Graphene, 2D Materials, and Carbon Nanotubes 2018-2028

This report provides the most comprehensive and authoritative view of the topic, giving detailed ten-year market forecasts segmented by application and material type. The market forecasts are given in tonnage and value at the material level. Furthermore, this report includes comprehensive interview-based profiles of all the key players the industry, providing intelligence on the investment levels, expected future revenues, and the production capacity across the industry and by supplier. In addition, this report critically reviews all existing and emerging production process.
Outline

- Diversity of graphene
- Price disparity
- Global production capacity
- Graphene application pipeline
- Investment, revenue and valuation trends
- Market forecasts
- Comparison with CNTs
  - Price and production trends
  - Diversity of forms
  - Application pipeline
Helping you profit from emerging technologies

Research
- Technology landscape
- Company assessments
- Market forecasts

Consulting
- Custom research
- Analyst access
- Advisory service

Events
- Conferences
- Exhibitions
- Masterclasses
Why choose to **work with us?**

**Deep Technical and Market Understanding**  
Our globally cited analysts are mostly PhD-educated subject matter experts.

**Research Methodology**  
We conduct primary research through interviews, site visits and events.

**Focus on Commercialization**  
We focus on assessing the needs of end users to identify problems where new technologies can add value.

**Reality Check**  
We provide a clear view of the real situation in complex subject matters.

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We host the World's largest events on the topics we cover. Connected with over 250,000 contacts.
Graphene becoming increasingly affordable?
Graphene applications going commercial?

Key
- **Barrier**
- **Multi-functional**
- **Electrical/electronic/optical**
- **Thermal**
- **Mechanical**

Source: IDTechEx

<table>
<thead>
<tr>
<th>Proof of Concept</th>
<th>Early Semi-Commercial Prototype</th>
<th>Semi Commercial Trials</th>
<th>Early Commercial Sales</th>
<th>Full Market Launch</th>
<th>Market Penetration</th>
<th>Maturity</th>
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<td>Antifouling coatings</td>
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<td>Graphene cable</td>
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<td>Conductive Plastics (automotive fuel system/tank)</td>
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<td>Graphene latex (condoms)</td>
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<td>Water purification porous filter</td>
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<td>Mechanically reinforced bike frames</td>
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<td>Supercapacitors</td>
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<td>Textile interconnect/heater</td>
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<td>Quantum dots</td>
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<td>Coloured conductive plastics</td>
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<td>Opaque black paint</td>
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Source: IDTechEx
Graphene products and prototypes

Graphene becoming increasingly available?

Source left: Infineon

[Graph showing tonnage per year for different suppliers, including Chinese and RoW categories, and exfoliation and other methods.]

Suppliers listed include:
- Ningbo Morsh
- SuperC Technologies
- Angstron Materials
- SFCNano
- Sixth Element
- Perpetuus
- XG Sciences
- Directa Plus
- Liaoning NanoXplore
- Thomas Swan
- Hongsong Technology
- 2D Carbon Graphene
- Imagine Intelligent Materials
- Knano Xiamen
- Cambridge Nanosystem
- Vorbeck
- XFNano
- Tunghsu
- Standard Graphene
- Applied Graphene Materials
- Gnext
- Graphenea
- IIT
Will revenue growth turn to industry-wide profits?

Profit/Loss

% change in stock value vs initial launch value

IDTechEx Research

AGM  Haydale  Directa Plus  Graphene 3D Labs  Graphene nanochem

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2020/2021 will be the inflection year?

**Aggregate Demand**

- SuperC Technologies
- Graphene Platform
- Cabot Corp
- Advanced Graphene Products
- Deyang Carbonene Tech
- 3D Graphene Lab
- Applied Graphene Materials
- Knano Xiamen
- JCNano
- XFNano
- Thomas Swan
- Grafenwerk
- Charmion
- Graphene Technologies
- Ningbo Morsh
- Graphenest
- Cambridge Nanosystem
- AzTrong
- Gnext
- Perpetuus
- gnanomat
- Incubation
- Haydale
- Directa Plus
- NanoXplore
- Nanomedical
- Sixth Element
- Graphenea
- XG Sciences
- BGT
- Angstrom Materials
- Vorbeck

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**Research**

- Other
- Thermal interface materials
- Tires
- Water filtration
- Anti corrosion coatings
- Transistors
- RFID antenna
- Permeation protection composites
- Thermal composites
- Other conductive plastics
- EMI shielding plastics
- Conductive 3D printing filaments
- Sensors
- Research/Equipment
- Li ion batteries
- Silicon anode batteries
- Li sulphur batteries
- Supercapacitors
- Conductive inks and adhesives
- Mechanically enhanced composites
- Transparent conducting films
MWCNT: volume growth phase

Idea

Hype

Disillusionment

Realism
Productivity rise

MWCNTs

Graphene

Source: IDTechEx
CNTs: ideal vs reality

**Ideal**

**Single wall**

**Multi wall**

**Commercial production**

**Commercial**
Not all CNTs are equal

Each box corresponds to the size range of CNTs supplied by a different company.
MWCNT: Evolution of production capacity

Past price evolution

Future

Accumulative tpa

Past

Future
### Strong pipeline of applications

#### Commercialization timeline

<table>
<thead>
<tr>
<th>R&amp;D</th>
<th>Prototype</th>
<th>Market entry</th>
<th>Market penetration</th>
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<tbody>
<tr>
<td>Concrete and Asphalt</td>
<td>Humidity sensors</td>
<td>Car body painting</td>
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<tr>
<td>Aluminium enforcement</td>
<td>Cables</td>
<td>Li ion batteries</td>
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<td>CNTRP</td>
<td>Supercapacitors</td>
<td>Vehicle fuel lines</td>
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<td>3D touch surface</td>
<td>ESD Packaging for electronic devices</td>
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<td></td>
<td>Memory</td>
<td>Silicone additive</td>
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<td>Conductive carbon fiber</td>
<td>ESD films</td>
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<td>Transparent conductive film</td>
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<td></td>
<td>Car tires</td>
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<td></td>
<td>Thin film transistors</td>
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<tr>
<td>Best for MWCNT</td>
<td>Best for SWCNT</td>
<td>Could be either MWCNT, SWCNT or FWCNT</td>
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</tbody>
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*Simplified pipeline*
MWCNT: Evolution of production capacity

The industry corrected some excess capacity as it went through hype curve

Capacity utilisation around 55%
Conclusion

Graphene and MWCNTs are part of a continuum of nanocarbon additives

Graphene

- Revenue growth but still loss making
- Production shifts to China?
- Market inflection from 2021/2022 onwards

CNTs

- Been there done that
- Diversity of forms
- Prices have fallen and production volume increased
Supporting your strategic business decisions on emerging technologies

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