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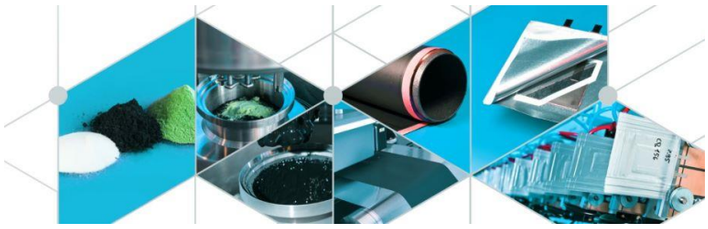
TECHFLASH

Fraunhofer

Sustainable Batteries



Sustainable battery technologies are steadily gaining relevance and are essential for a cost-effective, environmentally friendly and non-hazardous technology. Due to growing environmental awareness, there is an increasing focus on sustainable manufacturing processes. Furthermore, due to resource scarcity, market-leading lithium-ion batteries (LIBs) cannot cover every area of use and alternative battery cell technologies, such as zinc- and sodium-based systems, are needed. Due to the expansion of battery production in Germany, the raw material requirements for lithium, cobalt and other metals are increasing, thus exacerbating ecological risks due to raw material extraction. As a result of the scarcity of resources and the CO2 footprint in particular, it is important to consider the entire value chain, from materials and production technology to efficient battery use and recycling.

Rechargeable metal-air batteries as a cost-effective alternative to lithium-ion batteries: Metal-air batteries have a high energy density and constitute a potential low-cost energy storage technology. They are already commercially available as primary batteries. However, rechargeability is a major challenge and is currently the subject of research. Fraunhofer IFAM is developing rechargeable metal-air batteries. The focus is on the development of gas diffusion electrodes (GDE) with new (carbon) carrier materials and catalysts as well as novel designs with adapted porosity and wetting properties.

At Fraunhofer IFAM, various manufacturing technologies are used for metal-air batteries, such as doctor blade or roller coating of porous substrates, in-situ fabrication of mesoporous carbons, spray coating, or printing. The cell design requirements are also multi-layered, as these are "open" systems in which gaseous oxygen is the active component. Fraunhofer IFAM is developing special and also hybrid metal-air cell designs. Understanding the interaction of electrolyte and gas diffusion electrode is another main focus of our work with corresponding (in-situ) special analysis.

Environmentally friendly cell production: Currently, extremely harmful solvents are being used in cell production, especially for the production of electrodes for lithium-ion batteries. These have to be recovered during production by means of energy-intensive process steps. The use of exclusively water-based solvents that enable more efficient drying or the adaptation of a solvent-free manufacturing process that does not require a drying step can save investment and operating costs. On top of this, these methods have a positive effect on CO2 emissions.

Zn- and Na-ion systems become more important: Lithium-ion technology in various forms represents the state of the art in areas such as consumer electronics and electro vehicles, which are in high demand today. Nevertheless, global reserves of the alkali metal are limited and mining is costly and not very environmentally friendly. Furthermore, cobalt and nickel are both required for the electrodes of lithium batteries, both of which are metals that are also mined under problematic conditions or are toxic.

Alternative technologies that are inexpensive, non-toxic and highly safe are therefore of overriding interest regardless of their application. Alternatives include Zn-ion and Na-ion systems. These are sufficiently and readily available, do not require cobalt or nickel, and the necessary manufacturing processes can be transferred to conventional battery production.

Online analysis of the battery condition: Another important contribution to sustainability is an adapted operating strategy for energy storage systems. This requires new methods for the online determination of the health of the battery cells, which is necessary for optimal and long-lasting safe operation. Dynamic impedance spectroscopy and data-based analysis processes using AI methods offer great potential in this area.

Environmentally friendly lithium recovery: The lithium-ion battery is currently the most common electrical storage technology. With its high energy and power density, it is extremely versatile in areas such as electromobility, power tools and also stationary applications. Growing demand requires an increase in lithium production and thus the development of new lithium resources. Environmentally friendly lithium extraction from brine or hydrogeological sources is a promising alternative to conventional raw material extraction. Furthermore, direct recycling and the handling of (process) water play a major role in sustainability. With the help of the so-called electrochemical “ion pumping” process, lithium ions can be selectively extracted from aqueous solutions. The process is being applied and evaluated for realistic industrial scenarios of lithium extraction from geothermal sources in the “EWA — Efficient Water Treatment” project building upon the previously obtained laboratory results.

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Thanks and Regards,

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