Energy

CELEST

The Center for Electrochemical Energy Storage Ulm & Karlsruhe, or 'CELEST' for short, carries out research in Baden-Württemberg on powerful and environmentally friendly energy storage systems for the future. One of the things the scientists from Europe's largest research platform for electrochemical energy storage want to achieve is to lay the foundations for a battery technology that doesn't need lithium. Their findings will show the way forward for electric cars and power grids.

The airtight containers contain colourful punching plates. They are made from magnesium, calcium or sodium elements that could play an important role in the batteries of the future. Here in the lab, they are tested for suitability. "It is one of many areas we work in", says Ulm-based Professor Dr. Maximilian Fichtner, Scientific Spokesperson for CELEST, Europe's largest research platform for electrochemical energy storage.

Since 2018, CELEST has pooled the expertise of three major research institutions in Baden-Württemberg. They are Karlsruhe Institute of Technology (KIT), Ulm University and the Center for Solar Energy and Hydrogen Research (ZSW) in Ulm, which also operates Europe's largest pilot plant for battery cell manufacture. These partners also work together in the Post Lithium Storage (POLiS) Cluster of Excellence, which has a significant influence on the content of the CELEST research area for post-lithium batteries. POLiS is receiving federal and state funding of roughly EUR 50 million for an initial period of seven years within the framework of Germany's Excellence Strategy. Furthermore, the three institutions are involved in using a new key technology to set up a European Materials Acceleration Platform, called 'MAP' for short. The collaboration involves developing and operating autonomous AI-based robotics that will considerably speed up the search for new functional materials. This will make CELEST a hub for European battery activities.

Electrochemical storage is seen as a key technology. The fight against climate change and scarce resources is driving the transformation of the energy system. "That's why we urgently need technologies that can be used to store electrical energy from renewable sources in a particularly efficient way", says Professor Dr. Helmut Ehrenberg from KIT, Deputy Scientific Spokesperson for CELEST. This applies to batteries for electric cars as well as for stationary grid storage for storing solar and wind energy.

At first glance, the structure of batteries looks simple. They comprise a positive terminal, a negative terminal, a separator that separates both sides electronically, and an electrolyte, through which ions (instead of electrons) move as charged particles. However, the internal processes are complex. "Even experts like us have not yet fully figured out what exactly is happening inside", says Ehrenberg.

This is also true of the well-known lithium ion technology. Although the capacity and number of charging cycles have now increased to a high level and the costs are reasonable, scientists are puzzled for example by what is referred to as an 'interfacial layer' that develops in the lithium ion battery when a small quantity of the electrolyte corrodes on an electrode. Researchers from CELEST are working to understand this phenomenon, which determines battery quality and is also important for service life.

Even though lithium ion technology is in use around the globe, it does have disadvantages, as one of its main components is still cobalt. In the form of lithium cobalt oxide, it increases the battery's storage density and improves fast-charging properties. In terms of serving a mass market, however, there is limited availability of cobalt, making it scarce and thus expensive. This is why several of CELEST's projects are geared to alternative technologies. Batteries that use sodium ions instead of lithium ions are hotly tipped as one such alternative. Sodium is present in large quantities in nature, for example in salt domes and in the ocean. But sodium ions are larger and heavier than lithium ions, which has a knock-on effect on energy density and weight. "This means that sodium batteries wouldn't be very suitable for electric cars", explains Fichtner, "but they would be suited to stationary stores."

For other uses, magnesium batteries could work. Several institutes in Ulm and Karlsruhe are currently collaborating on research into magnesium batteries. "Scientists recently succeeded in using an organic polymer to create a positive terminal", says Fichtner. The plan is to now create cells, and then an entire battery. Computer simulations and digital twins of the systems help to understand the different techniques. In addition, technology impact assessment experts are scrutinising the entire life cycle – from the raw material to factory production and recycling of the components.

INFORMATION AT
www.celest.de

DATA AND FACTS

YEAR OF FOUNDING	INNOVATION ALLIANCE	POOLED COMPETENCE
2018	*31* INSTITUTES INVOLVED	*47* WORKING GROUPS