

# The Global Market for Carbon Nanomaterials 2022-2032

<https://marketpublishers.com/r/G2121A65CA0FEN.html>

Date: September 2022

Pages: 1180

Price: US\$ 1,800.00 (Single User License)

ID: G2121A65CA0FEN

## Abstracts

Carbon based-nanomaterials include a range of carbon nanotubes (CNTs), carbon nanofibers, graphene and its derivatives, graphene oxide, nanodiamonds, fullerenes, graphene quantum dots (GQDs) and 2D materials. Due to their unique structural dimensions and excellent mechanical, electrical, thermal, optical and chemical properties, carbon nanomaterials have gained great interest in a wide range of industrial market. Two-dimensional (2D) materials are currently one of the most active areas of nanomaterials research, and offer a huge opportunity for both fundamental studies and practical applications, including superfast, low-power, flexible and wearable electronics, sensors, photonics and electrochemical energy storage devices that will have an immense impact on our society.

Report contents include:

Analysis of carbon nanotubes, carbon nanofibers, fullerenes, nanodiamonds, graphene quantum dots and graphene based products products.

Assessment of carbon nanomaterials and 2D materials market including production volumes, competitive landscape, commercial prospects, applications, demand by market and region, commercialization timelines, prices and producer profiles. Markets covered include batteries, supercapacitors, sensors, composite and plastic additives, filtration membranes, concrete additives, textiles, electronics packaging, displays, quantum electronics, paints, anti-corrosion coatings etc.

Unique assessment tools for the carbon nanomaterials and 2D materials market, end user applications, economic impact, addressable markets and market

challenges to provide the complete picture of where the real opportunities in carbon nanomaterials and 2D materials are.

Company profiles of carbon nanotubes, graphene, 2D materials, fullerenes, carbon nanofibers, graphene quantum dots and nanodiamonds producers and product developers, including products, target markets and contact details

Assessment of carbon nanomaterials and 2D materials by market including applications, key benefits, market megatrends, market drivers for, technology drawbacks, competing materials, potential consumption of to 2032 and main players.

In depth-assessment of carbon nanomaterials producer and distributor pricing in 2021.

Global market for carbon nanomaterials in tons, by sector, historical and forecast to 2032.

Full list of technology collaborations, strategic partnerships, and M&As in the global carbon nanomaterials and 2D materials market.

In-depth profiles of >570 carbon nanomaterials and 2D materials producers including products, production capacities, manufacturing methods, collaborations, licensing, customers and target markets. Companies profiled include Akhan Semiconductor, Atrago, Avadain, C12 Quantum Electronics, Carbonova, Ceylon Graphite, Chasm Advanced Materials, COnovate, DexMat, General Graphene Corp, Grapheal, Graphene One, Graphene-X, GRIP Molecular Technologies, Levidian, Li-S Energy Ltd., Micro Powder Inc, Nano-C, Nanograf, NanoXplore, Nantero, OCSiAI, Paragraf, SkyNano, Sixonia Tech, SmartNanotubes Technologies, Universal Matter, Volexion etc.

Detailed forecasts for key growth areas, opportunities and demand.

## Contents

### 1 GRAPHENE

#### 1.1 Market overview

##### 1.1.1 Graphene properties

##### 1.1.2 Commercialization

##### 1.1.3 The graphene market to date

##### 1.1.4 Market outlook for 2022 and beyond

##### 1.1.5 The market in 2021

##### 1.1.6 Graphene commercial market developments 2020-2022

##### 1.1.7 Graphene funding and investments 2020-2022

##### 1.1.8 Publicly listed graphene companies

##### 1.1.9 Graphene global production capacities, in tons and by type

##### 1.1.10 Global demand for graphene

###### 1.1.10.1 Global graphene demand, to 2032, tons

###### 1.1.10.2 Global graphene demand, by end user market to 2032

###### 1.1.10.3 Graphene market, by region

###### 1.1.10.3.1 Asia-Pacific

###### 1.1.10.3.1.1 China

###### 1.1.10.3.1.2 Main graphene producers in Asia-Pacific

###### 1.1.10.3.2 North America

###### 1.1.10.3.2.1 Main graphene producers in North America

###### 1.1.10.3.3 Europe

###### 1.1.10.3.3.1 Main graphene producers in Europe

##### 1.1.11 Graphene products

###### 1.1.11.1 Industrial collaborations and licence agreements

#### 1.2 Graphene market challenges

#### 1.3 Types of graphene

##### 1.3.1 Graphene materials

###### 1.3.1.1 CVD Graphene

###### 1.3.1.1.1 Applications

###### 1.3.1.2 Graphene nanoplatelets

###### 1.3.1.3 Graphene oxide and reduced Graphene Oxide

###### 1.3.1.4 Graphene quantum dots (GQDs)

###### 1.3.1.4.1 Composition

###### 1.3.1.4.2 Comparison to quantum dots

###### 1.3.1.4.3 Properties

###### 1.3.1.4.4 Synthesis

- 1.3.1.4.4.1 Top-down method
- 1.3.1.4.4.2 Bottom-up method
- 1.3.1.4.4.3 Comparison of synthesis methods
- 1.3.1.4.5 Applications
- 1.3.1.4.6 Markets for graphene quantum dots
  - 1.3.1.4.6.1 Electronics and photonics
  - 1.3.1.4.6.2 Energy storage and conversion
  - 1.3.1.4.6.3 Sensors
  - 1.3.1.4.6.4 Biomedicine and life sciences
  - 1.3.1.4.6.5 Anti-counterfeiting
- 1.3.1.4.7 Challenges
- 1.3.1.4.8 Production of graphene quantum dots
- 1.3.1.4.9 Current and projected revenues
- 1.3.1.4.10 Pricing
- 1.3.2 Intermediate products
  - 1.3.2.1 Graphene masterbatches
  - 1.3.2.2 Graphene dispersions
- 1.4 Graphene patents
- 1.5 Graphene production
  - 1.5.1 Quality
  - 1.5.2 Assessment of graphene production methods
  - 1.5.3 Commercial production capacities
  - 1.5.4 Graphene oxide and reduced Graphene Oxide production capacities
    - 1.5.4.1 By producer
  - 1.5.5 Graphene nanoplatelets production capacities
    - 1.5.5.1 By producer
  - 1.5.6 CVD graphene film
    - 1.5.6.1 By producer
  - 1.5.7 Graphene production issues and challenges
    - 1.5.7.1 Oversupply
    - 1.5.7.2 Quality
    - 1.5.7.3 Large-volume markets
    - 1.5.7.4 Commoditisation
    - 1.5.7.5 Industrial end-user perspective
- 1.6 Graphene pricing
  - 1.6.1 Pristine graphene flakes pricing/CVD graphene
  - 1.6.2 Few-Layer graphene pricing
  - 1.6.3 Graphene nanoplatelets pricing
  - 1.6.4 Graphene oxide (GO) and reduced Graphene Oxide (rGO) pricing

- 1.6.5 Graphene quantum dots pricing
- 1.6.6 Multilayer graphene (MLG) pricing
- 1.6.7 Graphene ink
- 1.7 Markets for graphene
  - 1.7.1 3D Printing
    - 1.7.1.1 Market outlook
    - 1.7.1.2 Market drivers, trends and applications
    - 1.7.1.3 Global market in tons, historical and forecast to 2032
    - 1.7.1.4 Product developers
  - 1.7.2 Adhesives
    - 1.7.2.1 Market outlook
    - 1.7.2.2 Market drivers, trends and applications
    - 1.7.2.3 Global market in tons, historical and forecast to 2032
    - 1.7.2.4 Product developers
  - 1.7.3 Aerospace
    - 1.7.3.1 Market overview
    - 1.7.3.2 Market prospects
    - 1.7.3.3 Market assessment
    - 1.7.3.4 Applications Map
    - 1.7.3.5 Global market in tons, historical and forecast to 2032
    - 1.7.3.6 Product developers
  - 1.7.4 Automotive
    - 1.7.4.1 Market outlook
    - 1.7.4.2 Market drivers, trends and applications
    - 1.7.4.3 Global market in tons, historical and forecast to 2032
    - 1.7.4.4 Product developers
  - 1.7.5 Batteries
    - 1.7.5.1 Market outlook
    - 1.7.5.2 Market drivers, trends and applications
    - 1.7.5.3 Global market in tons, historical and forecast to 2032
    - 1.7.5.4 Product developers
  - 1.7.6 Composites
    - 1.7.6.1 Fiber-based polymer composite parts
      - 1.7.6.1.1 Market outlook
      - 1.7.6.1.2 Market drivers, trends and applications
    - 1.7.6.2 Metal-matrix composites
      - 1.7.6.2.1 Market drivers, trends and applications
    - 1.7.6.3 Global market in tons, historical and forecast to 2032
    - 1.7.6.4 Product developers

