Knowledge is power

Big Data is driving sustainable innovation in LIB manufacturing

Ratingen, Germany 10th January 2023

Lithium-ion battery (LIB) cells are at the core of global electrification strategies, helping to meet ambitious net zero emission targets. To address the fast-growing demand for these products, LIB cell manufacturers need to ramp up production, delivering products of high quality with limited environmental footprints and short lead times. These goals are becoming easier to reach when adopting data-driven, automated solutions.

Klaus Petersen, Director Lithium Battery Industry EMEA at Mitsubishi Electric Europe BV, looks at how LIB cell manufacturing can rapidly increase productivity and throughput while improving their environmental impact by leveraging Big Data.

[Source: Mitsubishi Electric Europe, Germany]

Image Caption: The number of electric vehicles is increasing with the total number of

EVs on the road in 2021 reaching a peak of 16.5 million.

The number of electric vehicles (EVs) is skyrocketing, with the total number of electric cars on the world's roads in 2021 reaching a peak of 16.5 million. In the same year, new EV sales hit a new record of 6.6 million, representing nearly 10% of global car sales.[1]

The move from traditional combustion-driven road transportation to EVs is supported by customer demand as well as ambitious vehicle efficiency and CO2 standards. In effect, in most leading EV markets, these means of transport are seen as key to achieving decarbonisation goals, as the use of EVs can lead to the displacement of 1.6 million barrels of oil per day by 2025 (excluding two- and three-wheelers). This figure is expected to reach 4.6 mb/d by 2030. Also, e-mobility can reduce net greenhouse gas emissions by nearly 580 Mt CO2-eq.[2]

Growing battery supply ten-fold to meet e-mobility growth

The currently favourable marketplace means that there are valuable opportunities for LIB manufacturers serving the transportation sector, as these electrochemical cells play a key role in the transition towards more sustainable mobility. More precisely, the annual global capacity covered by EV batteries is estimated to ramp up from approximately 340 GWh today to more than 3,500 GWh per year by 2030.[2]

At the core of EVs are lithium-ion battery packs, where a number of cells are assembled in a frame to form a module, which is equipped with key

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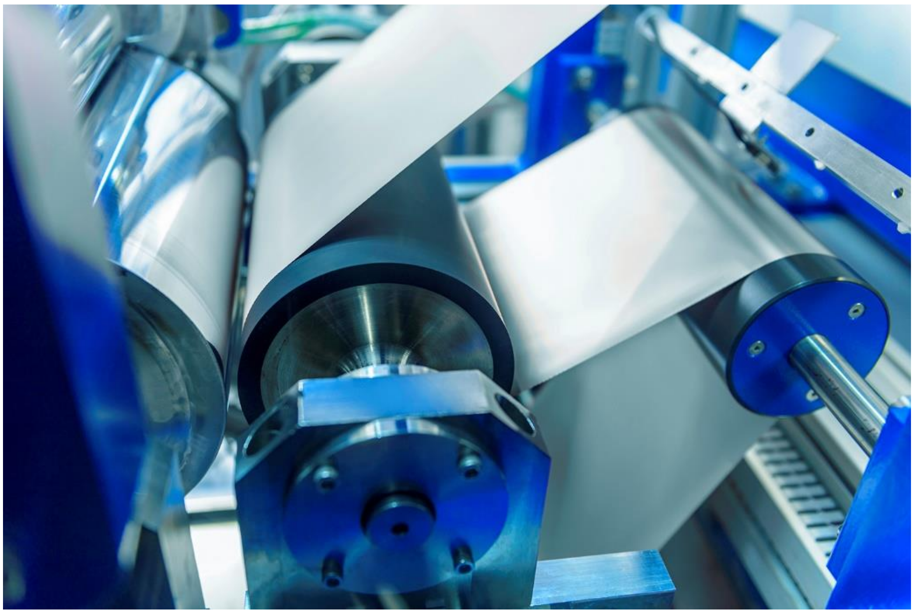
[1] IEA (2022), Global EV Outlook 2022, IEA, Paris https://www.iea.org/reports/global-ev-outlook-2022

