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Shaping the future of electromobility: Research on high-performance battery materials

Electromobility is an important contribution towards addressing global mobility needs – especially in combination with renewable energy. Lithium-ion batteries are used in the majority of today's electric vehicles. BASF is conducting global research on innovative cathode materials, one of the most important components of these batteries.

Materials for both lithium-ion and all-solid-state batteries

Cathode materials essentially determine efficiency, reliability, costs, durability and the size of the battery. Their properties enable speed, acceleration and power – from compact cars to SUVs, from trucks to buses. BASF's research includes the synthesis of cathode materials (including precursors), characterization of material properties and performance testing. At the same time, experts are working on components for next-generation batteries, such as all-solid-state batteries.

(01) Research on high-performance battery materials for electromobility
Synthesis of a precursor for a cathode material in the laboratory

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The synthesis conditions for cathode materials significantly influence the properties of the end product, such as the range and fast charging capability of a battery. To meet the customers' requirements, BASF researchers develop individual strategies for the synthesis and post-treatment of the materials.

They have several approaches: Changes in the chemical composition, morphology and synthesis parameters. Cathode materials for lithium-ion batteries usually consist of mixed metal oxides. In the first synthesis step, various metal salts are precipitated with sodium hydroxide and then calcined at more than 700°C. Depending on the required property profile, the cathode materials are additionally post-treated. BASF is a strong player in the battery materials market and runs pilot and production plants in all major regions.

(02) Research on high-performance battery materials for electromobility

Production of a cathode

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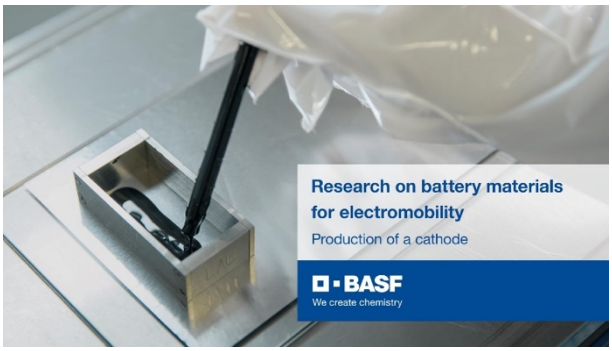

Cathode materials offer the broadest innovation potential of a lithium-ion battery as they make the batteries more powerful, reliable and affordable. BASF researchers are thus contributing in the best way to shape the future of electromobility.

BASF's battery materials portfolio includes Nickel Cobalt Aluminum Oxide (NCA) and Nickel Cobalt Manganese Oxide (NCM).

BASF researchers can tailor the materials through selected changes in the chemical composition, morphology (shape and structure) and the manufacturing process. By 2025, innovative chemistry will help to double the real driving range of a mid-size car from 300 to 600 kilometers with a single battery charge and to reduce the charging time to 15 minutes. At the same time, the researchers are working on reducing the size of the battery by half and doubling its lifetime. Today, BASF is already supplying cathode active materials to leading battery producers.

(03) Research on high-performance battery materials for electromobility

Production of a mini test battery (pouch cell): Assembly

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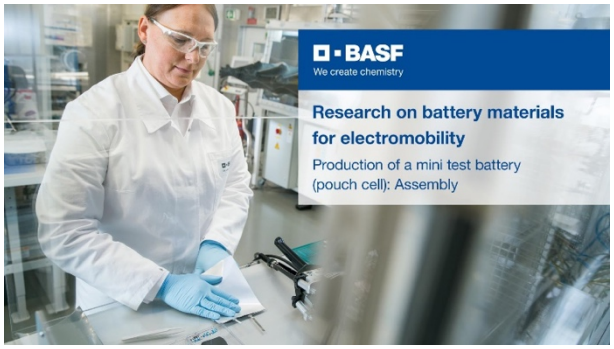

To gain insights into the properties of cathode materials produced in the laboratory, BASF researchers use pouch cells. Pouch cells are a common cell type in electric vehicles with a lithium-ion battery. A few hundreds of such cells are assembled therein.

BASF researchers use this special mini-battery cell to investigate the long-term stability of cathode materials. They can only confirm their assumptions about the quality of the cathode material produced in the laboratory when they have been tested under real conditions. With the help of standardized tests, they can, for example, determine how fast the cathode material degrades and how fast the lithium ions are transported in the battery cell. These tests last up to 12 months.

(4) Research on high-performance battery materials for electromobility

Production of a mini test battery (pouch cell): Filling with electrolyte

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(5) Research on high-performance battery materials for electromobility

Production of a mini test battery (pouch cell): Examination

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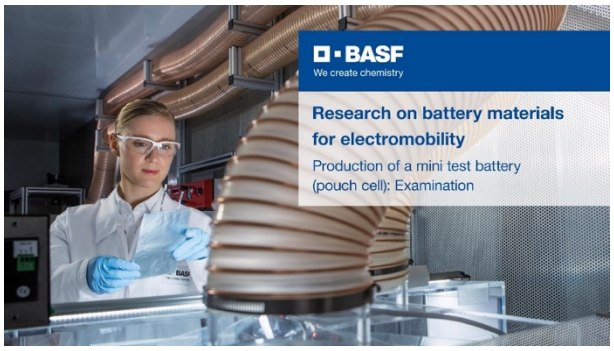

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(06) Research on high-performance battery materials for electromobility

Exploration of materials for all-solid-state-batteries: Assembly

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In addition to cathode materials for lithium-ion batteries, BASF researchers are working on materials for next-generation batteries, such as all-solid-state batteries. Due to their higher thermal stability, they have advantages compared to conventional batteries with liquid electrolyte.

For car manufacturers, this type of battery could offer advantages in terms of safety and battery volume. At the same time, this battery type also allows the use of materials with high energy content such as lithium anodes or high-voltage cathodes, which is much more difficult to realize in liquid electrolyte cells. Research on all-solid-state batteries is still at its beginning. The researchers do not anticipate commercial implementation for at least ten years.

(07) Research on high-performance battery materials for electromobility

Exploration of materials for all-solid-state-batteries: Thickness measurement

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(08) Research on high-performance battery materials for electromobility

Exploration of materials for all-solid-state-batteries: Compaction

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(09) Research on high-performance battery materials for electromobility

Atmosphere in a research laboratory

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BASF runs R&D sites around the world near its customers in Ludwigshafen, Germany; Beachwood, Ohio, U.S.; Shanghai, China as well as Amagasaki and Onoda, Japan.

This proximity ensures a good understanding of customer expectations and market needs. BASF supplements its in-house capabilities by collaborating with leading scientists, start-ups and academia around the globe conducting joint projects. BASF's battery materials portfolio includes Nickel Cobalt Aluminum Oxide (NCA) and Nickel Cobalt Manganese Oxide (NCM). BASF's researchers are determined to bring cathode active materials to the next level of efficiency to support the ongoing evolution of electromobility.