### 1.7.7 Conductive inks

#### 1.7.7.1 Market outlook

#### 1.7.7.2 Market drivers, trends and applications

#### 1.7.7.3 Global market in tons, historical and forecast to 2032

#### 1.7.7.4 Product developers

### 1.7.8 Construction and buildings

#### 1.7.8.1 Market outlook

#### 1.7.8.2 Market drivers, trends and applications

##### 1.7.8.2.1 Cement

##### 1.7.8.2.2 Asphalt bitumen

##### 1.7.8.2.3 Aerogels

###### 1.7.8.2.3.1 3D printed aerogels

###### 1.7.8.2.3.2 Carbon-based aerogel composites

#### 1.7.8.3 Global market in tons, historical and forecast to 2032

#### 1.7.8.4 Product developers

### 1.7.9 Electronics

#### 1.7.9.1 Wearable electronics and displays

##### 1.7.9.1.1 Graphene in wearable electronics and displays

##### 1.7.9.1.2 Market outlook

##### 1.7.9.1.3 Market drivers, trends and applications

##### 1.7.9.1.4 Global market, historical and forecast to 2032

##### 1.7.9.1.5 Product developers

#### 1.7.9.2 Transistors and integrated circuits

##### 1.7.9.2.1 Market outlook

##### 1.7.9.2.2 Market drivers, trends and applications

##### 1.7.9.2.3 Global market, historical and forecast to 2032

##### 1.7.9.2.4 Product developers

#### 1.7.9.3 Memory devices

##### 1.7.9.3.1 Market outlook

##### 1.7.9.3.2 Market drivers, trends and applications

##### 1.7.9.3.3 Global market in tons, historical and forecast to 2031

##### 1.7.9.3.4 Product developers

### 1.7.10 Filtration membranes

#### 1.7.10.1 Market outlook

#### 1.7.10.2 Market drivers, trends and applications

#### 1.7.10.3 Global market in tons, historical and forecast to 2032

#### 1.7.10.4 Product developers

### 1.7.11 Fuel cells

#### 1.7.11.1 Market outlook

- 1.7.11.2 Market drivers, trends and applications
- 1.7.11.3 Global market in tons, historical and forecast to 2032
- 1.7.11.4 Product developers
- 1.7.12 Life sciences and medicine
  - 1.7.12.1 Market outlook
    - 1.7.12.1.1 Drug delivery
    - 1.7.12.1.2 Imaging and diagnostics
    - 1.7.12.1.3 Implants
    - 1.7.12.1.4 Medical biosensors
    - 1.7.12.1.5 Woundcare
    - 1.7.12.1.6 Medical wearables
    - 1.7.12.1.7 Gene delivery
  - 1.7.12.2 Market drivers, trends and applications
  - 1.7.12.3 Global market in tons, historical and forecast to 2032
  - 1.7.12.4 Product developers
- 1.7.13 Lighting
  - 1.7.13.1 Market outlook
  - 1.7.13.2 Market drivers, trends and applications
  - 1.7.13.3 Global market in tons, historical and forecast to 2032
  - 1.7.13.4 Product developers
- 1.7.14 Lubricants
  - 1.7.14.1 Market outlook
  - 1.7.14.2 Market drivers, trends and applications
  - 1.7.14.3 Global market in tons, historical and forecast to 2032
  - 1.7.14.4 Product developers
- 1.7.15 Oil and gas
  - 1.7.15.1 Market outlook
  - 1.7.15.2 Market drivers, trends and applications
  - 1.7.15.3 Global market in tons, historical and forecast to 2032
  - 1.7.15.4 Product developers
- 1.7.16 Paints and coatings
  - 1.7.16.1 Market outlook
  - 1.7.16.2 Market drivers, trends and applications
  - 1.7.16.3 Global market in tons, historical and forecast to 2031
  - 1.7.16.4 Product developers
- 1.7.17 Photonics
  - 1.7.17.1 Market outlook
  - 1.7.17.2 Market drivers, trends and applications
  - 1.7.17.3 Global market in tons, historical and forecast to 2031

- 1.7.17.4 Product developers
- 1.7.18 Photovoltaics
  - 1.7.18.1 Market outlook
  - 1.7.18.2 Market drivers, trends and applications
  - 1.7.18.3 Global market in tons, historical and forecast to 2031
  - 1.7.18.4 Product developers
- 1.7.19 Rubber and tires
  - 1.7.19.1 Market outlook
  - 1.7.19.2 Market drivers, trends and applications
  - 1.7.19.3 Global market in tons, historical and forecast to 2031
  - 1.7.19.4 Product developers
- 1.7.20 Sensors
  - 1.7.20.1 Market outlook
  - 1.7.20.2 Market drivers, trends and applications
  - 1.7.20.3 Global market in tons, historical and forecast to 2031
  - 1.7.20.4 Product developers
- 1.7.21 Textiles and apparel
  - 1.7.21.1 Market outlook
  - 1.7.21.2 Market drivers, trends and applications
  - 1.7.21.3 Global market in tons, historical and forecast to 2031
  - 1.7.21.4 Product developers
- 1.7.22 Supercapacitors
  - 1.7.22.1 Market outlook
  - 1.7.22.2 Market drivers, trends and applications
  - 1.7.22.3 Global market in tons, historical and forecast to 2031
  - 1.7.22.4 Product developers
- 1.7.23 Other markets
  - 1.7.23.1 Audio equipment
  - 1.7.23.2 Sporting goods and apparel
- 1.8 Graphene company profiles 354 (341 company profiles)

## **2 CARBON NANOTUBES**

- 2.1 Market overview
  - 2.1.1 The global market for carbon nanotubes in 2021
    - 2.1.1.1 Demand for Multi-walled carbon nanotubes (MWCNTs) increasing
    - 2.1.1.2 Single-walled carbon nanotubes (SWCNTs) gaining market traction
  - 2.1.2 Exceptional properties
  - 2.1.3 Market outlook in 2022



- 2.1.4 Commercial CNT-based products
- 2.1.5 MWCNTs
  - 2.1.5.1 Applications
  - 2.1.5.2 Key players
  - 2.1.5.3 Production capacities in 2021
  - 2.1.5.4 Market demand, metric tons (MT)
- 2.1.6 SWCNTs
  - 2.1.6.1 Applications
  - 2.1.6.2 Global SWCNT market consumption
  - 2.1.6.3 Production capacities
- 2.1.7 Carbon nanotubes market challenges
- 2.2 Carbon nanotube materials
  - 2.2.1 Multi-walled nanotubes (MWCNT)
    - 2.2.1.1 Properties
    - 2.2.1.2 Applications
  - 2.2.2 Single-wall carbon nanotubes (SWCNT)
    - 2.2.2.1 Properties
    - 2.2.2.2 Applications
    - 2.2.2.3 Comparison between MWCNTs and SWCNTs
  - 2.2.3 Double-walled carbon nanotubes (DWNTs)
    - 2.2.3.1 Properties
    - 2.2.3.2 Applications
  - 2.2.4 Vertically aligned CNTs (VACNTs)
    - 2.2.4.1 Properties
    - 2.2.4.2 Synthesis of VACNTs
      - 2.2.4.2.1 Physical- arc discharge and laser ablation methods
      - 2.2.4.2.2 Chemical vapor deposition (CVD) method
        - 2.2.4.2.2.1 Thermal CVD
        - 2.2.4.2.2.2 PECVD
    - 2.2.4.3 Applications
  - 2.2.5 Few-walled carbon nanotubes (FWNTs)
    - 2.2.5.1 Properties
    - 2.2.5.2 Applications
  - 2.2.6 Carbon Nanohorns (CNHs)
    - 2.2.6.1 Properties
    - 2.2.6.2 Applications
  - 2.2.7 Carbon Onions
    - 2.2.7.1 Properties
    - 2.2.7.2 Applications

- 2.2.8 Boron Nitride nanotubes (BNNTs)
  - 2.2.8.1 Properties
  - 2.2.8.2 Applications
- 2.3 Intermediate products
  - 2.3.1 CNT yarns
  - 2.3.2 CNT films
- 2.4 Synthesis and production
  - 2.4.1 Arc discharge synthesis
  - 2.4.2 Chemical Vapor Deposition (CVD)
    - 2.4.2.1 Thermal CVD
    - 2.4.2.2 Plasma enhanced chemical vapor deposition (PECVD)
  - 2.4.3 High-pressure carbon monoxide synthesis
    - 2.4.3.1 High Pressure CO (HiPco)
    - 2.4.3.2 CoMoCAT
  - 2.4.4 Flame synthesis
  - 2.4.5 Laser ablation synthesis
  - 2.4.6 Vertically aligned nanotubes production
  - 2.4.7 Silane solution method
  - 2.4.8 Advantages and disadvantages of CNT synthesis methods
- 2.5 Carbon nanotubes patents
- 2.6 Carbon nanotubes pricing
  - 2.6.1 MWCNTs
  - 2.6.2 SWCNTs
- 2.7 Markets for carbon nanotubes
  - 2.7.1 3D Printing
    - 2.7.1.1 Market overview
    - 2.7.1.2 Applications
    - 2.7.1.3 Market assessment
    - 2.7.1.4 Global market in tons, historical and forecast to 2032
    - 2.7.1.5 Product developers
  - 2.7.2 Adhesives
    - 2.7.2.1 Market overview
    - 2.7.2.2 Applications
    - 2.7.2.3 Market assessment
    - 2.7.2.4 Global market in tons, historical and forecast to 2032
    - 2.7.2.5 Product developers
  - 2.7.3 Aerospace
    - 2.7.3.1 Market overview
    - 2.7.3.2 Applications

- 2.7.3.3 Market assessment
- 2.7.3.4 Global market in tons, historical and forecast to 2032
- 2.7.3.5 Product developers
- 2.7.4 Automotive
  - 2.7.4.1 Market overview
  - 2.7.4.2 Applications
  - 2.7.4.3 Market assessment
  - 2.7.4.4 Global market in tons, historical and forecast to 2032
  - 2.7.4.5 Product developers
- 2.7.5 Batteries
  - 2.7.5.1 Market overview
  - 2.7.5.2 Applications
    - 2.7.5.2.1 CNTs in Lithium–sulfur (Li–S) batteries
    - 2.7.5.2.2 CNTs in Nanomaterials in Sodium-ion batteries
    - 2.7.5.2.3 CNTs in Nanomaterials in Lithium-air batteries
    - 2.7.5.2.4 CNTs in Flexible and stretchable batteries in electronics
    - 2.7.5.2.5 CNTs in Flexible and stretchable LIBs
    - 2.7.5.2.6 CNTs in Flexible and stretchable supercapacitors
  - 2.7.5.3 Market assessment
  - 2.7.5.4 Global market in tons, historical and forecast to 2032
  - 2.7.5.5 Product developers
- 2.7.6 Composites
  - 2.7.6.1 Market overview
  - 2.7.6.2 Fiber-based polymer composite parts
    - 2.7.6.2.1 Applications
    - 2.7.6.2.2 Market assessment
  - 2.7.6.3 Metal-matrix composites
    - 2.7.6.3.1 Market assessment
  - 2.7.6.4 Global market in tons, historical and forecast to 2032
  - 2.7.6.5 Product developers
- 2.7.7 Conductive inks
  - 2.7.7.1 Market overview
  - 2.7.7.2 Applications
  - 2.7.7.3 Market assessment
  - 2.7.7.4 Global market in tons, historical and forecast to 2032
  - 2.7.7.5 Product developers
- 2.7.8 Construction
  - 2.7.8.1 Market overview
  - 2.7.8.2 Market assessment

