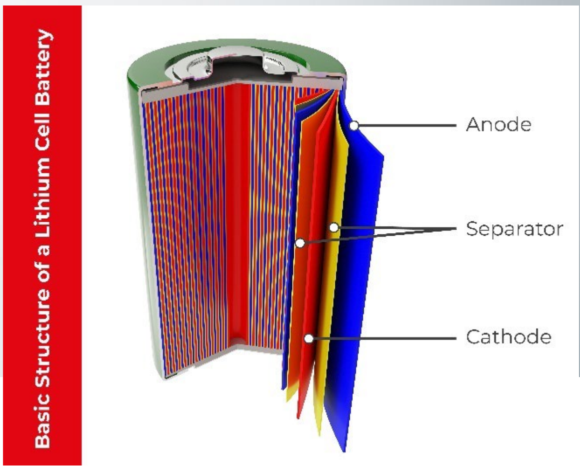
Heat Treatment Solutions for Innovative Battery Components



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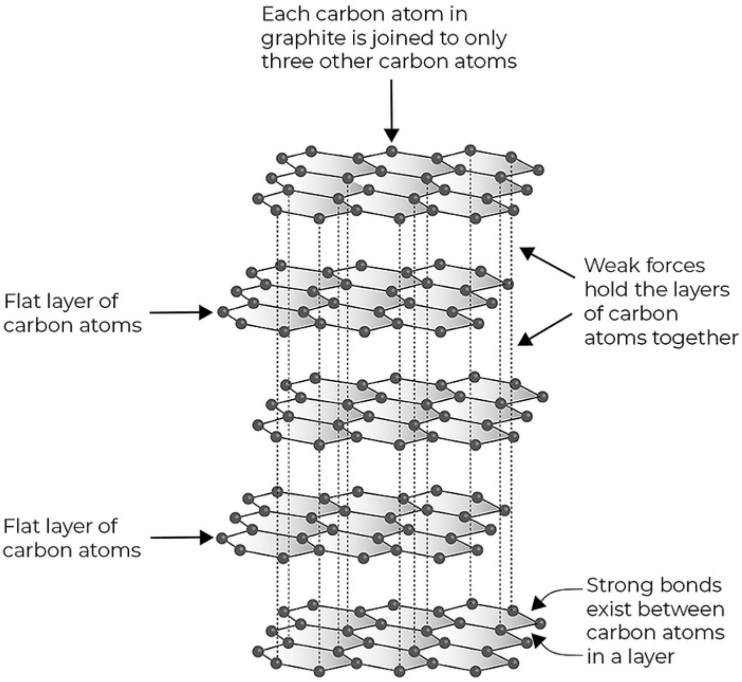
APPLICATION

In the realm of battery manufacturing, the quality of materials and the precision of production processes play a pivotal role in determining the efficiency and longevity of the final product. High-quality materials ensure that the batteries can store and deliver energy reliably, while meticulous production processes guarantee consistency and safety.
The journey of creating a superior battery involves several critical steps, each demanding the utmost attention to detail. From the selection of raw materials to the assembly of components, every phase must adhere to stringent quality standards. This not only enhances the performance of the batteries but also extends their lifespan, making them more cost-effective and environmentally friendly in the long run.
What makes a good battery? Purity and homogeneity of the material, the crystal structure, and a good electrolyte are just some of the aspects that we should consider.

Starting with the raw material the main steps can be summarized:

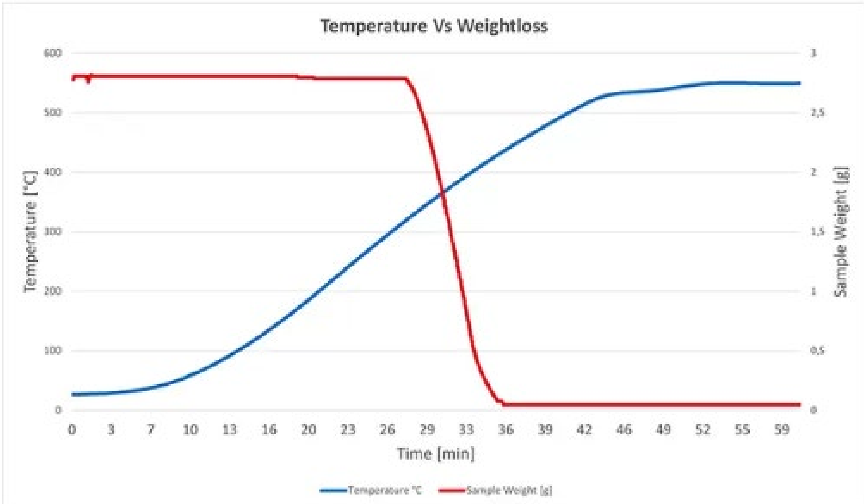


Graphitization

Graphitization is a crucial step in the production of battery materials, particularly for the anode in lithium-ion batteries. This is a multi-step process that begins with debinding, followed by carbonization, and finally the reordering of the structure. During this final step, the structure aligns into layers that move together at approximately 2500°C. This process involves pyrolysis, carbonization, and graphitization to achieve the desired material properties.

