LITHIUM BATTERY

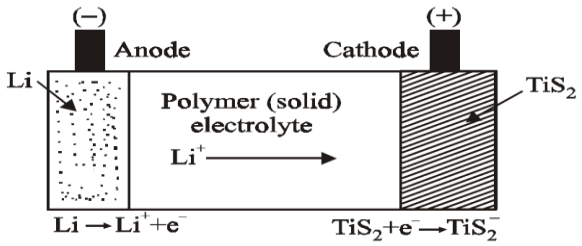
Lithium battery is a solid state battery because instead of liquid or a paste electrolyte, solid electrolyte is used.

Construction

The lithium battery consists of a lithium anode and a TiS_2 cathode. A solid electrolyte, generally a polymer, is packed in between the electrodes. The electrolyte (polymer) permits the passage of ions but not that of electrons.

Working (Discharging)

When the anode is connected to cathode, lithium ions move from anode to cathode. The anode is elemental lithium, which is the source of the lithium ions and electrons. The cathode is a material capable of receiving the lithium ions and electrons.



Solid State Lithium Battery

At anode: $Li(s) \rightarrow Li^+ + e^-$

At cathode: $TiS_{2(s)} + e^- \rightarrow TiS^{2-}$

Overall reaction:

$LiTiS_2$ -----→ $Li^+ + TiS^{2-}$

Recharging the Battery

The lithium battery can be recharged by supplying an external current, which drives the lithium ions back to the anode.

The overall reaction is

$LiTiS_2$ ———> $Li^+ + TiS_2$

This cell is rechargeable and the cell voltage is 3.0V.

Advantages of Li-battery

1. Its voltage is high 3.0V

2. Since Li is a light weight metal, only 7g (1mole) material is required to produce I mole of electrons.

3. Since Li has the most electronegative E° value, it generates a higher voltage than other types of cells.

4. Since all the constituents of the battery are solids there is no risk of leakage from the battery.

5. This battery can be made in a variety of sizes and shapes.

Disadvantages

Lithium battery is more expensive than other batteries.

Uses: Button sized lithium battery are used in calculators, watches, cameras, mobile phones, laptop, computers,etc.

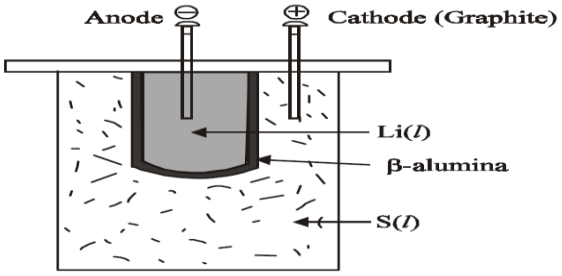
LITHIUM-SULPHUR BATTERY

Lithium-Sulphur battery is a rechargeable battery. Its anode is made of Li. Sulphur is the electron acceptor; the electron from Li is conducted to S by a graphite cathode.

β-Alumina ($NaAl_{11}O_{17}$) is used as the solid electrolyte, which separates anode and liquid sulphur.

This solid electrolyte allows the Li+ ions to migrate to equalize the charge, but will not allow the big poly sulphide product ions.

This battery is operated at high temperatures as Li and S should be in their molten states.



Various reactions

The various electrode reactions are

At anode: $2Li \longrightarrow 2Li^+ + 2e^-$

At cathode: $S + 2e^- \longrightarrow S^{2-}$

Overall reaction: $2Li + S \longrightarrow 2Li^+ + S^{2-}$

The S^{2-} ions, formed, react with elemental sulphur to form the polysulphide ion.

$$S^{2-} + nS \longrightarrow [S_{n+1}]^{2-}$$

The direct reaction between Li and S is prevented by the alumina present in the cell.

Advantages of Li-S battery

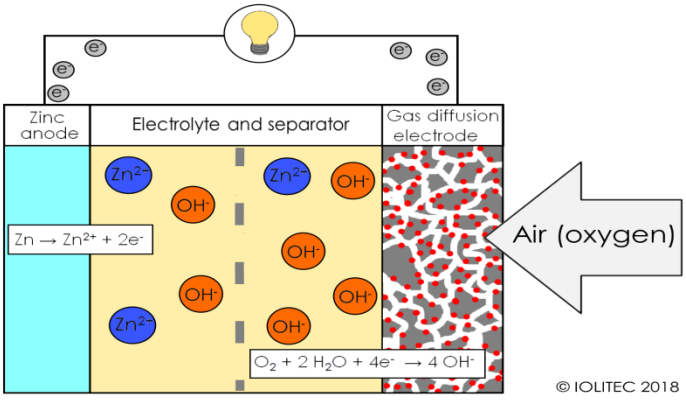
1. Li-S battery has light weight unlike the lead acid battery.
2. It possesses a high energy density.
3. It is used in electric cars.

Other types of Secondary Lithium Batteries

(i) Li/MnO_2 (ii) Li/V_2O_5 (iii) Li/MoO_2 (iv) Li/Cr_3O_8

Zinc Air battery

Anode is composed of granulated zinc powder mixed with an aqueous solution 30% KOH and a gelling agent to immobilize the material. • Cathode is composed of mixture of carbon and the catalyst and a gelling agent held on a nickel coated steel matrix. • Several hydrophobic, gas permeable, thin layers of Teflon are provided to steady the air entry. • Electrolyte contains 30% KOH. • There is also vent for the entry of air or O2 into the cell. • The container is made of glass and has a separator made of nylon.



At the anode:

$$Zn \xrightarrow{-----} Zn^{2+} + 2e^-$$

$$Zn^{2+} + 2OH^- \xrightarrow{-----} ZnO + H_2O$$

$$Zn + 2OH^- \xrightarrow{-----} ZnO + H_2O + 2e^-$$

At the cathode:

$$H_2O + {}^1/_2\, O_2 + 2e^- \xrightarrow{-----} 2OH^-$$

The over all cell reaction :

$$Zn + {}^1/_2\, O_2 \xrightarrow{-----} ZnO$$

The battery offers an EMF of 1.25-1.35V.