- 2.7.8.2.1 Cement
- 2.7.8.2.2 Asphalt bitumen
- 2.7.8.3 Global market in tons, historical and forecast to 2032
- 2.7.8.4 Product developers
- 2.7.9 Electronics
  - 2.7.9.1 Wearable electronics and displays
    - 2.7.9.1.1 Market overview
    - 2.7.9.1.2 Applications
    - 2.7.9.1.3 Market assessment
    - 2.7.9.1.4 Global market, historical and forecast to 2032
    - 2.7.9.1.5 Product developers
  - 2.7.9.2 Transistors and integrated circuits.
    - 2.7.9.2.1 Market overview
    - 2.7.9.2.2 Applications
    - 2.7.9.2.3 Market assessment
    - 2.7.9.2.4 Global market, historical and forecast to 2032
    - 2.7.9.2.5 Product developers
  - 2.7.9.3 Memory devices
    - 2.7.9.3.1 Market overview
    - 2.7.9.3.2 Market assessment
    - 2.7.9.3.3 Global market in tons, historical and forecast to 2032
    - 2.7.9.3.4 Product developers
- 2.7.10 Filtration
  - 2.7.10.1 Market overview
  - 2.7.10.2 Applications
  - 2.7.10.3 Market assessment
  - 2.7.10.4 Global market in tons, historical and forecast to 2032
  - 2.7.10.5 Product developers
- 2.7.11 Fuel cells
  - 2.7.11.1 Market overview
  - 2.7.11.2 Applications
  - 2.7.11.3 Market assessment
  - 2.7.11.4 Global market in tons, historical and forecast to 2032
  - 2.7.11.5 Product developers
- 2.7.12 Life sciences and biomedicine
  - 2.7.12.1 Market overview
  - 2.7.12.2 Applications
    - 2.7.12.2.1 Drug delivery
    - 2.7.12.2.2 Imaging and diagnostics

- 2.7.12.2.3 Implants
- 2.7.12.2.4 Medical biosensors
- 2.7.12.2.5 Woundcare
- 2.7.12.3 Market assessment
- 2.7.12.4 Global market in tons, historical and forecast to 2032
- 2.7.12.5 Product developers
- 2.7.13 Lubricants
  - 2.7.13.1 Market overview
  - 2.7.13.2 Applications
  - 2.7.13.3 Market assessment
  - 2.7.13.4 Global market in tons, historical and forecast to 2032
  - 2.7.13.5 Product developers
- 2.7.14 Oil and gas
  - 2.7.14.1 Market overview
  - 2.7.14.2 Applications
  - 2.7.14.3 Market assessment
  - 2.7.14.4 Global market in tons, historical and forecast to 2032
  - 2.7.14.5 Product developers
- 2.7.15 Paints and coatings
  - 2.7.15.1 Market overview
  - 2.7.15.2 Applications
  - 2.7.15.3 Market assessment
  - 2.7.15.4 Global market in tons, historical and forecast to 2032
  - 2.7.15.5 Product developers
- 2.7.16 Photovoltaics
  - 2.7.16.1 Market overview
  - 2.7.16.2 Market assessment
  - 2.7.16.3 Global market in tons, historical and forecast to 2032
  - 2.7.16.4 Product developers
- 2.7.17 Rubber and tires
  - 2.7.17.1 Market overview
  - 2.7.17.2 Applications
  - 2.7.17.3 Market assessment
  - 2.7.17.4 Global market in tons, historical and forecast to 2032
  - 2.7.17.5 Product developers
- 2.7.18 Sensors
  - 2.7.18.1 Market overview
  - 2.7.18.2 Applications
  - 2.7.18.3 Market assessment

- 2.7.18.4 Global market in tons, historical and forecast to 2032
- 2.7.18.5 Product developers
- 2.7.19 Smart textiles, electronic textiles and apparel.
  - 2.7.19.1 Market overview
  - 2.7.19.2 Applications
  - 2.7.19.3 Market assessment
  - 2.7.19.4 Global market in tons, historical and forecast to 2032
  - 2.7.19.5 Product developers
- 2.7.20 Supercapacitors
  - 2.7.20.1 Market overview
  - 2.7.20.2 Applications
  - 2.7.20.3 Market assessment
  - 2.7.20.4 Global market in tons, historical and forecast to 2032
  - 2.7.20.5 Product developers
- 2.7.21 Other markets
  - 2.7.21.1 Thermal interface materials
    - 2.7.21.1.1 Market assessment
  - 2.7.21.2 Power cables
    - 2.7.21.2.1 Market assessment
- 2.8 Multi-walled carbon nanotubes company profiles 851 (131 company profiles)
- 2.9 Single-walled carbon nanotubes company profiles 950 (16 company profiles)

### **3 CARBON NANOFIBERS**

- 3.1 Properties
- 3.2 Synthesis
  - 3.2.1 Chemical vapor deposition
  - 3.2.2 Electrospinning
  - 3.2.3 Template-based
  - 3.2.4 From biomass
- 3.3 Markets
  - 3.3.1 Batteries
  - 3.3.2 Supercapacitors
  - 3.3.3 Fuel cells
  - 3.3.4 CO<sub>2</sub> capture
- 3.4 Companies 975 (10 company profiles)

### **4 2-D MATERIALS**

## 4.1 2D MATERIALS PRODUCTION METHODS

### 4.1.1 Top-down exfoliation

#### 4.1.1.1 Mechanical exfoliation method

#### 4.1.1.2 Liquid exfoliation method

### 4.1.2 Bottom-up synthesis

#### 4.1.2.1 Chemical synthesis in solution

#### 4.1.2.2 Chemical vapor deposition

## 4.2 TYPES OF 2D MATERIALS

### 4.2.1 Hexagonal boron-nitride (h-BN)/Boron nitride nanosheets (BNNSs)

#### 4.2.1.1 Properties

#### 4.2.1.2 Applications and markets

##### 4.2.1.2.1 Electronics

##### 4.2.1.2.2 Fuel cells

##### 4.2.1.2.3 Adsorbents

##### 4.2.1.2.4 Photodetectors

##### 4.2.1.2.5 Textiles

##### 4.2.1.2.6 Biomedical

### 4.2.2 MXenes

#### 4.2.2.1 Properties

#### 4.2.2.2 Applications

##### 4.2.2.2.1 Catalysts

##### 4.2.2.2.2 Hydrogels

##### 4.2.2.2.3 Energy storage devices

###### 4.2.2.2.3.1 Supercapacitors

###### 4.2.2.2.3.2 Batteries

###### 4.2.2.2.3.3 Gas Separation

###### 4.2.2.2.3.4 Liquid Separation

###### 4.2.2.2.3.5 Antibacterials

### 4.2.3 Transition metal dichalcogenides (TMD)

#### 4.2.3.1 Properties

##### 4.2.3.1.1 Molybdenum disulphide (MoS<sub>2</sub>)

##### 4.2.3.1.2 Tungsten ditelluride (WTe<sub>2</sub>)

#### 4.2.3.2 Applications

##### 4.2.3.2.1 Electronics

##### 4.2.3.2.2 Optoelectronics

##### 4.2.3.2.3 Biomedical

##### 4.2.3.2.4 Piezoelectrics

##### 4.2.3.2.5 Sensors

##### 4.2.3.2.6 Filtration

- 4.2.3.2.7 Batteries and supercapacitors
- 4.2.3.2.8 Fiber lasers
- 4.2.4 Borophene
  - 4.2.4.1 Properties
  - 4.2.4.2 Applications
    - 4.2.4.2.1 Energy storage
    - 4.2.4.2.2 Hydrogen storage
    - 4.2.4.2.3 Sensors
    - 4.2.4.2.4 Electronics
- 4.2.5 Phosphorene/ Black phosphorus
  - 4.2.5.1 Properties
  - 4.2.5.2 Applications
    - 4.2.5.2.1 Electronics
    - 4.2.5.2.2 Field effect transistors
    - 4.2.5.2.3 Thermoelectrics
    - 4.2.5.2.4 Batteries
      - 4.2.5.2.4.1 Lithium-ion batteries (LIB)
      - 4.2.5.2.4.2 Sodium-ion batteries
      - 4.2.5.2.4.3 Lithium–sulfur batteries
    - 4.2.5.2.5 Supercapacitors
    - 4.2.5.2.6 Photodetectors
    - 4.2.5.2.7 Sensors
- 4.2.6 Graphitic carbon nitride (g-C<sub>3</sub>N<sub>4</sub>)
  - 4.2.6.1 Properties
  - 4.2.6.2 C<sub>2</sub>N
  - 4.2.6.3 Applications
    - 4.2.6.3.1 Electronics
    - 4.2.6.3.2 Filtration membranes
    - 4.2.6.3.3 Photocatalysts
    - 4.2.6.3.4 Batteries
    - 4.2.6.3.5 Sensors
- 4.2.7 Germanene
  - 4.2.7.1 Properties
  - 4.2.7.2 Applications
    - 4.2.7.2.1 Electronics
    - 4.2.7.2.2 Batteries
- 4.2.8 Graphdiyne
  - 4.2.8.1 Properties
  - 4.2.8.2 Applications



- 4.2.8.2.1 Electronics
- 4.2.8.2.2 Batteries
  - 4.2.8.2.2.1 Lithium-ion batteries (LIB)
  - 4.2.8.2.2.2 Sodium ion batteries
- 4.2.8.2.3 Separation membranes
- 4.2.8.2.4 Water filtration
- 4.2.8.2.5 Photocatalysts
- 4.2.8.2.6 Photovoltaics
- 4.2.8.2.7 Gas separation
- 4.2.9 Graphane
  - 4.2.9.1 Properties
  - 4.2.9.2 Applications
    - 4.2.9.2.1 Electronics
    - 4.2.9.2.2 Hydrogen storage
- 4.2.10 Rhenium disulfide (ReS<sub>2</sub>) and diselenide (ReSe<sub>2</sub>)
  - 4.2.10.1 Properties
  - 4.2.10.2 Applications
- 4.2.11 Silicene
  - 4.2.11.1 Properties
  - 4.2.11.2 Applications
    - 4.2.11.2.1 Electronics
    - 4.2.11.2.2 Thermoelectrics
    - 4.2.11.2.3 Batteries
    - 4.2.11.2.4 Sensors
    - 4.2.11.2.5 Biomedical
- 4.2.12 Stanene/tinene
  - 4.2.12.1 Properties
  - 4.2.12.2 Applications
    - 4.2.12.2.1 Electronics
- 4.2.13 Antimonene
  - 4.2.13.1 Properties
  - 4.2.13.2 Applications
- 4.2.14 Indium selenide
  - 4.2.14.1 Properties
  - 4.2.14.2 Applications
    - 4.2.14.2.1 Electronics
- 4.2.15 Layered double hydroxides (LDH)
  - 4.2.15.1 Properties
  - 4.2.15.2 Applications

