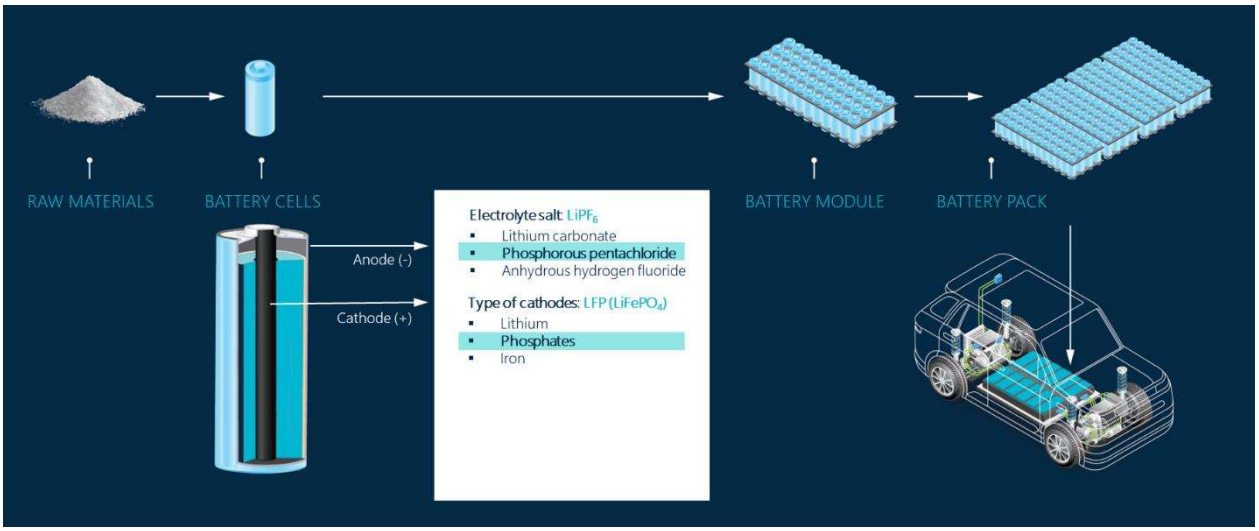
Lithium Iron Phosphate (LFP)

Lithium ion batteries (LIB) have a dominant position in both clean energy vehicles (EV) and energy storage systems (ESS), with significant penetration into both of the markets during recent years. However, supply chain and operational safety issues have plagued the manufacturers of the EV and ESS lately. Typical LIB cathode chemistries such as lithium cobalt oxide (LCO) and nickel manganese cobalt (NMC) chemistries are considered sensitive to operational abuse and create unsafe conditions, resulting in uncontrollable battery fires. LCO and NMC cathodes also contain significant amounts of cobalt, which is a critical mineral in low supply and often unethically mined. Lithium Iron Phosphate (LFP) cathode material contains only abundant elements - Iron and Phosphorous - besides Lithium and, although LIBs with LFP cathode have lower energy densities compared to LCO and NMC cathodes, they are free from cobalt and less likely to elicit operational abuse. LFP has the added value of excellent cycle life compared to other cathode materials. The benefits of LFP have resulted in several EV and ESS manufacturers announcing that a significant portion of their current and future products will have LFP batteries.



LFP cathode active material (CAM) can be prepared by both, solid state, and solution-based methods. Solid state techniques are carried out at high temperatures and, in general, are energy intensive and not practiced at commercial scale. On the other hand, solution-based methods consume relatively less energy and are based on reactions that take place in one of the following modes - (a) Hydrothermal Synthesis, (b) Spray Pyrolysis, (c) Sol-Gel Synthesis, and (d) Co-precipitation.

Sol-Gel Synthesis has low throughput and therefore is not ideal for high volume production. Co-precipitation requires fine control of process and solution parameters and therefore does not scale to very large production vessels, thus requiring large number of parallel processing tanks and spray pyrolysis is in its infancy – more research is required to scale it up to large production throughput. Commercial production follows the Hydrothermal Synthesis route, which requires

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