Lithium battery

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Batteries have always been a critical design feature, for everything from handheld tools to computers and mobile phones and from uninterruptible power supplies to satellites. Battery research has been going on for years to increase energy density (the amount of energy in a given size and weight)—the need of which came during the upswing in handheld devices, from industrial measuring tools to mobile phones.

The increase in telecommunications satellites meant that battery weight was a factor, and every technological advancement tended to put battery capabilities in the forefront. While laboratories were working on upgrading battery technology, electronics technologies continued to advance more quickly—requiring ever-increasing amounts of energy and power.

But it wasn’t until electric vehicles (EVs) came onto the scene that manufacturers began to seriously consider the importance of batteries to provide greater range, higher reliability, and lower costs. For the EV market, size and weight are as important as cycle life. Categorized as primary (single-use typically for long-term, low power applications) and secondary (rechargeable), batteries have seen one innovation after another as they attempt to provide more energy density than ever before.

Today, state-of-the-art primary battery technology is based on lithium metal, thionyl chloride (Li-SOCl2), and manganese oxide (Li-MnO2). They are suitable for long-term applications of five to twenty years, including metering, electronic toll collection, tracking, and the Internet of Things (IoT). The leading chemistry for rechargeable batteries used in telecom, aviation, and rail applications is nickel-based (Ni-Cd, Ni-MH) batteries. Lithium-based (Li-ion) batteries dominate the consumer electronics market and have expanded their applications to electric vehicles.

It’s important to note here that the quantity of Li-ion batteries used in EVs exceeds the volume of mobile and IT applications combined.

Lithium-ion batteries, spurred by the growth in mobile phone, tablet, and laptop computer markets, have been pushed to achieve increasingly higher energy densities, which are directly related to the number of hours a battery can operate. Battery experts in the field have continually adjusted the technology to gain greater densities, including changing chemistries and modifying the designs. They’ve even looked at the raw material supply chain, considering it expensive and difficult to source cobalt as an additive to Li-ion designs.

Energy density is measured in Watt-hours per kilogram (Wh/kg). Li-ion designs provide the highest density of up to 250-270 Wh/kg for commercially available batteries. As a comparison, consider that lead-acid batteries offer less than 100 Wh/kg and nickel metal hydride batteries reach barely over 100 Wh/kg.

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In addition to energy density, power density is also an important consideration. Power density measures the rate a battery can be discharged (or charged) versus energy density, which is a measure of the total amount of charge. A high-power battery, for example, can be discharged in just a few minutes compared to a high-energy battery that discharges in hours. Battery design inherently trades energy density for power density.

“Li-ion batteries can be extremely powerful in terms of power density,” says Joong Sun Park, technical manager for Solid State Technology. “Saft produces one of the highest power density Li-ion cells in the world used in Joint Strike Fighter and Formula 1 racing cells that range up to 50kW/kg.”

Li-ion battery technology has progressed significantly over the last 30 years, but the best Li-ion batteries are nearing their performance limits due to material limitations. They also have significant safety concerns—such as catching on fire if overheated—leading to increased costs because safety features must be designed into the battery system.

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