



## General Studies-3; Topic: Science and Technology- developments and their applications and effects in everyday life.

### Graphene Production

#### Introduction

- What Artificial Intelligence (AI) is to software and quantum computing is to computers, graphene is to materials.
- India needs to catch up in the area of graphene.

#### Properties of Graphene

- **Graphene is the world's thinnest, strongest, and most conductive material of both electricity and heat.**
- It conducts electricity better than copper.
- It is 200 times stronger than steel but six times lighter.
- It is almost perfectly transparent as it absorbs only 2% of light.
- It is impermeable to gases, even those as light as hydrogen and helium.

#### Applications

- Graphene composites are used in aerospace, automotive, sports equipment and construction.
- It is used for high-performance batteries and super-capacitors, touchscreens, and conductive inks.
- Graphene-based sensors are used for **environmental monitoring, healthcare and wearable devices.**
- Graphene oxide membranes are used for **water purification and desalination.**
- Graphene-based masks were made during COVID.
- Its exceptional strength makes it promising material for **armour and ballistic protection.**

- It is an excellent candidate for **sensing chemical and biological agents, explosives, radiation, and other hazardous substances.**

## Graphene Market

- Global graphene market is expected to grow at a CAGR of 46.6% between 2023 and 2030.
- At least one graphene-enhanced product was launched every week in 2022.
- Among the leading countries in graphene research are China, the U.S., the U.K., Japan, South Korea, Russia, and Singapore.
- China and Brazil are global leaders in the commercial production of graphene.

## International efforts

- China declared graphene a priority in its 13th Plan.
- Europe set up the Graphene Flagship, with a budget of €1 billion in 2013.
- At the Beijing Graphene Institute, several companies produce industry-grade graphene products.

## India's progress

- India produced a graphene-based system several years ago.
- Tata Steel has succeeded in growing graphene.
- It has also mixed graphene with used plastic products to recycle them as new.
- Setting up of the India Innovation Centre for Graphene in Kerala.

## Concerns / Challenges

- Graphene produced by India is about one-twentieth compared to China and one-third compared to Brazil.
- High cost-to-volume ratio for high-grade graphene.
- Its production may get concentrated in a few locations as in the case of semiconductors.

## Way Forward

- The Centre needs to become the nodal point to spur large-scale innovation activity around graphene.
- A nodal Ministry needs to be entrusted with the responsibility of national graphene mission.
- India missed the semiconductor bus in the mid-1990s. The time to step on the graphene pedal is now.