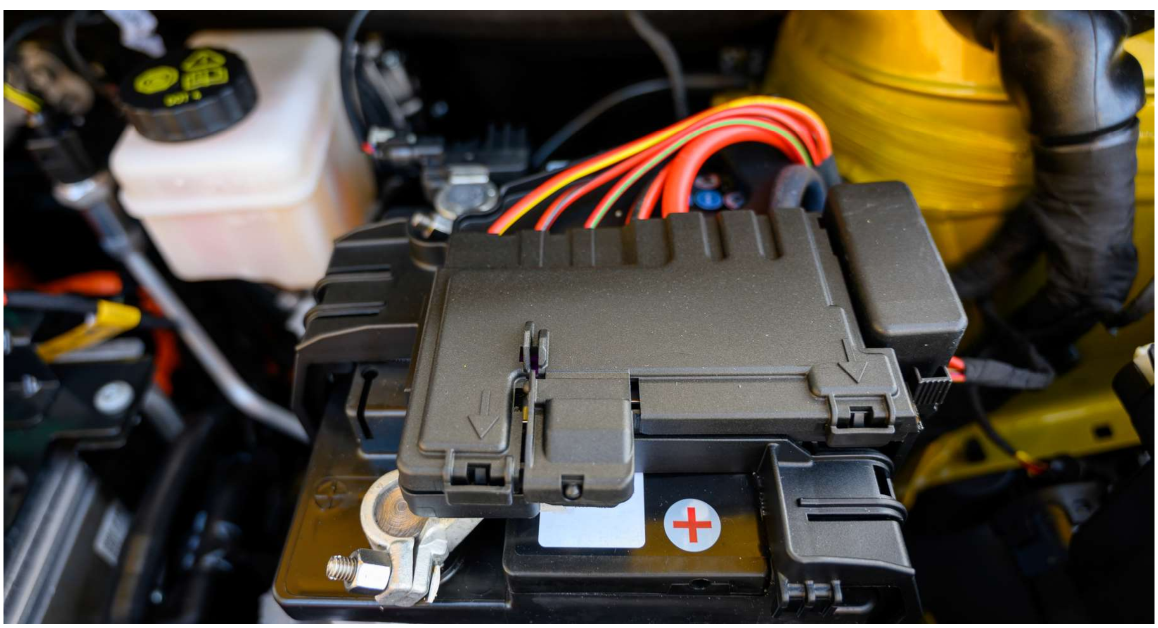
Emerging Environmentally Compatible

# LITHIUM-ION

Battery Technologies And Trends For Electric Vehicles



Among the various battery compositions available today for use in electric vehicles (EVs), lithium-ion batteries (LIBs) are the most sought after. They are expected to dominate the EV market in the next decade, thus playing a substantial role in realising fossil-free transport. However, the cathode materials used in LIBs pose some environmental issues during various stages of their life cycle (mining, production, operation, and afterlife).

The mining and production processes of critical cathode combinations such as lithium nickel manganese cobalt (LNMC), lithium iron phosphate (LFP), and lithium manganese oxide (LMO) lead to ozone depletion, eutrophication, human toxicity, resource depletion, climate change, etc. Currently, lithium is extracted largely from sea brine and hard rocks. Brine extraction uses chemicals that pollute water. Other mining and post-processing processes cause soil damage and air pollution. In countries such as Congo, Zambia, Cuba, and Australia, studies report that exposure to mining-generated toxic dust causes lung disease, heart failure, and cancer.

To mitigate these issues, emerging battery technologies are using alternative cathode materials such as Li-sulphur (LiS), Li-air, solid-state and thin-film batteries. Li-air and solid-state batteries have higher energy densities but poor conductivity and low cycle life. Other emerging technologies such as Li-metal and thin films have technical challenges (dendrite growth, fragile nature, etc.).

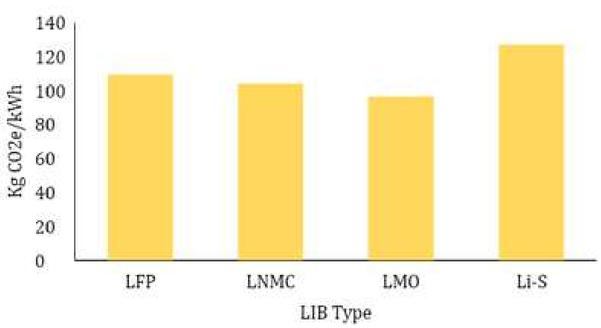



Figure 1: Environmental Impacts of Various LIBs

"Currently, LNMC is the predominantly used battery type for EVs. However, LiS and LMO have the potential to replace cobalt and nickel owing to their lower cost, domestic availability, and eco-friendliness."

LiS batteries have higher energy density and are lighter and cheaper compared to traditional LIBs. While sulphur is abundant, easily sourced, and environmentally benign, it does pose safety and degradation concerns. The average life-cycle emissions (cradle-to-gate) of LiS are marginally higher than those of other battery chemistries (Figure 1). However, LiS batteries do not require sulphur mining as sulphur is a by-product of industries such as oil refining and gas processing—thus avoiding the adverse impact on ozone and human health and encouraging optimal resource utilisation. Advanced LiS batteries are being explored to increase the cycle life because sulphur is an insulator, which limits its complete utilisation as an active material. Eco-friendly materials such as cardanol and eugenol are being explored to replace cathode materials that cause high environmental impact. LMO has a low environmental impact, but its cycle life and energy density are low.

Currently, LNMC is the predominantly used battery type for EVs. However, LiS and LMO have the potential to replace cobalt and nickel owing to their lower cost, domestic availability, and eco-friendliness.

To promote domestic manufacturing of LIB cells, the Government of India (GoI) has approved a financial outlay of INR 18,000 crore through a production-linked incentive scheme. To manufacture cells domestically and to achieve the GoI's target of 30% EV deployment by 2030, the right combination of electrode materials should be chosen that offer high energy density, can be sourced domestically, and do not harm the environment.

Further, to reduce the afterlife environmental impact of LIBs, a recycling ecosystem should be created. Recovery and reuse of critical materials would minimise their mining and reduce environmental and health impacts.

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