ABB MEASUREMENT & ANALYTICS | APPLICATION NOTE

Improve control of electrode coating in battery production

Maximize production efficiency, battery quality and safety with ABB's robust, calibration-free measurement solutions

ABB's proven flatness, thickness and tension measurement solutions deliver reliable performance in tough settings

Measurement made easy

Introduction

The lithium-ion battery market is booming as the world transitions towards more sustainable energy systems, thanks in part to the roll-out of electric vehicles and other electrification efforts. In addition, rechargeable, lightweight, energy-efficient and boasting a high energy density, lithium-ion batteries are in high demand to power consumer electronics such as laptops, tablets and smart watches.

Some forecasters project that the growth in demand for batteries will top 25 percent per year, yet the market remains highly competitive. Manufacturers are therefore looking to ramp up production and drive down costs while maintaining high levels of quality and safety. In such a competitive and demanding manufacturing environment, even small improvements in performance can make a big difference.

One of the key steps in battery production involves coating foil strips with a series of active layers to form the electrodes. Any flaws in this step will have an adverse impact on the performance and durability of the finished battery and can even pose a risk to user safety. Close monitoring and control of the coating process is therefore essential.

Application

Electrodes are built by depositing multiple layers of active materials, conductors and binding agents on strips of aluminium foil for the cathode and copper for the anode. Supplied in rolls, these foil strips range in thickness from around 5 to 25µm, depending on the cell design. The fragile metal foils demand careful handing to within extremely fine tolerances during the coating process.

The coating is applied in layers as a finely mixed slurry. The thickness and composition of the electrode coatings directly influence the battery performance and energy efficiency, so the layers must be deposited evenly and adhere reliably to the foil strips.

Challenge
The thin, fast-moving foil has to enter the coating process perfectly flat, at the right thickness and at the correct tension to help ensure an even distribution of the slurry across the surface of the foil. All three parameters must be monitored closely because any one of them can have a negative impact on battery performance if they stray off-spec.

Even small imperfections in the electrode's surface finish such as cracks, pits or delamination can cause significant performance and safety issues in the finished battery. In the worst case, an uneven coating can result in the formation of dendrites, which are lithium metal protrusions that can cause short circuits and thermal runaway. That poses a significant safety risk for end users.

Accurate tension control is critical. If the tension is too high, there is a risk that the fragile foil will tear or break. If it is too low, the distribution of the slurry could be affected and the rapidly uncoiling foil runs the risk of wrinkling during the coating process.

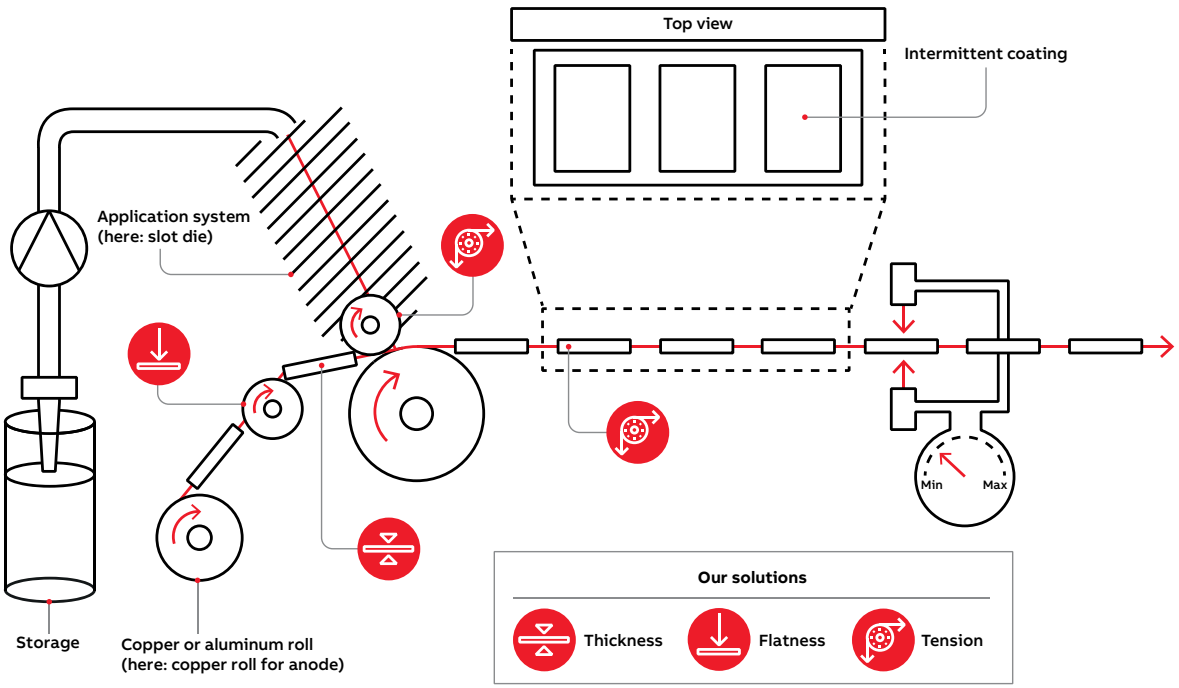
Solution
The answer is to monitor and control the flatness, thickness and tension of the foil strips throughout the coating process using accurate and reliable measurement systems. However, maintaining the accuracy and reliability of measurement systems for flatness, tension and thickness can be challenging in a demanding factory environment, where equipment must be able to withstand physical vibration, impact forces and extremes of temperature.

