carbon nanotubes market.

Challenges: However, the market growth would be negatively impacted by various challenges such as growing environmental and safety concerns, high production and manufacturing cost, etc. The high production and manufacturing cost of CNTs is associated with rising complexity of synthesis process, and increased need for controlled environment, specialized equipment, and precise conditions. These processes often demand expensive catalyst materials, such as transition metals & high-quality carbon feedstock, such as carbon monoxide or hydrocarbon gases, that are costly to be obtained, especially if specific purity and quality standards are required. Therefore, high production and manufacturing cost will have negative effect on the production of carbon nanotubes, impeding the growth of global carbon nanotubes

market in the forecasted years.

Trends: The market is projected to grow at a fast pace during the forecasted period, due to various latest trends such as integration of AI and ML, rising adoption of electric vehicles (EVs), emergence of functionalized carbon nanotubes, increasing integration of nanotechnology and biotechnology, etc. CNT manufacturers are increasingly integrating real-time process monitoring, sensor data, and AI analytics to better analyze production process parameters, identify correlations, and recognize optimal synthesis conditions, resulting in improved control over CNT growth, increased production efficiency, higher yield, and improved quality control. Similarly, machine learning is used to analyze device performance data, experimental results, and factors influencing device behavior and performance under different settings, further optimizing the performance of CNT-based devices, such as transistors, sensors, or energy storage systems. Therefore, increasing integration of artificial intelligence (AI), machine learning (ML), and deep learning technologies will continue to boost the growth of global carbon nanotubes market in the forecasted years.

Impact Analysis of COVID-19 and Way Forward:

COVID-19 brought in many changes in the world in terms of reduced productivity, loss of life, business closures, closing down of factories and organizations, and shift to an online mode of work. Lockdown policies, imposed by the government to prevent the spread of virus forced various end user industries to either shut down or run low on production capacity, resulting in lower production and manufacturing activities by various end user industries. Since end user industries demand carbon nanotubes-based materials and products for production of electronic components, high-performance energy storage devices, and development of supercapacitors, biosensors & diagnostic devices, drug delivery systems, fuel cells, etc., there was a sudden fall in the demand of CNTs as result of reduced production activities, having negative impact on both demand and consumption of CNTs by end user industries.

Furthermore, there were increasing restrictions in the form of social distancing policies & the number of people that were allowed by industries to work in a physical environment and with CNT manufacturing companies relying heavily on physical presence of experienced workforce to handle the intricate processes involved in CNT production, COVID-19 pandemic shifted everything online, making it difficult for CNT manufacturing facilities to meet up with the ongoing demand, provide in-person training to new employees, and maintain regular repairs and upgrades of complex equipment and machinery, resulting in reduced production capacity & lower output productivity,

further hampering the overall growth of the global carbon nanotube market.

Competitive Landscape:

Global carbon nanotube market is consolidated with top four players accounting for more than 60% market share. Established companies in the market are engaged in various R&D activities & initiatives to develop and deploy new and more efficient products in the market. For instance, on June 14, 2022, OCSiAl announced that the company would launch a graphene nanotube synthesis facility near Belgrade, Serbia, in the first half of 2023.

The key players of the market are:

Arkema Group (Arkema S.A.)

Resonac Holdings Corporation (Showa Denko K.K.)

LG Chem Ltd.

Cabot Corporation

Klean Industries Inc.

CHASM Advanced Materials, Inc.

OCSiAl; Raymor Industries Inc.

Raymor Industries Inc.

Chengdu Organic Chemicals Co. Ltd. (Timesnano)

Cheap Tubes Inc.

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