- 4.2.15.2.1 Adsorbents
- 4.2.15.2.2 Catalyst
- 4.2.15.2.3 Sensors
- 4.2.15.2.4 Electrodes
- 4.2.15.2.5 Flame Retardants
- 4.2.15.2.6 Biosensors
- 4.2.15.2.7 Tissue engineering
- 4.2.15.2.8 Anti-Microbials
- 4.2.15.2.9 Drug Delivery

4.3 2D materials producer and supplier profiles (19 company profiles)

## **5 NANODIAMONDS**

### **5.1 Types**

- 5.1.1 Commercial nanodiamonds
- 5.1.2 Fluorescent nanodiamonds (FNDs)

### **5.2 Production methods-advantages and disadvantages**

### **5.3 Applications**

### **5.4 Markets**

#### **5.4.1 Lubricants**

##### **5.4.1.1 Nanolubricants**

##### **5.4.1.2 Products**

##### **5.4.1.3 Applications**

##### **5.4.1.4 Global market demand for nanodiamonds in lubricants to 2032, tons**

#### **5.4.2 Electronic polishing materials**

##### **5.4.2.1 Applications**

##### **5.4.2.2 Global market demand for nanodiamonds in polishing additives to 2032 (tons)**

#### **5.4.3 Electroplating and anti-wear/friction coatings**

##### **5.4.3.1 Applications**

##### **5.4.3.2 Global market demand for nanodiamonds in electroplating and anti-wear/friction coatings to 2032 (tons)**

#### **5.4.4 Composites**

##### **5.4.4.1 Fiber-based polymer composite parts**

##### **5.4.4.1.1 Applications**

##### **5.4.4.1.2 Global market demand for nanodiamonds in composites to 2032 (tons)**

##### **5.4.4.1.2.1 Thermosets**

##### **5.4.4.1.2.2 Thermoplastics**

##### **5.4.4.2 Metal-matrix composites**

##### **5.4.4.2.1 Market overview**

5.4.4.2.2 Global market demand for nanodiamonds in metal composites to 2032, tons

#### 5.4.5 Skincare

5.4.5.1 Market for nanodiamonds in skincare

5.4.5.2 Market and applications

5.4.5.3 Global market demand for nanodiamonds in skincare to 2032 (tons)

#### 5.4.6 Supercapacitors

5.4.6.1 Market for nanodiamonds in supercapacitors

5.4.6.2 Applications

5.4.6.3 Global market demand for nanodiamonds in supercapacitors to 2032 (tons)

#### 5.4.7 Batteries

5.4.7.1 Market for nanodiamonds in batteries

5.4.7.2 Applications

5.4.7.3 Global market demand for nanodiamonds in batteries to 2032 (tons)

#### 5.4.8 Drug delivery

5.4.8.1 Market for nanodiamonds in drug delivery

5.4.8.2 Applications

### 5.5 Nanodiamonds pricing

### 5.6 Nanodiamond company profiles (31 company profiles)

## 6 FULLERENES

### 6.1 Properties

### 6.2 Products

### 6.3 Applications

### 6.4 Global consumption in metric tonnes, 2010-2032

### 6.5 Prices 1131

### 6.6 Fullerene company profiles (20 company profiles)

## 7 RESEARCH METHODOLOGY

### 7.1 Technology Readiness Level (TRL)

## 8 REFERENCES

## List Of Tables

### LIST OF TABLES

- Table 1. Graphene commercial market developments 2020-2022.
- Table 2. Graphene funding and investments 2020-2022.
- Table 3. Publicly listed graphene companies.
- Table 4. Main graphene producers by country, annual production capacities, types and main markets they sell to.
- Table 5. Demand for graphene (tons), 2018-2032.
- Table 6. Main graphene producers in North America.
- Table 7. Main graphene producers in Europe.
- Table 8. Commercial products incorporating graphene.
- Table 9. Graphene industrial collaborations, licence agreements and target markets.
- Table 10. Graphene market challenges.
- Table 11. Applications of GO and rGO.
- Table 12. Comparison of graphene QDs and semiconductor QDs.
- Table 13. Advantages and disadvantages of methods for preparing GQDs.
- Table 14. Applications of graphene quantum dots.
- Table 15. Markets and applications for graphene quantum dots in electronics and photonics.
- Table 16. Markets and applications for graphene quantum dots in energy storage and conversion.
- Table 17. Markets and applications for graphene quantum dots in sensors.
- Table 18. Markets and applications for graphene quantum dots in biomedicine and life sciences.
- Table 19. Markets and applications for graphene quantum dots in electronics.
- Table 20. Market and technology challenges for graphene quantum dots.
- Table 21. Prices for graphene quantum dots.
- Table 22. Accumulated number of patent publications for graphene, 2004-2019.
- Table 23. Assessment of graphene production methods.
- Table 24. Demand for graphene (tons), 2018-2032.
- Table 25. Graphene oxide production capacity by producer, 2014-2022.
- Table 26. Graphene nanoplatelets capacity in tons by producer, 2010-2022.
- Table 27. CVD graphene film capacity by producer, 2014-2022 in 000s m<sup>2</sup>.
- Table 28. Types of graphene and typical prices.
- Table 29. Pristine graphene flakes pricing by producer.
- Table 30. Few-layer graphene pricing by producer.
- Table 31. Graphene nanoplatelets pricing by producer.

Table 32. Graphene oxide and reduced graphene oxide pricing, by producer.
Table 33. Graphene quantum dots pricing by producer.
Table 34. Multi-layer graphene pricing by producer.
Table 35. Graphene ink pricing by producer.
Table 36. Market overview for graphene in 3D printing.
Table 37. Market outlook for graphene in 3D printing.
Table 38. Market and applications for graphene in 3D printing.
Table 39. Demand for graphene in 3-D printing (tons), 2018-2032.
Table 40. Product developers in graphene 3D printing.
Table 41. Market overview for graphene in adhesives.
Table 42. Market outlook for graphene in adhesives.
Table 43. Market and applications for graphene in adhesives.
Table 44. Demand for graphene in adhesives (tons), 2018-2032.
Table 45. Product developers in graphene adhesives.
Table 46. Market overview for graphene in aerospace.
Table 47. Scorecard for graphene in aerospace.
Table 48. Market and applications for graphene in aerospace.
Table 49. Demand for graphene in aerospace (tons), 2018-2030.
Table 50. Product developers in graphene for aerospace.
Table 51. Market overview for graphene in the automotive market.
Table 52. Market outlook for graphene in automotive.
Table 53. Market and applications for graphene in automotive.
Table 54. Demand for graphene in automotive (tons), 2018-2032.
Table 55. Product developers in the graphene automotive market.
Table 56. Applications of nanomaterials in batteries.
Table 57. Market overview for graphene in batteries.
Table 58. Market outlook for graphene in batteries.
Table 59. Market drivers for use of nanomaterials in batteries.
Table 60. Applications of nanomaterials in flexible and stretchable batteries, by materials type and benefits thereof.
Table 61. Market and applications for graphene in batteries.
Table 62. Estimated demand for graphene in batteries (tons), 2018-2032.
Table 63. Product developers in graphene batteries.
Table 64. Market overview for graphene in composites.
Table 65. Market outlook for graphene in fiber-based polymer composite parts.
Table 66. Market and applications for graphene in fiber-based composite parts.
Table 67. Market and applications for graphene in metal matrix composites.
Table 68. Global market for graphene in composites 2018-2032, tons.
Table 69. Product developers in graphene composites.

Table 70. Market overview for graphene in conductive inks.
Table 71. Market outlook for graphene in conductive inks.
Table 72. Market and applications for graphene in conductive inks.
Table 73. Comparative properties of conductive inks.
Table 74. Demand for graphene in conductive ink (tons), 2018-2032.
Table 75. Product developers in graphene conductive inks.
Table 76. Market overview for graphene in construction and buildings.
Table 77. Market outlook for graphene in construction.
Table 78. Graphene for cement.
Table 79. Graphene for asphalt bitumen.
Table 80. Demand for graphene in construction (tons), 2018-2032.
Table 81: Graphene product developers in construction.
Table 82. Market overview for graphene in wearable electronics and displays.
Table 83. Market outlook for graphene in wearable electronics and displays.
Table 84. Market and applications for graphene in electronics.
Table 85. Comparison of ITO replacements.
Table 86. Demand for graphene in wearable, flexible and stretchable electronics, 2018-2032.
Table 87. Product developers in graphene-based electronics.
Table 88. Market overview for graphene in transistors and integrated circuits.
Table 89. Comparative properties of silicon and graphene transistors.
Table 90. Market outlook for graphene in transistors and integrated circuits.
Table 91. Market and applications for graphene in transistors and integrated circuits.
Table 92. Demand for graphene in transistors and integrated circuits, 2018-2032.
Table 93. Product developers in graphene transistors and integrated circuits.
Table 94. Market overview for graphene in memory devices.
Table 95. Market outlook for graphene in memory devices.
Table 96. Market and applications for graphene in memory devices.
Table 97. Demand for graphene in memory devices, 2018-2032.
Table 98. Product developers in graphene memory devices.
Table 99. Market overview for graphene in filtration.
Table 100. Market outlook for graphene in filtration.
Table 101. Market and applications for graphene in filtration.
Table 102. Demand for graphene in filtration (tons), 2018-2032.
Table 103. Graphene companies in filtration.
Table 104. Market overview for graphene in fuel cells.
Table 105. Market outlook for graphene in fuel cells.
Table 106. Market and applications for graphene in fuel cells.
Table 107. Demand for graphene in fuel cells (tons), 2018-2032.

