SODIUM-ION BATTERY – SCIENCE & TECHNOLOGY

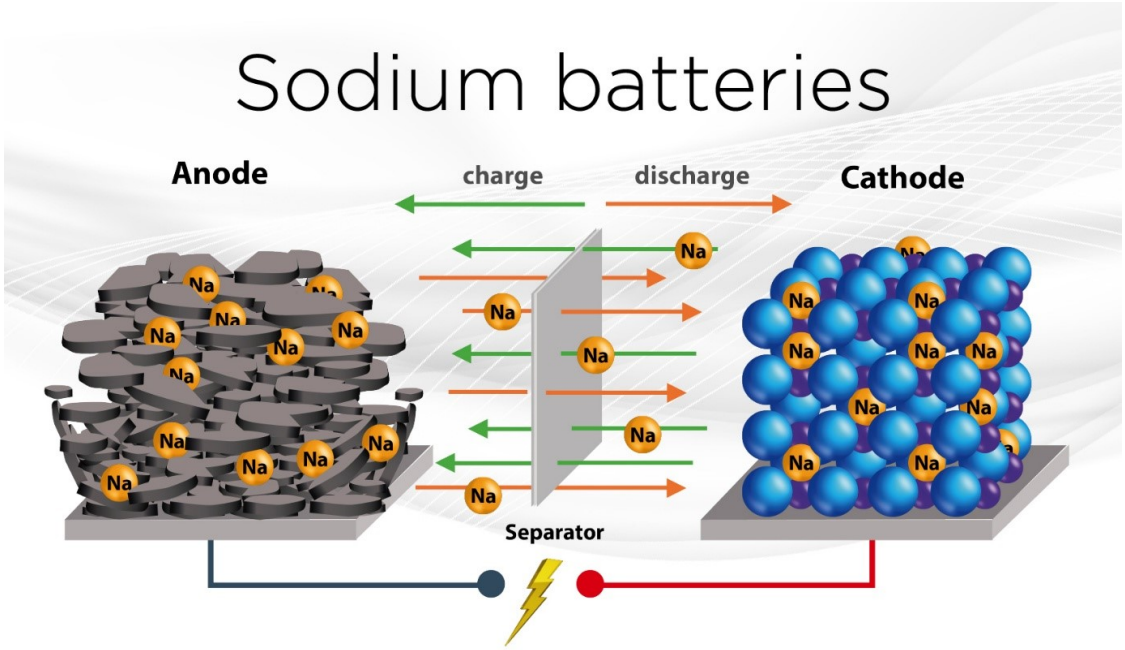
NEWS: A research team at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) has developed a super-fast charging sodium-ion battery (SIB).

WHAT'S IN THE NEWS?

Overview of Sodium-Ion Batteries

1. Charge Carrier:
   Sodium-ion batteries use sodium ions (Na^+) as charge carriers instead of the lithium ions (Li^+) used in traditional lithium-ion batteries.

2. Rechargeable Nature:
   Like lithium-ion batteries, Na-ion batteries are rechargeable and suitable for multiple charge-discharge cycles.



Key Features of the Fast-Charging Sodium-Ion Battery

1. High-Speed Charging Capability:
   The battery can be charged up to 80% of its capacity within just six minutes, making it highly suitable for fast turnaround needs like electric vehicles (EVs) and emergency power systems.

2. Long Battery Life:
   It can endure more than 3000 charge-discharge cycles, which ensures durability and reduced need for frequent replacements.

3. NASICON-Type Materials:
    - The battery employs NASICON-type (Sodium Super Ionic Conductor) materials for both cathode and anode.
    - These materials have a 3D open framework that allows for high ionic conductivity and excellent thermal stability, enabling safe and efficient performance.
4. Advanced Anode Composition:
   The anode is made of a specially engineered material — $Na_{1.0}V_{0.25}Al_{0.25}Nb_{1.5}(PO_4)_3$ — which is optimized for faster ion transport and high energy efficiency.
5. Nanoscale Engineering:
   The anode particles are reduced to the nanoscale, which shortens the diffusion path for sodium ions, allowing for quicker charge-discharge cycles.
6. Carbon Coating:
    - A layer of carbon is applied to the electrode materials.
    - This enhances electrical conductivity, improves battery performance, and provides structural stability during cycling.
7. Aluminium Doping:
   Aluminium is doped into the material to improve its mechanical strength and facilitate faster movement of sodium ions, thus enhancing overall speed and efficiency.
8. High Safety Profile:
   Compared to lithium-ion batteries, Na-ion batteries present a lower risk of fire, overheating, and thermal runaway, making them safer for use in consumer and industrial environments.

Economic and Environmental Advantages

1. Cost-Effective Raw Material:
   Sodium is abundant and cheap, especially in India, reducing costs significantly compared to expensive and imported lithium.
2. Domestic Resource Availability:
   India has ample reserves of sodium (e.g., in salt and minerals), unlike

lithium and cobalt, which are largely imported from geopolitically sensitive regions.

3. Eco-Friendly Technology:
   Sodium-ion batteries have a lower environmental impact during mining, manufacturing, and disposal compared to lithium-ion counterparts.

4. Non-Geopolitical Dependency:
   Since sodium and aluminium are easily available within India, reliance on foreign supply chains is minimized, strengthening energy security.

Relevance to India's Development Goals

1. Supports Atmanirbhar Bharat:
   - Sodium-ion batteries align with the Indian government's vision of self-reliance (Atmanirbhar Bharat) in clean energy and technology.
   - Reduces dependency on imported lithium and cobalt, helping India become more technologically sovereign.

2. Encourages Indigenous Innovation:
   Promotes domestic R&D and manufacturing ecosystems for advanced battery technologies, creating jobs and boosting local industry.

Applicability and Use-Cases

1. Electric Vehicles (EVs):
   Fast-charging capability and safety make it ideal for urban EV applications, especially two-wheelers and public transport.

2. Solar Energy Storage:
   Suitable for storing solar power in both rural and urban grid applications due to its cost-efficiency and durability.

3. Rural Electrification:
   Can be used for off-grid energy storage solutions in remote villages, supporting government electrification schemes.

4. Drones and Lightweight Electronics:
   Its lightweight design and fast-charging feature also support modern applications like drones and portable electronics.

5. Stationary Energy Storage:
   Despite lower energy density than lithium-ion batteries, they are ideal for grid-level stationary energy storage, where weight and volume are not constraints.

Source: https://www.pib.gov.in/PressReleasePage.aspx?PRID=2129649