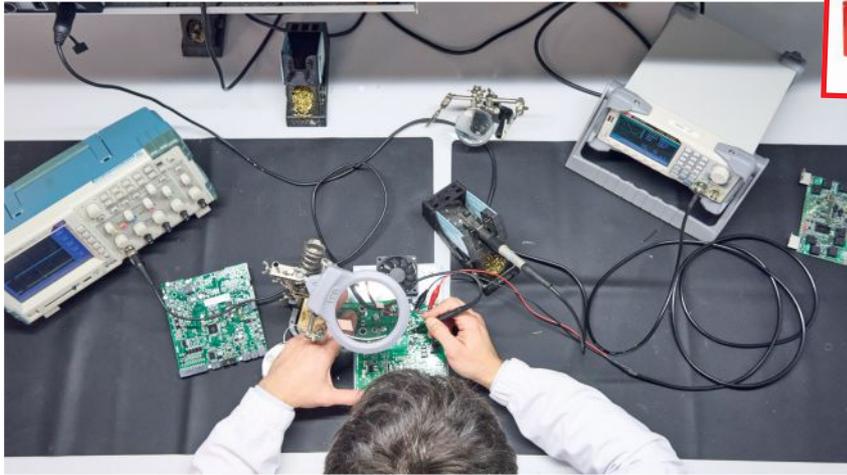


GREATER POWER, SAME CAPACITY

Italy-based Flash Battery shares their insights with Deputy Editor James Muir about lithium battery chemistries.



Since its foundation in 2012, Flash Battery has set the benchmark for lithium batteries in industrial vehicles and machines. Alongside the design and production of custom battery systems, Flash Battery continues to invest in research and development to explore new lithium battery chemistries and evaluate their suitability for industrial applications.

For Flash Battery, chemistry selection is never a purely technical choice, but a strategic decision that directly affects safety, reliability, operational continuity and total cost of ownership over the entire life of the machine.

Lithium-Iron-Phosphate (LFP) is Flash Battery's preferred chemistry because of its high levels of safety and stability. These characteristics make it particularly suitable for industrial vehicles and machines operating in demanding conditions.

The latest generation of cells reach energy density levels of up to 190 Wh/kg, enabling improved performance while maintaining a robust safety profile.

There are alternatives including Lithium Titanate Oxide (LTO), which Flash Battery calls a game-changer for applications requiring high performance in terms of power and lifespan. LTO chemistry stands out for its higher specific power and C-rate, providing greater power to be delivered for the same capacity and faster charging and discharging processes.

However, despite these advantages, LTO is not intended as a general-purpose solution. Flash Battery adopts LTO only in

highly specific use cases, where extremely high daily cycling, rapid charging requirements and very long operational lifetime outweigh the constraints related to significantly lower energy density and higher costs. This selective approach ensures that each chemistry is applied only where it can deliver measurable value over the entire life of the machine.

LTO has the disadvantages of notably lower energy density than LFP and its very high cost means careful consideration is required when using the chemistry. As a result, LTO chemistry batteries are available for specific cyclic applications, such as LGVs in automated logistics that require a very high number of daily charge and discharge cycles.

Nickel-Manganese-Cobalt (NMC) chemistry is not a strategic focus for Flash Battery because it is inherently less stable and safe than LFP chemistry, making it less suitable for industrial machines and vehicles.

The limited life of around 2,000 cycles, which would result in operational life of approximately five to six years in industrial vehicles charged daily, also counts against NMC chemistry. For many industrial applications, this lifespan is considered insufficient when compared to alternative chemistries designed for long-term reliability. Higher costs and the environmental impact associated with cobalt further limit the attractiveness of NMC solutions.

Flash Battery's R&D team continues to study new chemistries and sodium-ion batteries appear promising, helped by

the widespread availability of sodium, the sustainability benefits and high safety levels. The absence of cobalt, the good thermal tolerance and relative low cost are major advantages. However, sodium-ion batteries are currently considered at an exploratory stage. Their very low energy density and the technical challenges caused by the large variation in voltage between charge and discharge states must be addressed before this chemistry can become a viable solution for most industrial applications.

Semi-solid state batteries are a promising development in LFP and NMC chemistries. In these cells, the liquid electrolyte is partially replaced by a solid or gel-based electrolyte, which could significantly reduce the risk of combustion and further improve safety.

Flash Battery's R&D activity focuses not only on validating new cell technologies in laboratory conditions, but also on understanding how these solutions behave once integrated into real industrial systems. Semi-solid state batteries are being evaluated to assess whether their theoretical safety benefits can be maintained throughout the entire operational life of the battery.

Lithium-Manganese-Iron-Phosphate (LMFP) is considered a potential evolution of LFP chemistry. Iron is partially substituted by manganese, LMFP cells may achieve higher operating voltage and an increase in energy density of up to 20% compared to standard LFP, while preserving safety and cycle life characteristics.

Studies suggest LMFP cells could bridge the gap between LFP and NMC chemistries, offering high performance levels and high safety at the same time. Flash Battery is currently validating LMFP through laboratory testing to assess its effectiveness in industrial environments and to understand whether it can represent the next step in lithium battery development without compromising safety or lifespan. If confirmed, LMFP could combine the structural robustness of LFP with higher energy density, opening new design possibilities for applications that still require compromises in electrification.