Debinding

Debinding is the process of removing binders and other organic compounds from the material. This is typically done by heating the material in a controlled environment to decompose and volatilize the binders without affecting the structural integrity of the material.



Calcination

Calcination is a thermal treatment process used to drive off volatile components and induce chemical reactions within the material. In battery production, calcination is used to remove impurities, initiate solid-state reactions and optimize properties such as particle size, morphology, and electrochemical performance.

For the process described above Carbolite Gero offers different levels of solutions:
For research and when an after-burning system is not required a tube furnace is the perfect choice. These furnaces can operate at temperatures up to 1800°C and are used for processes like material synthesis, calcination, and drying. Otherwise a larger system that includes an after burner can be provide with the GLO systems.

The GLO system is designed for battery production. It features a vacuum-tight retort and highly symmetric heating elements, ensuring precise temperature control up to 1100°C. This system is ideal for processes like annealing, degassing, and pyrolysis, which are crucial for producing high-quality battery materials.

For graphitization that requires a high-end precision system we can proved LHTG & HTK GR furnaces that can accommodate off-gassing and residual elements. Featuring graphite felt insulation and graphite heating elements they can operate at up to 3000°C

Nickel Purification

Pure nickel is crucial in battery production. The purification process of nickel involves roasting copper, iron, and nickel in air, melting and converting them to nickel sulfide (NiS), which is then oxidized in air to form nickel oxide (NiO). This NiO is reduced to coke. Raw nickel is purified and then re-purified using the Mond process.

The **Mond process**, also known as the carbonyl process has the following steps:

- **Reaction with Syngas**: Nickel oxide (NiO) reacts with hydrogen gas (H_2) at around 200°C to produce impure nickel (Ni) and water (H_2O).

NiO (s) + H2 (g) → Ni (s) + H2O (g)

- **Formation of Nickel Carbonyl**: The impure nickel reacts with carbon monoxide (CO) at 50-60°C to form nickel carbonyl ($Ni(CO)_4$), a volatile gas, leaving impurities behind.

Ni (s) + 4 CO (g) → Ni(CO)4 (g)

- **Decomposition of Nickel Carbonyl**: The nickel carbonyl gas is then heated to 220-250°C, causing it to decompose back into pure nickel and carbon monoxide.

Ni(CO)4 (g) → Ni (s) + 4 CO (g)

Carbolite Gero provides the TSO furnace for calcination and reduction at typical temperatures ranging from 550°C to 1150°C. The TSO furnace provides precise temperature and controlled atmosphere conditions necessary for the efficient execution of this process, ensuring high-purity nickel production.

For continuous operations a TSR rotating tube furnace is used. This furnace features a rotating tube design, which enhances the efficiency of the reaction by increasing the surface area of the material exposed to the atmosphere. The TSR furnace provides precise temperature control and can operate under modified atmospheres, making it ideal for the high-purity nickel production required in battery manufacturing.

The Mond process known is a Chemical Vapor Transport (CVT) method and uses a gradient furnace because it allows for precise control of temperature gradients along the length of the furnace. This is crucial for the CVT process, where materials are transported in vapor form from a high-temperature zone to a lower-temperature zone, facilitating the deposition of purified material. The gradient furnace ensures uniform heating and precise thermal conditions, which are essential for efficient and high-purity nickel production.

Electrolyte Sol-Gel Processed

The sol-gel process is a low-temperature method for synthesizing high-purity and homogeneous materials used for electrolyte used in batteries. In battery production, sol-gel processed materials are dried to remove solvents and form a solid gel. This drying step is crucial to prepare for further thermal treatments such as sintering where Carbolite Gero plays a key role providing perfect solutions for this heat treatment.

Carbolite Gero has contributed to the development of various high-density materials in silicon chemistry.

Combining materials like silicon, nickel, and niobium in solid gel electrolytes can enhance their performance in energy storage applications. Silicon can improve mechanical stability and ionic conductivity, while nickel and niobium can contribute to higher electrochemical stability and better cycling performance. These materials, when integrated into a solid gel matrix, can create electrolytes that are safer and more efficient for use in batteries.

The GLO is the ideal choice for this critical process. It efficiently synthesizes silicon-lithium materials using quartz boats, allowing for continuous layering, heating, and synthesis without interruption.