[2] IEA (2022), Global Supply Chains of EV Batteries, IEA, Paris https://www.iea.org/reports/global-supply-chains-of-ev-batteries

systems, such as control, protection and cooling. Therefore, these are the enabling technology to power next-generation means of transportation.
LIB cells, in turn, are made of layers of metal foil coated with a fine layer of active conductive material. These two components form the battery's key elements, the anode and cathode, which are separated by a porous film and electrolytes. Typically, it is necessary to combine multiple layers of anodes and cathodes arranged in a cylindrical or prismatic shape, giving batteries the shape required by the application.



[Source: Mitsubishi Electric Europe, Germany]

Image Caption: At the core of EVs are lithium-ion battery packs, where a number of cells are assembled in a frame to form a module.

This structure is obtained by coating the metal foil and calendaring, which is a complex and precise process involving drying and rolling stages. Slitting of the material then follows, which involves cutting the foil into strips. Finally, depending on the battery format, they are die cut to size, stacked or wound and subsequently sent to the final process steps before undergoing end of line testing.

Delivering products of consistent and high quality is key to ramping up production, as these are essential to ensure the right capacity, voltage and resistance are offered, ultimately determining battery performance and safety. As so many critical stages are involved in LIB cell manufacturing, companies need to invest in robust, resilient and future-oriented production assets if they want to be able to address today's and tomorrow's skyrocketing market demands while reducing their environmental impact.

LIB production processes under the microscope

In continuous LIB cell production processes this can be challenging. Firstly, it is necessary to handle delicate, thin foil materials at high speed without sacrificing accuracy and precision. As battery energy density needs to continue to increase, the foils used may even become thinner, depending on the chosen technology, and thus more difficult to process. This means that producers need to find solid solutions for optimal tensioning. Secondly, inaccuracies and impurities accumulate through the different processing stages and conventional quality control may lead to high reject rates. These aspects can ultimately affect productivity and efficiency.

In addition to these issues, LIB cell producers should consider other key aspects. For example, with the metals required by the industry being scarce, expensive and involving carbon-intensive mining processes, it is crucial for manufacturers to ensure optimum resource use for efficient LIB production. By doing this, they can minimise their costs and environmental impact while increasing their profitability and ROI.

Addressing the potential of any battery performance issues is another challenge that manufacturers should be proactive about. Being able to leverage material track and trace systems to quickly complete root cause analysis and address any processing issues on the shop floor is key to avoiding the release of sub-par products.

Leveraging the power of Big Data

Data-driven, quality assurance strategies are well suited to supporting companies in developing optimised production environments. By promptly flagging anomalies, detecting and preventing quality shortcomings, especially in the early process steps, they help avoid larger issues further down the production line. This, in turn, can reduce the volume of off-spec and sub-optimal LIB cells while improving material and energy usage. Besides, data-driven approaches are at the core of track and trace strategies, as they can provide accurate insights, even in continuous processes, which are highly complex.

Companies should therefore invest in automation devices that can generate key data on processes, equipment and materials being used. These should then be analysed or mined to create predictive models that can be used to identify the parameters that determine product quality, optimum operations and asset performance.

The data crunching power of today's technology based on artificial intelligence (AI) is unprecedented. It is so advanced that traditional expert-based methods cannot even compete. In fact, they can scan through large volumes of figures, identify key patterns, inliners and outliners as well as interpolating multiple datasets to generate predictive algorithms on different processes. Besides, it is possible to develop overarching models that take all the different steps and assets of the whole LIB cell production chain into account to provide key indications on final product quality.

Once this knowledge is generated, LIB companies can leverage these insights to monitor and control their activities in real-time. Even more, by using time stamps and marks for film section identification, they can facilitate tracking and tracing that ultimately aid serialisation, problem solving and root cause identification.