Table 108.	Product developers in graphene fuel cells.
Table 109.	Market overview for graphene in life sciences and medicine.
Table 110.	Market outlook for graphene in drug delivery.
Table 111.	Scorecard for graphene in imaging and diagnostics.
Table 112.	Scorecard for graphene in medical implants.
Table 113.	Scorecard for graphene in medical biosensors.
Table 114.	Scorecard for graphene in woundcare.
Table 115.	Market and applications for graphene in life sciences and medicine.
Table 116.	Demand for graphene in life sciences and medical (tons), 2018-2032.
Table 117.	Product developers in graphene life sciences and biomedicine.
Table 118.	Market overview for graphene in lighting.
Table 119.	Market outlook for graphene in lighting.
Table 120.	Market and applications for graphene in lighting.
Table 121.	Demand for graphene in lighting, 2018-2032.
Table 122.	Product developers in graphene lighting.
Table 123.	Market overview for graphene in lubricants.
Table 124.	Market outlook for graphene in lubricants.
Table 125.	Market and applications for graphene in lubricants.
Table 126.	Demand for graphene in lubricants (tons), 2018-2032.
Table 127.	Product developers in graphene lubricants.
Table 128.	Market overview for graphene in oil and gas.
Table 129.	Market outlook for graphene in oil and gas.
Table 130.	Market and applications for graphene in oil and gas.
Table 131.	Demand for graphene in oil and gas (tons), 2018-2032.
Table 132.	Product developers in graphene oil and gas.
Table 133.	Market overview for graphene in paints and coatings.
Table 134.	Market outlook for graphene in paints and coatings.
Table 135.	Market and applications for graphene in paints and coatings.
Table 136.	Demand for graphene in paints and coatings (tons), 2018-2032.
Table 137.	Product developers in graphene paints and coatings.
Table 138.	Market outlook for graphene in photonics.
Table 139.	Market and applications for graphene in photonics.
Table 140.	Demand for graphene in photonics, 2018-2032.
Table 141.	Product developers in graphene photonics.
Table 142.	Market overview for graphene in photovoltaics.
Table 143.	Market outlook for graphene in photovoltaics.
Table 144.	Market and applications for graphene in photovoltaics.
Table 145.	Demand for graphene in photovoltaics (tons), 2018-2032.
Table 146.	Product developers in graphene solar.



Table 147. Market overview for graphene in rubber and tires.
Table 148. Market outlook for graphene in rubber and tires.
Table 149. Market and applications for graphene in rubber and tires.
Table 150. Demand for graphene in rubber and tires (tons), 2018-2032.
Table 151. Product developers in rubber and tires.
Table 152. Market overview for graphene in sensors.
Table 153. Market outlook for graphene in sensors.
Table 154. Market and applications for graphene in sensors.
Table 155. Demand for graphene in sensors (tons), 2018-2032.
Table 156. Product developers in graphene sensors.
Table 157. Market overview for graphene in smart textiles and apparel.
Table 158. Market outlook for graphene in smart textiles and apparel.
Table 159. Market and applications for graphene in smart textiles and apparel.
Table 160. Demand for graphene in textiles (tons), 2018-2032.
Table 161. Graphene product developers in smart textiles and apparel.
Table 162. Market overview for graphene in supercapacitors.
Table 163. Market outlook for graphene in supercapacitors.
Table 164. Comparative properties of graphene supercapacitors and lithium-ion batteries.
Table 165. Market and applications for graphene in supercapacitors.
Table 166. Demand for graphene in supercapacitors (tons), 2018-2032.
Table 167. Product developers in graphene supercapacitors.
Table 168. Graphene audio equipment producers and products.
Table 169. Graphene sporting goods producers and products.
Table 170. Performance criteria of energy storage devices.
Table 171. Market summary for carbon nanotubes-Selling grade particle diameter, usage, advantages, average price/ton, high volume applications, low volume applications and novel applications.
Table 172. Typical properties of SWCNT and MWCNT.
Table 173. Applications of MWCNTs.
Table 174. Annual production capacity of the key MWCNT producers in 2021 (MT).
Table 175. Demand for MWCNT by region in 2020, 2031.
Table 176. Markets, benefits and applications of Single-Walled Carbon Nanotubes.
Table 177. SWCNT market demand forecast (metric tons), 2018-2032.
Table 178. Annual production capacity of SWCNT producers in 2021 (KG).
Table 179. Carbon nanotubes market challenges.
Table 180. Markets, benefits and applications of Single-Walled Carbon Nanotubes.
Table 181. Comparison between single-walled carbon nanotubes and multi-walled carbon nanotubes.



- Table 182. Comparative properties of BNNTs and CNTs.
- Table 183. Applications of BNNTs.
- Table 184. Comparison of well-established approaches for CNT synthesis.
- Table 185. SWCNT synthesis methods.
- Table 186. Advantages and disadvantages of CNT synthesis methods
- Table 187. MWCNTs and BNNTs pricing, by producer.
- Table 188. SWCNTs pricing.
- Table 189. Market overview for carbon nanotubes in 3D printing.
- Table 190. Applications of carbon nanotubes in 3D printing.
- Table 191. Market and applications for carbon nanotubes in 3D printing.
- Table 192. Demand for carbon nanotubes in 3-D printing (tons), 2018-2032.
- Table 193. Product developers in carbon nanotubes in 3D printing.
- Table 194. Market overview for carbon nanotubes in adhesives.
- Table 195. Applications of carbon nanotubes in adhesives.
- Table 196. Market and applications for carbon nanotubes in adhesives.
- Table 197. Demand for carbon nanotubes in adhesives (tons), 2018-2032.
- Table 198. Product developers in carbon nanotubes for adhesives.
- Table 199. Market overview for carbon nanotubes in aerospace.
- Table 200. Applications of carbon nanomaterials in aerospace.
- Table 201. Market and applications for carbon nanotubes in aerospace.
- Table 202. Demand for carbon nanotubes in aerospace (tons), 2018-2032.
- Table 203. Product developers in carbon nanotubes for aerospace.
- Table 204. Market overview for carbon nanotubes in automotive.
- Table 205. Applications of carbon nanotubes in automotive.
- Table 206. Market and applications for carbon nanotubes in automotive.
- Table 207. Demand for carbon nanotubes in automotive (tons), 2018-2032
- Table 208. Product developers in carbon nanotubes in the automotive market.
- Table 209. Market overview for carbon nanotubes in batteries.
- Table 210. Applications of carbon nanotubes in batteries.
- Table 211. Applications in sodium-ion batteries, by nanomaterials type and benefits thereof.
- Table 212. Applications in lithium-air batteries, by nanomaterials type and benefits thereof.
- Table 213. Applications in flexible and stretchable supercapacitors, by advanced materials type and benefits thereof.
- Table 214. Market and applications for carbon nanotubes in batteries.
- Table 215. Estimated demand for carbon nanotubes in batteries (tons), 2018-2032.
- Table 216. Product developers in carbon nanotubes for batteries.
- Table 217. Market overview for carbon nanotubes in composites.

Table 218. Applications of carbon nanotubes in fiber-based polymer composite parts.

Table 219. Market and applications for carbon nanotubes in fiber-based composite parts.

Table 220. Market and applications for carbon nanotubes in metal matrix composites.

Table 221. Global market for carbon nanotubes in composites 2018-2030, tons.

Table 222. Product developers in carbon nanotubes in composites.

Table 223. Market overview for carbon nanotubes in conductive inks.

Table 224. Applications of carbon nanomaterials in conductive ink.

Table 225. Market and applications for carbon nanotubes in conductive inks.

Table 226. Comparative properties of conductive inks.

Table 227. Demand for carbon nanotubes in conductive ink (tons), 2018-2027.

Table 228. Product developers in carbon nanotubes for conductive inks.

Table 229. Market overview for carbon nanotubes in construction.

Table 230. Carbon nanotubes for cement.

Table 231. Carbon nanotubes for asphalt bitumen.

Table 232. Demand for carbon nanotubes in construction (tons), 2018-2032.

Table 233. Carbon nanotubes product developers in construction.

Table 234. Market overview for carbon nanotubes in wearable electronics and displays.

Table 235. Applications of carbon nanotubes in wearable electronics and displays.

Table 236. Market and applications for carbon nanotubes in wearable electronics and displays.

Table 237. Comparison of ITO replacements.

Table 238. Demand for carbon nanotubes in wearable electronics and displays, 2018-2032.

Table 239. Product developers in carbon nanotubes for electronics.

Table 240. Market overview for carbon nanotubes in transistors and integrated circuits.

Table 241. Applications of carbon nanotubes in transistors and integrated circuits.

Table 242. Market and applications for carbon nanotubes in transistors and integrated circuits.

Table 243. Demand for carbon nanotubes in transistors and integrated circuits, 2018-2032.

Table 244. Product developers in carbon nanotubes in transistors and integrated circuits.

Table 245. Market overview for carbon nanotubes in memory devices.

Table 246. Market and applications for carbon nanotubes in memory devices.

Table 247. Demand for carbon nanotubes in memory devices, 2018-2032.

Table 248. Product developers in carbon nanotubes for memory devices.

Table 249. Comparison of CNT membranes with other membrane technologies

Table 250. Market overview for carbon nanotubes in filtration.

Table 251.	Applications of carbon nanotubes in filtration.
Table 252.	Market and applications for carbon nanotubes in filtration.
Table 253.	Demand for carbon nanotubes in filtration (tons), 2018-2032.
Table 254.	Carbon nanotubes companies in filtration.
Table 255.	Electrical conductivity of different catalyst supports compared to carbon nanotubes.
Table 256.	Market overview for carbon nanotubes in fuel cells.
Table 257.	Applications of carbon nanotubes in fuel cells.
Table 258.	Market and applications for carbon nanotubes in fuel cells.
Table 259.	Demand for carbon nanotubes in fuel cells (tons), 2018-2032.
Table 260.	Product developers in carbon nanotubes for fuel cells.
Table 261.	Market overview for carbon nanotubes in life sciences and medicine.
Table 262.	Applications of carbon nanotubes in life sciences and biomedicine
Table 263.	Scorecard for carbon nanotubes in drug delivery.
Table 264.	Scorecard for carbon nanotubes in imaging and diagnostics.
Table 265.	Scorecard for carbon nanotubes in medical implants.
Table 266.	Scorecard for carbon nanotubes in medical biosensors.
Table 267.	Scorecard for carbon nanotubes in woundcare.
Table 268.	Market and applications for carbon nanotubes in life sciences and medicine.
Table 269.	Demand for carbon nanotubes in life sciences and medical (tons), 2018-2032.
Table 270.	Product developers in carbon nanotubes for life sciences and biomedicine.
Table 271.	Market overview for carbon nanotubes in lubricants.
Table 272.	Nanomaterial lubricant products.
Table 273.	Applications of carbon nanotubes in lubricants.
Table 274.	Market and applications for carbon nanotubes in lubricants.
Table 275.	Demand for carbon nanotubes in lubricants (tons), 2018-2032.
Table 276.	Product developers in carbon nanotubes for lubricants.
Table 277.	Market overview for carbon nanotubes in oil and gas.
Table 278.	Applications of carbon nanotubes in oil and gas.
Table 279.	Market and applications for carbon nanotubes in oil and gas.
Table 280.	Demand for carbon nanotubes in oil and gas (tons), 2018-2032.
Table 281.	Product developers in carbon nanotubes for oil and gas.
Table 282.	Markets for carbon nanotube coatings.
Table 283.	Market overview for carbon nanotubes in paints and coatings.
Table 284.	Applications of carbon nanotubes in paints and coatings.
Table 285.	Market and applications for carbon nanotubes in paints and coatings.
Table 286.	Demand for carbon nanotubes in paints and coatings (tons), 2018-2032.
Table 287.	Product developers in carbon nanotubes for paints and coatings.

