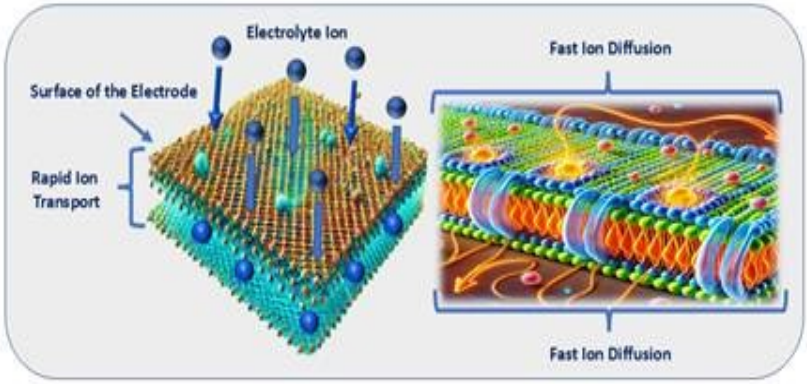
High-Voltage Graphene Supercapacitor for EVs

Prelims: *Current events of national and international importance*

Why in News?

Recently, a novel porous graphene-based supercapacitor (PGCN) has been developed in India to enhance energy storage for electric vehicles (EVs).

- **Supercapacitor –** A supercapacitor is a ***high-capacity energy storage device*** that bridges the gap between conventional capacitors and rechargeable batteries.
  - **Main components –** Electrode, electrolyte, separator, and current collector.
  - **Advantages** – High power density, long durability, and ultrafast charging compared to conventional capacitors and lithium-ion batteries (LIBs).
- **PGCN Supercapacitor –** A high-voltage supercapacitor based on dual-functional PGCN electrodes.
- **Developed by –** International ***Advanced Research Centre for Powder Metallurgy and New Materials (ARCI).***
- **Nodal Authority –** The Department of Science and Technology (DST), the Ministry of Science and Technology.
- **Working Principle –** The supercapacitor stores energy by pulling ions from the electrolyte onto its porous graphene surface.
  - **Function** – The surface acts like a sponge for ions and a fast pathway for electricity, allowing quick charging and high-power output.



- **Key Features – Type –** Graphene-based high-voltage supercapacitor.
- **Dual Functional Surface –** The PGCN surface is *both water-repellent (to prevent moisture-induced degradation) and highly compatible with organic electrolytes* (super organophilic), enabling efficient and rapid penetration into the pores.
- **Porous Structure –** The micro- and mesoporous architecture significantly boosts ion diffusion compared to traditional electrodes,
- It results in high power density up to 17,000 W/kg.
- **Performance Metrics –** The electrode achieves an operating voltage of 3.4 V (surpassing the conventional 3.0 V limit)
- And, it *holds 33% more energy*, enhancing suitability for electric vehicles and grid storage.
- **Eco-Friendly & Scalable Synthesis –** The material is produced using a sustainable hydrothermal method.
- It is environmentally friendly and capable of being scaled up from lab-level to industrial-scale production.
- **Applications –** Electric vehicles, solar panels, grid-scale energy storage, and portable electronics.
- **Benefits –** Faster acceleration and increased range for EVs.
- Improved safety and electrolyte stability.
- Reduced need for stacking multiple cells.
- Long-term durability with ***96% performance retention after 15,000 cycles.***
- **Significance –** Supports India's clean energy goals and the ***Aatma Nirbhar Bharat initiative*** by strengthening indigenous capabilities in advanced energy-storage technologies.

Reference

PIB | Novel supercapacitor for EVs