Satisfying the rapidly escalating demand for batteries calls for production lines that can operate with minimal downtime, so pausing production to calibrate or service instrumentation is potentially an issue. Calibration can bring production to a halt for several hours at a time, with further delays caused by related factors such as difficulty in accessing machinery and the need for equipment to cool before handling and maintenance.

The most appropriate measurement technologies therefore provide stable readings while minimizing or eliminating the need for regular calibration.

In tension measurement applications, for example, typical load cells based on strain gauge and LVDT (Linear Variable Differential Transformer) technologies can be impacted by a variety of factors, including vibration, unexpected shock loads, electrical interference and incorrect specification and installation. This can increase the frequency of calibration checks, and/or recalibration, increasing downtime and reducing productivity.

These issues can all be successfully overcome by opting instead for measurement technologies that can function for long periods of time under arduous conditions without drift or loss of calibration.



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Example of a coating process in battery manufacturing, highlighting ideal installation points for thickness, flatness and tension measurement instruments.

What can ABB offer?

Building on years of experience gained in the tough environment of the metals and paper industries, ABB's proven flatness, thickness and tension measurement solutions deliver accurate and reliable performance throughout their operational lifetimes in the most challenging industrial settings. This makes them ideal for use in battery production.

Flatness measurement and control
ABB's flatness measurement and control system combines the best strip flatness performance with the lowest cost of ownership and the highest levels of reliability and accuracy.

Offering stable, calibration-free performance, ABB stressometer flatness systems are proven to deliver unsurpassed measurement density and response time, long-term accuracy and integrated model-based multivariable control. Direct and parallel measurement provides accurate measurements within milliseconds of rolling, reducing the likelihood of any downstream issues.

ABB's solution minimizes the risk of breaks in the foil caused by poor flatness, reducing downtime and improving quality. This in turn helps to minimize both rejects and pass times for improved yield.

Thickness measurement
Specifically designed for harsh environments, ABB's C-frame thickness gauges are based on pulsed eddy current technology, which uses weak magnetic fields to carry out measurements. They offer dependable long-term stability and performance.

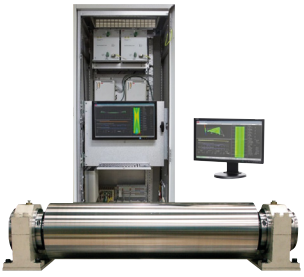
Pulsed eddy current technology is completely insensitive to anything in the measuring zone except the foil strip. All measurements are independent of the foil material, so the gauge does not need to be calibrated for different metal alloys.

Tension measurement
By combining electronics with high-accuracy ABB Pressductor load cells, our foil tension measurement systems provide high-accuracy tension control. By maintaining a constant tension within the desired range, regardless of any acceleration or deceleration, our solution maintains quality with a minimal risk of stoppages caused by torn or broken foil.

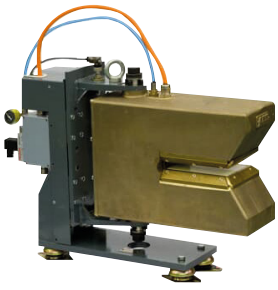
Pressductor load cells are sensitive and accurate yet rugged, reliable and compact. They are impervious to difficult factory conditions, such as high overloads and vibrations. That's because they rely on a measurement principle based on the magnetoelastic effect, whereby the magnetic properties of a material are influenced by the mechanical force applied to it. This makes Pressductor technology extremely robust and reliable, with no drift and no need for recalibration.

A complete measurement solution for battery manufacture
Electrode coating is just one of several steps in battery production that calls for high-precision monitoring and control. ABB offers a complete set of measurement solutions for high-quality, efficient and safe battery production.

To find out more about ABB's solutions, contact your local representative, or visit **https://new.abb.com/products/measurement-products/industry-and-application/battery**



Flatness measurement and control



Thickness gauging

Tension measurement

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