- Table 288. Market overview for carbon nanotubes in photovoltaics.
- Table 289. Market and applications for carbon nanotubes in photovoltaics.
- Table 290. Demand for carbon nanotubes in photovoltaics (tons), 2018-2032.
- Table 291. Product developers in carbon nanotubes for solar.
- Table 292. Market overview for carbon nanotubes in rubber and tires.
- Table 293. Applications of carbon nanomaterials in rubber and tires.
- Table 294. Market and applications for carbon nanotubes in rubber and tires.
- Table 295. Demand for carbon nanotubes in rubber and tires (tons), 2018-2032.
- Table 296. Product developers in carbon nanotubes in rubber and tires.
- Table 297. Market overview for carbon nanotubes in sensors.
- Table 298. Applications of carbon nanotubes in sensors.
- Table 299. Market and applications for carbon nanotubes in sensors.
- Table 300. Demand for carbon nanotubes in sensors (tons), 2018-2032.
- Table 301. Product developers in carbon nanotubes for sensors.
- Table 302. Desirable functional properties for the textiles industry afforded by the use of nanomaterials.
- Table 303. Market overview for carbon nanotubes in smart textiles and apparel.
- Table 304. Applications of carbon nanotubes in smart textiles and apparel.
- Table 305. Market and applications for carbon nanotubes in smart textiles and apparel.
- Table 306. Demand for carbon nanotubes in textiles (tons), 2018-2032.
- Table 307. Carbon nanotubes product developers in smart textiles and apparel.
- Table 308. Market overview for carbon nanotubes in supercapacitors.
- Table 309. Applications of carbon nanotubes in supercapacitors.
- Table 310. Market and applications for carbon nanotubes in supercapacitors.
- Table 311. Demand for carbon nanotubes in supercapacitors (tons), 2018-2032.
- Table 312. Product developers in carbon nanotubes for supercapacitors.
- Table 313. Market and applications for carbon nanotubes in thermal interface materials.
- Table 314. Market and applications for carbon nanotubes in power cables.
- Table 315. Properties of carbon nanotube paper.
- Table 316. Chasm SWCNT products.
- Table 317. Thomas Swan SWCNT production.
- Table 318. Comparison of synthesis methods for carbon nanofibers.
- Table 319. 2D materials types.
- Table 320. Comparison of top-down exfoliation methods to produce 2D materials.
- Table 321. Comparison of the bottom-up synthesis methods to produce 2D materials.
- Table 322. Properties of hexagonal boron nitride (h-BN).
- Table 323. Electronic and mechanical properties of monolayer phosphorene, graphene and MoS<sub>2</sub>.
- Table 324. Properties and applications of functionalized germanene.

Table 325. GDY-based anode materials in LIBs and SIBs

Table 326. Physical and electronic properties of Stanene.

Table 327. Properties of nanodiamonds.

Table 328. Summary of types of NDS and production methods-advantages and disadvantages.

Table 329. Markets, benefits and applications of nanodiamonds.

Table 330. Nanomaterial lubricant products.

Table 331. Market overview for nanodiamonds in lubricants-market maturity, market demand, competitive landscape.

Table 332. Market and applications for nanodiamonds in lubricants-applications, benefits, market megatrends, market drivers for use of nanodiamonds, technology challenges, competing materials, market demand

Table 333. Market demand for nanodiamonds in lubricants to 2032, tons

Table 334. Market overview for NDs in polishing materials-market maturity, market demand, competitive landscape.

Table 335. Market and applications for nanodiamonds in polishing materials-applications, benefits, market megatrends, market drivers for use of nanodiamonds, technology challenges, competing materials, market demand.

Table 336. Global market demand for nanodiamonds in polishing additives to 2032 (tons).

Table 337. Market overview for NDs in electroplating and anti-friction/wear coatings-market maturity, market demand, competitive landscape.

Table 338. Market and applications for NDs in electroplating and anti-wear/friction coatings-applications, benefits, market megatrends, market drivers for use of nanodiamonds, technology challenges, competing materials, market demand.

Table 339. Global market demand for nanodiamonds in electroplating and anti-wear/friction coatings to 2032 (tons)

Table 340. Market overview for nanodiamonds in composites-market maturity, market demand, competitive landscape.

Table 341. Market overview for nanodiamonds in fiber-based polymer composite parts.

Table 342. Market and applications for nanodiamonds in fiber-based composite parts-applications, benefits, market megatrends, market drivers for use of nanodiamonds, technology challenges, competing materials, market demand.

Table 343. Global market demand for nanodiamonds in thermosets to 2032 (tons).

Table 344. Global market demand for nanodiamonds in thermoplastics to 2032 (tons).

Table 345. Market and applications for NDs in metal matrix composites-market maturity, market demand, competitive landscape.

Table 346. Global market demand for nanodiamonds in metal composites to 2032, tons

Table 347. Market overview for NDs in skincare (cosmetics).



- Table 348. Market and applications for nanodiamonds in skincare (cosmetics)-applications, benefits, market megatrends, market drivers for use of nanodiamonds, technology challenges, competing materials, market demand.
- Table 349. Global market demand for nanodiamonds in skincare to 2032 (tons)
- Table 350. Market overview for nanodiamonds in supercapacitors-market maturity, market demand, competitive landscape.
- Table 351. Market and applications for nanodiamonds in supercapacitors- applications, benefits, market megatrends, market drivers for use of nanodiamonds, technology challenges, competing materials, market demand.
- Table 352. Global market demand for nanodiamonds in supercapacitors to 2032 (tons)
- Table 353. Market overview for nanodiamonds in batteries -market maturity, market demand, competitive landscape.
- Table 354. Market and applications for NDs in batteries- applications, benefits, market megatrends, market drivers for use of nanodiamonds, technology challenges, competing materials, market demand.
- Table 355. Global market demand for nanodiamonds in batteries to 2032 (tons).
- Table 356. Market overview for NDs in drug delivery.
- Table 357. Different nanoparticle vehicles used in nanomedicine.
- Table 358. FDA-approved nanotechnology-based products and clinical trials.
- Table 359. NDs for drug delivery-applications, benefits, market megatrends, market drivers for use of nanodiamonds, technology challenges, competing materials, market demand.
- Table 360. Pricing of nanodiamonds, by producer/distributor.
- Table 361. Production methods, by main ND producers.
- Table 362. Adamas Nanotechnologies, Inc. nanodiamond product list.
- Table 363. Carbodeon Ltd. Oy nanodiamond product list.
- Table 364. Daicel nanodiamond product list.
- Table 365. FND Biotech Nanodiamond product list.
- Table 366. JSC Sintia nanodiamond product list.
- Table 367. Plasmachem product list and applications.
- Table 368. Ray-Techniques Ltd. nanodiamonds product list.
- Table 369. Comparison of ND produced by detonation and laser synthesis.
- Table 370. Market overview for fullerenes-Selling grade particle diameter, usage, advantages, average price/ton, high volume applications, low volume applications and novel applications.
- Table 371. Types of fullerenes and applications.
- Table 372. Products incorporating fullerenes.
- Table 373. Markets, benefits and applications of fullerenes.
- Table 374. Global consumption of fullerenes in metric tonnes, 2010-2031.

Table 375. Example prices of fullerenes.

Table 376. Technology Readiness Level (TRL) Examples.

## List Of Figures

### LIST OF FIGURES

- Figure 1. Demand for graphene, by market, 2021.
- Figure 2. Demand for graphene, 2018-2032, tons.
- Figure 3. Global graphene demand by market, 2018-2032 (tons), conservative estimate.
- Figure 4. Global graphene demand by market, 2018-2032 (tons). Medium estimate.
- Figure 5. Global graphene demand by market, 2018-2032 (tons). High estimate.
- Figure 6. Demand for graphene in China, by market, 2021.
- Figure 7. Demand for graphene in Asia-Pacific, by market, 2021.
- Figure 8. Main graphene producers in Asia-Pacific.
- Figure 9. Demand for graphene in North America, by market, 2021.
- Figure 10. Demand for graphene in Europe, by market, 2021.
- Figure 11. Graphene and its descendants: top right: graphene; top left: graphite = stacked graphene; bottom right: nanotube=rolled graphene; bottom left: fullerene=wrapped graphene.
- Figure 12. Types of CVD methods.
- Figure 13. Schematic of the manufacture of GnPs starting from natural graphite.
- Figure 14. Green-fluorescing graphene quantum dots.
- Figure 15. Schematic of (a) CQDs and (c) GQDs. HRTEM images of (b) C-dots and (d) GQDs showing combination of zigzag and armchair edges (positions marked as 1–4).
- Figure 16. Graphene quantum dots.
- Figure 17. Top-down and bottom-up graphene QD synthesis methods.
- Figure 18. Revenues for graphene quantum dots 2019-2032, millions USD
- Figure 19. Published patent publications for graphene, 2004-2019.
- Figure 20. Fabrication methods of graphene.
- Figure 21. TEM micrographs of: A) HR-CNFs; B) GANF® HR-CNF, it can be observed its high graphitic structure; C) Unraveled ribbon from the HR-CNF; D) Detail of the ribbon; E) Scheme of the structure of the HR-CNFs; F) Large single graphene oxide sheets derived from GANF.
- Figure 22. (a) Graphene powder production line The Sixth Element Materials Technology Co. Ltd. (b) Graphene film production line of Wuxi Graphene Films Co. Ltd.
- Figure 23. Schematic illustration of the main graphene production methods.
- Figure 24. Demand for graphene, 2018-2032, tons.
- Figure 25. CVD Graphene on Cu Foil.
- Figure 26. Applications of graphene in 3D printing.
- Figure 27. Demand for graphene in 3-D printing (tons), 2018-2032.
- Figure 28. CNCTArch lightweight mounting for digital signalling.



