32ND RESEARCH SYMPOSIUM ASNT EVENTS.

Presented At: ASNT Research Symposium:
25 – 28 June 2024
Pittsburgh, Pennsylvania, USA

Using ultrasound and machine learning for real-time inspection of complex processes within battery cells during their manufacturing

Shaurjo Biswas[1] and Austin Dulaney[1]

[1]Liminal Insights Inc.
1175 Park Avenue, Emeryville, CA 94608
shaurjo@liminalinsights.com

ABSTRACT

As the demand for electric vehicle (EV) batteries continues to increase, so too does the need for innovative inspection techniques in order to speed up research and development, accelerate yield ramps, and improve productivity, reliability, and profitability of battery cell manufacturing. At Liminal, we use ultrasound inspection and machine learning (ML) to rapidly and non-destructively provide actionable insights during cell production.

Cell manufacturing involves a series of complex physical and electrochemical process steps to assemble and activate the batteries for use in EVs and other applications. The quality and performance of the cells produced is heavily dependent on the inspection methods and data analysis tools used at each of these processes. Incumbent inspection technologies have been good but limited. State-of-the-art electrical methods inherently offer battery-averaged information and consequently, are often blind to local defects, physical inconsistencies (e.g. gas pockets or unwanted debris) that can lead to internal short-circuits in cells. On the other hand, 2D/3D imaging methods (e.g. X-ray, CT scan, MRI) can provide a lot of physical detail, but are prohibitively expensive and non-deployable in-line at gigafactories. Liminal's ultrasound inspection platform, EchoStat®, offers both speed of measurement and insight into the battery's internal physical state.

EchoStat consists of hardware for transmitting and receiving ultrasonic pulses into batteries; software for hardware control and data collection; and data analysis software for delivering actionable insights. Ultrasonic pulses are transformed as they travel through a battery, resulting in unique signatures representative of the density, modulus, and structure of the components that the pulses travel through. This makes EchoStat sensitive to subtle changes in a cell's physical integrity, soft materials properties, and construction quality, and measuring cells at multiple positions gives spatially-resolved information, key advantages over electrical and x-ray inspection methods.

In this talk, we use the electrolyte fill and soak process, a very critical process step, as a case study to illustrate how ultrasound is used to inspect battery cells and is differentiated from other inspection methods in this process step. We also demonstrated how EchoStat can be used to track saturation quality in real-time during process development and assess the quality of electrolyte saturation in-line during production, using data collected in collaboration with battery manufacturing partners. Finally, we highlight some of the other use-cases, applications, and capabilities of EchoStat in cell manufacturing.

Keywords: ultrasound NDE, battery, cell manufacturing, electrolyte saturation, machine learning, manufacturing quality