The hot topics   
in battery research

Battery research is a broad field. Therefore, it is important to define the research objectives as precisely as possible. Empa researcher Corsin Battaglia explains where we are heading.

Battery research is currently a hot topic. For Empa’s battery researchers, this means they have to hold their own among the stiff international competition. Therefore, it is crucial to exactly define the direction, in which the research is supposed to head. After all, batteries need to fulfil very different criteria depending on the desired application – whether it be as a stationary solar power storage system for a mountain cabin or as a battery to power a sports car.

Swift and safe charging

In order to construct electric cars with a greater range, batteries with a higher charge density are required. At the same time, they have to withstand large charging currents if they are to be recharged rapidly at, say, highway rest stops. However, quick charging is not without risks, especially at low temperatures: Tree-like entities made of metallic lithium – known as dendrites – can form in the battery. These electrically conductive metallic deposits can cause a short circuit in the cell and, in the worst-case scenario, even set the battery on fire. Modern fast-charging systems thus check the temperature of the battery before the charging current flows. Battery researchers are on the lookout for performance-enhancing ingredients for batteries without compromising their safety.

The crux with rare raw materials

Lithium ion battery technology has largely defined our society in the last few years. Since its commercial launch in 1991, it has been instrumental in the laptop, smartphone and tablet revolution. In recent years, however, the roaring success of lithium ion batteries has also triggered such a steep increase in the demand for the raw materials needed to build the batteries that, a few years ago, the European Commission classed cobalt and graphite as critical raw materials, for instance.

Unfortunately, for the time being cobalt cannot easily be replaced as it facilitates both high charge densities (i.e. a lot of energy in a small volume) and high charge cycle stability for the battery (i.e. many charging and discharging processes, hence a long battery lifetime). Batteries that are used in electric cars today are very similar to those found in our electronic devices such as tablets and smartphones, which is why the demand for cobalt and graphite is set to keep on rising in years to come.

All over the world, the search is well underway to find substitute materials that are cost-effective and in abundant supply but do not have any technical drawbacks. Empa was involved in the development of a vanadium-based battery, for instance, which is currently being commercialized by the Swatch subsidiary Belenos.

Price is key – for stationary devices

An increasing amount of solar and wind power is to be stored locally to place less of a strain on the power grids. For these “large” batteries, short charging times and a high power density is less important as the battery can be a lot heavier and bulkier in a basement than in a smartphone or in the undercarriage of a car. In contrast, the price and the operating costs throughout the system’s lifetime are crucial as the battery has to compete with other energy storage systems.

Apart from studies aimed at understanding and improving the behavior of current lithium ion batteries, Empa’s research also concentrates on developing completely new concepts for batteries and exploring their potential – a long and oftentimes tedious process, as Corsin Battaglia, head of Empa’s Materials for Energy Conversion lab, points out: “Once a new battery system has proved itself in the lab, there is still a long way to go. It often takes years before we have a product or concept that’s ready for the market. It’s our job to speed up this process.”

Research at the materials level is accompanied by life cycle assessments (LCA) to improve the battery’s recyclability, for instance, or compare different technologies in terms of their environmental impact throughout the battery’s life cycle. //