- Figure 29. Applications of graphene in adhesives.
- Figure 30. Demand for graphene in adhesives (tons), 2018-2032.
- Figure 31. Graphene Adhesives.
- Figure 32. Applications of graphene in aerospace.
- Figure 33: Demand for graphene in aerospace (tons), 2018-2032.
- Figure 34. Orbex Prime rocket.
- Figure 35: Graphene enhanced aircraft cargo container.
- Figure 36: Graphene aircraft.
- Figure 37. Summary of graphene in automobiles.
- Figure 38. Applications of graphene in automotive.
- Figure 39. Demand for graphene in automotive (tons), 2018-2032.
- Figure 40. Supercar incorporating graphene.
- Figure 41. Graphene anti-corrosion primer.
- Figure 42. Graphene-R Brake pads.
- Figure 43. Antistatic graphene tire.
- Figure 44. Graphene engine oil additives.
- Figure 45. Applications of graphene in batteries.
- Figure 46. Demand for graphene in batteries (tons), 2018-2032.
- Figure 47. Apollo Traveler graphene-enhanced USB-C / A fast charging power bank.
- Figure 48. Exide Graphene Lead Acid Battery.
- Figure 49. 6000mAh Portable graphene batteries.
- Figure 50. Real Graphene Powerbank.
- Figure 51. Graphene Functional Films - UniTran EH/FH.
- Figure 52. Applications of graphene in composites.
- Figure 53. Demand for graphene in composites (tons), 2018-2032.
- Figure 54. Graphene bike.
- Figure 55. Graphene lacrosse equipment.
- Figure 56. Graphene-based suitcase made from recycled plastic.
- Figure 57. Aros Create.
- Figure 58. Grays graphene hockey sticks.
- Figure 59. Applications of graphene in conductive inks.
- Figure 60. Demand for graphene in conductive ink (tons), 2018-2032.
- Figure 61. BGT Materials graphene ink product.
- Figure 62. Printed graphene conductive ink.
- Figure 63. Textiles covered in conductive graphene ink.
- Figure 64. Comparison of nanofillers with supplementary cementitious materials and aggregates in concrete.
- Figure 65. Demand for graphene in construction (tons), 2018-2032.
- Figure 66. Graphene asphalt additives.

Figure 67. OG (Original Graphene) Concrete Admix Plus.

Figure 68. Demand for graphene in wearable, flexible and stretchable electronics, 2018-2032.

Figure 69. Moxi flexible film developed for smartphone application.

Figure 70. Applications of graphene in transistors and integrated circuits.

Figure 71. Demand for graphene in transistors and integrated circuits, 2018-2032.

Figure 72. Graphene IC in wafer tester.

Figure 73. Schematic cross-section of a graphene based transistor (GBT, left) and a graphene field-effect transistor (GFET, right).

Figure 74. Demand for graphene in memory devices, 2018-2032.

Figure 75. Layered structure of tantalum oxide, multilayer graphene and platinum used for resistive random-access memory (RRAM).

Figure 76. Applications of graphene in filtration.

Figure 77. Demand for graphene in filtration (tons), 2018-2032.

Figure 78. Graphene anti-smog mask.

Figure 79. Graphene filtration membrane.

Figure 80. Graphene water filter cartridge.

Figure 81. Applications of graphene in fuel cells.

Figure 82. Demand for graphene in fuel cells (tons), 2018-2032.

Figure 83. Graphene-based E-skin patch.

Figure 84. Flexible and transparent bracelet that uses graphene to measure heart rate, respiration rate etc.

Figure 85. Applications of graphene in life sciences and medicine

Figure 86. Demand for graphene in life sciences and medical (tons), 2018-2032.

Figure 87. Graphene medical biosensors for wound healing.

Figure 88. Graphene Frontiers' Six™ chemical sensors consists of a field effect transistor (FET) with a graphene channel. Receptor molecules, such as DNA, are attached directly to the graphene channel.

Figure 89. GraphWear wearable sweat sensor.

Figure 90. BioStamp nPoint.

Figure 91. Applications of graphene in lighting.

Figure 92. Demand for graphene in lighting, 2018-2032.

Figure 93. Graphene LED bulbs.

Figure 94. Applications of graphene in lubricants.

Figure 95. Demand for graphene in lubricants (tons), 2018-2032.

Figure 96. Tricolit spray coating.

Figure 97. Graphenoil products.

Figure 98. Applications of graphene in oil and gas.

Figure 99. Demand for graphene in oil and gas (tons), 2018-2032.

Figure 100. Directa Plus Grafysorber.

Figure 101. Applications of graphene in paints and coatings.

Figure 102. Demand for graphene in paints and coatings (tons), 2018-2032.

Figure 103. Cryorig CPU cooling system with graphene coating.

Figure 104. Four layers of graphene oxide coatings on polycarbonate.

Figure 105. 23303 ZINCTON GNC graphene paint.

Figure 106. Graphene-enhanced anti-corrosion aerosols under their Hycote brand.

Figure 107. Scania Truck head lamp brackets ACT chamber 6 weeks, equivalent to 3y field use. Piece treated with GO to the left together with different non-GO coatings.

Figure 108. Schematic of graphene heat film.

Figure 109. Applications of graphene in photonics.

Figure 110. Demand for graphene in photonics, 2018-2032.

Figure 111. All-graphene optical communication link demonstrator operating at a data rate of 25 Gb/s per channel.

Figure 112. Applications of graphene in photovoltaics.

Figure 113. Demand for graphene in photovoltaics (tons), 2018-2032.

Figure 114. Graphene coated glass.

Figure 115. Applications of graphene in rubber and tires.

Figure 116. Demand for graphene in rubber and tires (tons), 2018-2032.

Figure 117. Eagle F1 graphene tire.

Figure 118. Graphene floor mats.

Figure 119. Vittoria Corsa G+ tire.

Figure 120. Graphene-based sensors for health monitoring.

Figure 121. Applications of graphene in sensors.

Figure 122. Demand for graphene in sensors (tons), 2018-2032.

Figure 123. AGILE R100 system.

Figure 124. Graphene fully packaged linear array detector.

Figure 125. GFET sensors.

Figure 126. Graphene is used to increase sensitivity to middle-infrared light.

Figure 127. Applications of graphene in smart textiles and apparel.

Figure 128. Demand for graphene in textiles (tons), 2018-2032.

Figure 129. 878 Project One jacket display.

Figure 130. Colmar graphene ski jacket.

Figure 131. Graphene dress. The dress changes colour in sync with the wearer's breathing.

Figure 132. G+ Graphene Aero Jersey.

Figure 133. Inov-8 graphene shoes.

Figure 134. Graphene Functional Membranes - UniTran GM.

Figure 135. Graphene jacket.

- Figure 136. Applications of graphene in supercapacitors.
- Figure 137. Demand for graphene in supercapacitors (tons), 2018-2032.
- Figure 138. KEPCO's graphene supercapacitors.
- Figure 139. Skeleton Technologies supercapacitor.
- Figure 140. Zapgo supercapacitor phone charger.
- Figure 141. Callaway Chrome Soft golf and Chrome Soft X golf balls.
- Figure 142. Graphene heating films.
- Figure 143. Graphene flake products.
- Figure 144. AIKA Black-T.
- Figure 145. Printed graphene biosensors.
- Figure 146. Brain Scientific electrode schematic.
- Figure 147. Graphene battery schematic.
- Figure 148. Dotz Nano GQD products.
- Figure 149. Graphene-based membrane dehumidification test cell.
- Figure 150. Proprietary atmospheric CVD production.
- Figure 151. Wearable sweat sensor.
- Figure 152. InP/ZnS, perovskite quantum dots and silicon resin composite under UV illumination.
- Figure 153. Sensor surface.
- Figure 154. BioStamp nPoint.
- Figure 155. Nanotech Energy battery.
- Figure 156. Hybrid battery powered electrical motorbike concept.
- Figure 157. NAWASStitch integrated into carbon fiber composite.
- Figure 158. Schematic illustration of three-chamber system for SWCNH production.
- Figure 159. TEM images of carbon nanobrush.
- Figure 160. Test performance after 6 weeks ACT II according to Scania STD4445.
- Figure 161. Quantag GQDs and sensor.
- Figure 162. The Sixth Element graphene products.
- Figure 163. Thermal conductive graphene film.
- Figure 164. Talcoat graphene mixed with paint.
- Figure 165. T-FORCE CARDEA ZERO.
- Figure 166. Market demand for carbon nanotubes by market, 2018-2032 (tons).
- Figure 167. Demand for MWCNT by application in 2021.
- Figure 168. Demand for MWCNT by application in 2021.
- Figure 169. Demand for MWCNT by region in 2021.
- Figure 170. SWCNT market demand forecast (metric tons), 2018-2032.
- Figure 171. Schematic of single-walled carbon nanotube.
- Figure 172. TIM sheet developed by Zeon Corporation.
- Figure 173. Double-walled carbon nanotube bundle cross-section micrograph and

model.

Figure 174. Schematic of a vertically aligned carbon nanotube (VACNT) membrane used for water treatment.

Figure 175. TEM image of FWNTs.

Figure 176. Schematic representation of carbon nanohorns.

Figure 177. TEM image of carbon onion.

Figure 178. Schematic of Boron Nitride nanotubes (BNNTs). Alternating B and N atoms are shown in blue and red.

Figure 179. Process flow chart from CNT thin film formation to device fabrication for solution and dry processes.

Figure 180. Schematic representation of methods used for carbon nanotube synthesis (a) Arc discharge (b) Chemical vapor deposition (c) Laser ablation (d) hydrocarbon flames.

Figure 181. Arc discharge process for CNTs.

