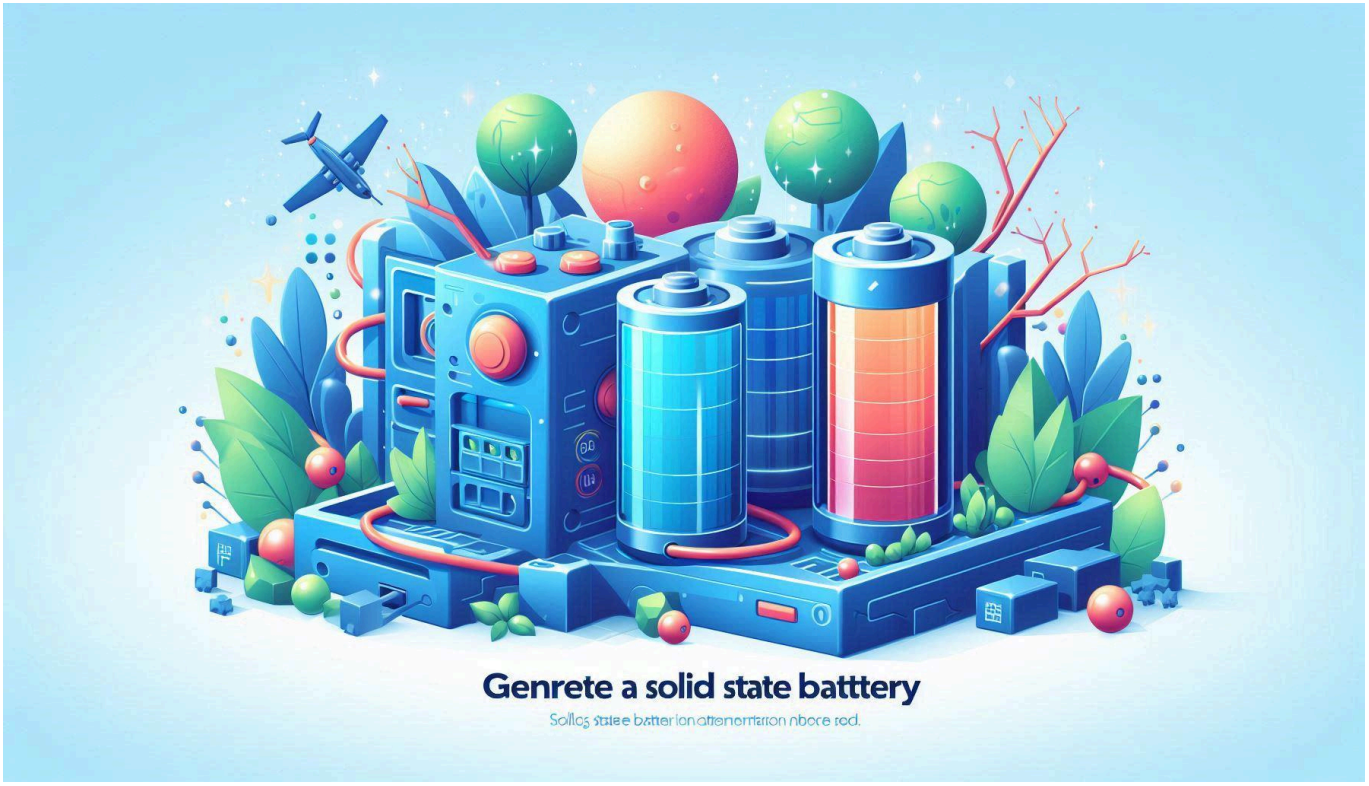
Solid-State Battery

Definition

A **solid-state battery** is a rechargeable battery that uses a solid electrolyte instead of the liquid or gel-based electrolytes found in conventional batteries. This design improves safety, energy density, and performance, making it a key technology for next-generation energy storage.

Examples

1. **Thin-Film Solid-State Batteries**: Used in wearables and medical devices.
2. **Bulk Solid-State Batteries**: Designed for electric vehicles (EVs) and grid storage.



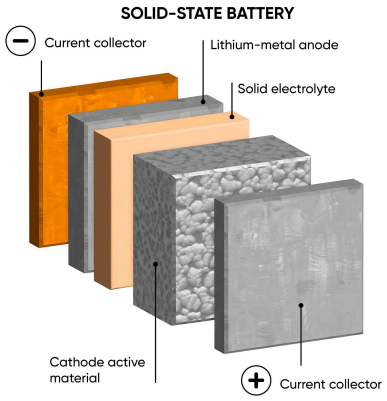
Advantages

- **Safety**: Non-flammable solid electrolytes reduce the risk of fire.
- **Higher Energy Density**: Stores more energy, enabling longer use in devices or driving range in EVs.
- **Durability**: Can withstand more charge-discharge cycles.
- **Wide Temperature Range**: Operates in extreme conditions (-50°C to 125°C).

Disadvantages

- **Cost**: High manufacturing and material costs.
- **Scalability Issues**: Challenges in producing large-scale batteries consistently.
- **Interfacial Resistance**: Difficulty ensuring efficient contact between components.

Cell Reactions



1. **At the Anode (Oxidation)**:

$$Li \rightarrow Li^+ + e^-$$

Lithium releases electrons and ions.

2. **At the Cathode (Reduction)**:

$$Li^+ + e^- + \text{Cathode Material} \rightarrow Li(\text{Cathode Material})$$

Lithium ions combine with electrons and the cathode material to store energy.

Performance Statistics

- **Energy Density**:
  - Thin-film: 300–900 Wh/kg
  - Bulk: 250–500 Wh/kg
- **Cycle Life**: 10,000–100,000 cycles.
- **Operating Voltage**: 2.5 V to 4.6 V.
- **Temperature Range**: -50°C to 125°C.

Applications

Electric Vehicles (EVs):

- Increases driving range and enables faster charging (~15 minutes to 80%).

Consumer Electronics:

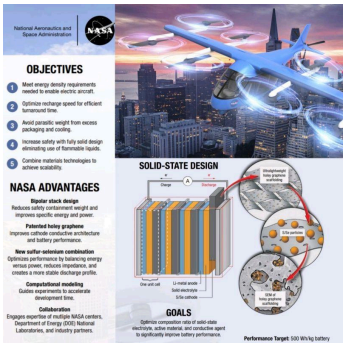
- Powers compact devices like smartphones and laptops.

Medical Devices:

- Reliable and safe for pacemakers and wearable health monitors.

Aerospace and Industrial Equipment:

- Functions under extreme conditions for satellites and drones.



THANK YOU

Submitted By

CHETHAN B

4SI24EC079