Thanks to all these aspects, data-driven LIB manufacturers can benefit from considerable savings in terms of efficiency and costs, which can drive profitability and sustainability. For example, a non data-oriented 10 GWh production line may be producing 70%,10%, 5% and 5% of cells that offer, respectively, 100%, 90%, 80%, 70% capacity with 10% of products that need to be scrapped. Considering the overall costs associated with each single cell, if smart manufacturing can improve these capabilities even by a single percentage point, the environmental and financial impact can be considerable. In effect, each 1% scrap avoided in a 10GWh line that generates revenue of 90 EUR/kWh of battery capacity results in 9 million EUR of savings.

LIB operations that are ready for the future

There are more opportunities to consider, as the adoption of smart, data-driven LIB cell factories lead to continually ongoing optimisation of manufacturing processes. The predictive models developed can utilise new data, which is regularly generated by automated equipment, to refine their forecasts and provide ever more accurate insights to improve operations, products and assets. As a result, manufacturers can use these as part of continuous improvement strategies that can help strengthen competitiveness in the long run.

Companies interested in advancing their LIB cell production lines can now leverage a number of proven, cutting-edge solutions. A leading example is offered by Mitsubishi Electric, which launched an innovative line scan bar to inspect the surface of in-process materials in real-time. The instrument is equipped with contact image sensor (CIS) technology, to provide high resolution feedback on the surface conditions of the coated current collector. By processing the data generated by this, companies can leverage a key tool to help determine the quality of LIB cells with extremely high resolution and accuracy, ultimately improving end product quality.

This device is only one solution in Mitsubishi Electric's comprehensive range of industrial automation technologies, which are designed to generate key operational data. This can be fed to dedicated software platforms using the company's advanced Maisart AI (Mitsubishi Electric's AI creates the State-of-the-ART in technology) to develop or refine predictive models. By partnering with a leading specialist, such as Mitsubishi Electric, LIB cell manufacturers can rely on a full-service provider to advance their production facilities and make them more eco-friendly while driving the electrification of the transport sector. All this is ultimately enabling more sustainable practices.

Find out more in our latest videocast on our YouTube channel here https://youtu.be/IH-zkWOqVyk

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About Mitsubishi Electric Corporation

With more than 100 years of experience in providing reliable, high-quality products, Mitsubishi Electric Corporation (TOKYO: 6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. Mitsubishi Electric enriches society with technology in the spirit of its "Changes for the Better." The company recorded a revenue of 4,476.7 billion yen (U.S.$ 36.7 billion*) in the fiscal year ended March 31, 2022.

For more information, please visit www.MitsubishiElectric.com

**U.S. dollar amounts are translated from yen at the rate of ¥122=U.S.$1, the approximate rate on the Tokyo Foreign Exchange Market on March 31, 2022.*

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For more about the story behind "Automating the World" please visit:
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For more information, please visit emea.mitsubishielectric.com/fa

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e-F@ctory is Mitsubishi Electric's integrated concept to build reliable and flexible manufacturing systems that enable users to achieve many of their high speed, information driven manufacturing aspirations. Through its partner solution activity, the e-F@ctory Alliance, and its work with open network associations such as the CC-Link Partners Association (CLPA), users can build comprehensive solutions based on a wide ranging "best in class" principle.

In summary, e-F@ctory and the e-F@ctory Alliance enable customers to achieve integrated manufacturing but still retain the ability to choose the most optimal suppliers and solutions.

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Press contact:
Mitsubishi Electric Europe B.V.
Factory Automation EMEA
Monika Torkel
Media Relations
Mitsubishi-Electric-Platz 1
40882 Ratingen, Germany
Tel: +49 (0)2102 486-2150
Mob: +49 (0)172 261 4824
Monika.Torkel@meg.mee.com
de.linkedin.com/in/Monika-Torkel
www.xing.com/Monika_Torkel

Story/Editor:
DMA Europa Ltd.
Philip Howe
Progress House, Great Western
Avenue, Worcester, UK, WR5 1AQ
Tel.: +44 (0)1905 917477
philip@dmaeuropa.com
www.dmaeuropa.com

Distribution/Circulation:
MEPAX
Romain CLASS
Tel.: +33 (0) 6 12 80 47 76
r.class@mepax.com
www.mepax.com