Figure 182. Schematic of thermal-CVD method.

Figure 183. Schematic of plasma-CVD method.

Figure 184. CoMoCAT® process.

Figure 185. Schematic for flame synthesis of carbon nanotubes (a) premixed flame (b) counter-flow diffusion flame (c) co-flow diffusion flame (d) inverse diffusion flame.

Figure 186. Schematic of laser ablation synthesis.

Figure 187. MWCNT patents filed 2007-2022.

Figure 188. SWCNT patent applications 2001-2021.

Figure 189. Demand for carbon nanotubes in 3-D printing (tons), 2018-2032.

Figure 190. Demand for carbon nanotubes in adhesives (tons), 2018-2032.

Figure 191. Carbon nanotube Composite Overwrap Pressure Vessel (COPV) developed by NASA.

Figure 192. Demand for carbon nanomaterials in aerospace (tons), 2018-2032.

Figure 193. HeatCoat technology schematic.

Figure 194. Veelo carbon fiber nanotube sheet.

Figure 195. Demand for carbon nanotubes in automotive (tons), 2018-2032.

Figure 196. Schematic of CNTs as heat-dissipation sheets.

Figure 197. Electrochemical performance of nanomaterials in LIBs.

Figure 198. Theoretical energy densities of different rechargeable batteries.

Figure 199. Printed 1.5V battery.

Figure 200. Materials and design structures in flexible lithium ion batteries.

Figure 201. LiBEST flexible battery.

Figure 202. Schematic of the structure of stretchable LIBs.

Figure 203. Electrochemical performance of materials in flexible LIBs.

Figure 204. Carbon nanotubes incorporated into flexible, rechargeable yarn batteries.

Figure 205. (A) Schematic overview of a flexible supercapacitor as compared to conventional supercapacitor.

Figure 206. Stretchable graphene supercapacitor.

Figure 207. Demand for carbon nanomaterials in batteries (tons), 2018-2032.

Figure 208. Demand for carbon nanotubes in composites (tons), 2018-2032.

Figure 209. CSCNT Reinforced Prepreg.

Figure 210. Demand for carbon nanotubes in conductive ink (tons), 2018-2032.

Figure 211. Nanotube inks

Figure 212. Comparison of nanofillers with supplementary cementitious materials and aggregates in concrete.

Figure 213. Demand for carbon nanotubes in construction (tons), 2018-2032.

Figure 214. Demand for carbon nanotubes in wearable electronics and displays, 2018-2032.

Figure 215. Demand for carbon nanomaterials in transistors and integrated circuits, 2018-2032.

Figure 216. Thin film transistor incorporating CNTs.

Figure 217. Demand for carbon nanotubes in memory devices, 2018-2032.

Figure 218. Carbon nanotubes NRAM chip.

Figure 219. Strategic Elements' transparent glass demonstrator.

Figure 220. Demand for carbon nanotubes in filtration (tons), 2018-2032.

Figure 221. Demand for carbon nanotubes in fuel cells (tons), 2018-2032.

Figure 222. Demand for carbon nanotubes in life sciences and medical (tons), 2018-2032.

Figure 223. CARESTREAM DRX-Revolution Nano Mobile X-ray System.

Figure 224. Graphene medical biosensors for wound healing.

Figure 225. Graphene Frontiers' Six™ chemical sensors consists of a field effect transistor (FET) with a graphene channel. Receptor molecules, such as DNA, are attached directly to the graphene channel.

Figure 226. GraphWear wearable sweat sensor.

Figure 227. Demand for carbon nanotubes in lubricants (tons), 2018-2032.

Figure 228. Demand for carbon nanotubes in oil and gas (tons), 2018-2032.

Figure 229. Demand for carbon nanotubes in paints and coatings (tons), 2018-2032.

Figure 230. CSCNT Reinforced Prepreg.

Figure 231. Demand for carbon nanotubes in photovoltaics (tons), 2018-2032.

Figure 232. Suntech/TCNT nanotube frame module

Figure 233. Demand for carbon nanotubes in rubber and tires (tons), 2018-2032.

Figure 234. Demand for carbon nanotubes in sensors (tons), 2018-2032.

Figure 235. Demand for carbon nanotubes in textiles (tons), 2018-2032.

Figure 236. Demand for carbon nanotubes in supercapacitors (tons), 2018-2032.



- Figure 237. Nawa's ultracapacitors.
- Figure 238. AWN Nanotech water harvesting prototype.
- Figure 239. Carbonics, Inc.'s carbon nanotube technology.
- Figure 240. Fuji carbon nanotube products.
- Figure 241. Internal structure of carbon nanotube adhesive sheet.
- Figure 242. Carbon nanotube adhesive sheet.
- Figure 243. Cup Stacked Type Carbon Nano Tubes schematic.
- Figure 244. CSCNT composite dispersion.
- Figure 245. Flexible CNT CMOS integrated circuits with sub-10 nanoseconds stage delays.
- Figure 246. Koatsu Gas Kogyo Co. Ltd CNT product.
- Figure 247. Test specimens fabricated using MECHnano's radiation curable resins modified with carbon nanotubes.
- Figure 248. Hybrid battery powered electrical motorbike concept.
- Figure 249. NAWASStitch integrated into carbon fiber composite.
- Figure 250. Schematic illustration of three-chamber system for SWCNH production.
- Figure 251. TEM images of carbon nanobrush.
- Figure 252. CNT film.
- Figure 253. Schematic of a fluidized bed reactor which is able to scale up the generation of SWNTs using the CoMoCAT process.
- Figure 254. Carbon nanotube paint product.
- Figure 255. MEIJO eDIPS product.
- Figure 256. HiPCO® Reactor.
- Figure 257. Smell iX16 multi-channel gas detector chip.
- Figure 258. The Smell Inspector.
- Figure 259. Toray CNF printed RFID.
- Figure 260. Structures of nanomaterials based on dimensions.
- Figure 261. Schematic of 2-D materials.
- Figure 262. Diagram of the mechanical exfoliation method.
- Figure 263. Diagram of liquid exfoliation method
- Figure 264. Structure of hexagonal boron nitride.
- Figure 265. BN nanosheet textiles application.
- Figure 266. Structure diagram of  $\text{Ti}_3\text{C}_2\text{Tx}$ .
- Figure 267. Types and applications of 2D TMDCs.
- Figure 268. Left: Molybdenum disulphide ( $\text{MoS}_2$ ). Right: Tungsten ditelluride ( $\text{WTe}_2$ )
- Figure 269. SEM image of  $\text{MoS}_2$ .
- Figure 270. Atomic force microscopy image of a representative  $\text{MoS}_2$  thin-film transistor.
- Figure 271. Schematic of the molybdenum disulfide ( $\text{MoS}_2$ ) thin-film sensor with the

deposited molecules that create additional charge.

Figure 272. Borophene schematic.

Figure 273. Black phosphorus structure.

Figure 274. Black Phosphorus crystal.

Figure 275. Bottom gated flexible few-layer phosphorene transistors with the hydrophobic dielectric encapsulation.

Figure 276: Graphitic carbon nitride.

Figure 277. Structural difference between graphene and C<sub>2</sub>N-h<sub>2</sub>D crystal: (a) graphene; (b) C<sub>2</sub>N-h<sub>2</sub>D crystal. Credit: Ulsan National Institute of Science and Technology.

Figure 278. Schematic of germanene.

Figure 279. Graphdiyne structure.

Figure 280. Schematic of Graphane crystal.

Figure 281. Schematic of a monolayer of rhenium disulfide.

Figure 282. Silicene structure.

Figure 283. Monolayer silicene on a silver (111) substrate.

Figure 284. Silicene transistor.

Figure 285. Crystal structure for stanene.

Figure 286. Atomic structure model for the 2D stanene on Bi<sub>2</sub>Te<sub>3</sub>(111).

Figure 287. Schematic of Indium Selenide (InSe).

Figure 288. Application of Li-Al LDH as CO<sub>2</sub> sensor.

Figure 289. Graphene-based membrane dehumidification test cell.

Figure 290. Detonation Nanodiamond.

Figure 291. DND primary particles and properties.

Figure 292. Functional groups of Nanodiamonds.

Figure 293. Market demand for nanodiamonds in lubricants to 2032, tons

Figure 294. Global market demand for nanodiamonds in polishing additives to 2032 (tons).

Figure 295. Global market demand for nanodiamonds in electroplating and anti-wear/friction coatings to 2032 (tons)

Figure 296. Global market demand for nanodiamonds in thermosets to 2032 (tons).

Figure 297. Global market demand for nanodiamonds in thermoplastics to 2032 (tons).

Figure 298. Global market demand for nanodiamonds in metal composites to 2032, tons

Figure 299. Prototypes of nanodiamonds, fullerene and lignin sunscreen.

Figure 300. Global market demand for nanodiamonds in skincare to 2032 (tons)

Figure 301. Global market demand for nanodiamonds in supercapacitors to 2032 (tons)

Figure 302. Global market demand for nanodiamonds in batteries to 2032 (tons).

Figure 303. Application of NDs in biomedicine based on synthesis method.

Figure 304. NBD battery.

Figure 305. Neomond dispersions.



Figure 306. Global consumption of fullerenes in metric tonnes, 2010-2032.

## I would like to order

Product name: The Global Market for Carbon Nanomaterials 2022-2032

Product link: <https://marketpublishers.com/r/G2121A65CA0FEN.html>

Price: US\$ 1,800.00 (Single User License / Electronic Delivery)

If you want to order Corporate License or Hard Copy, please, contact our Customer Service:

[info@marketpublishers.com](mailto:info@marketpublishers.com)

## Payment

To pay by Credit Card (Visa, MasterCard, American Express, PayPal), please, click button on product page <https://marketpublishers.com/r/G2121A65CA0FEN.html>

To pay by Wire Transfer, please, fill in your contact details in the form below:

First name:  
Last name:  
Email:  
Company:  
Address:  
City:  
Zip code:  
Country:  
Tel:  
Fax:  
Your message:

**\*\*All fields are required**

Customer signature \_\_\_\_\_

Please, note that by ordering from marketpublishers.com you are agreeing to our Terms & Conditions at <https://marketpublishers.com/docs/terms.html>

To place an order via fax simply print this form, fill in the information below and fax the completed form to +44 20 7900 3970