Track / Trace Inspection Application

Rechargeable Battery (Round) Cell Assembly

Rechargeable battery cells are becoming a new focus for assembly automation in the US and globally.

WHITE PAPER

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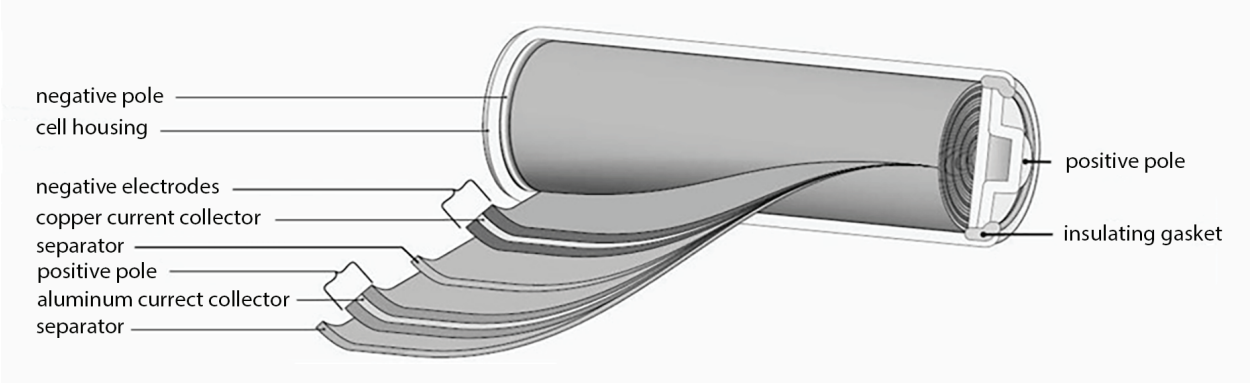
Content:

Ideal for
assembly automation

Direction of the Industry

Rechargeable battery cells are becoming a new focus for assembly automation in the United States and globally. While there are several types of cells (pouch, round, prismatic), the trend has been a movement toward the round cells due to ease of manufacture, high energy density at the cell level, and flexibility. There are a few centralized suppliers of these cells globally, the largest being LG Electronics, Samsung, Panasonic, and Toshiba.

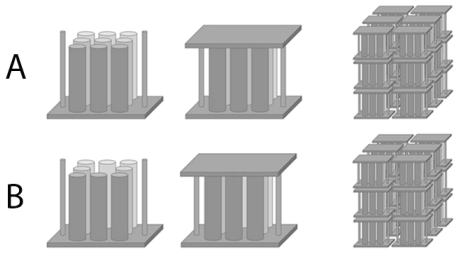
Pouch Round Prismatic



While a round cell offers the best option for energy density and limited complexity, assemblers have identified the sub assembly process (module production) as a key element critical to reducing overall weight and size of the final battery pack for end use.

This has resulted in an optimization of the module production to ensure that components are reused between a pack with a resulting 5 mWh, and a 10 mWh pack. It is achieved by varying the number of cells and their voltages within the module subassembly. It results in a tracing challenge as the packs all utilize the same components, and from the exterior, look the same to the assembler.

As an example of the challenges faced by the industry, the below represents:



The assembly process from a 10 mWh pack

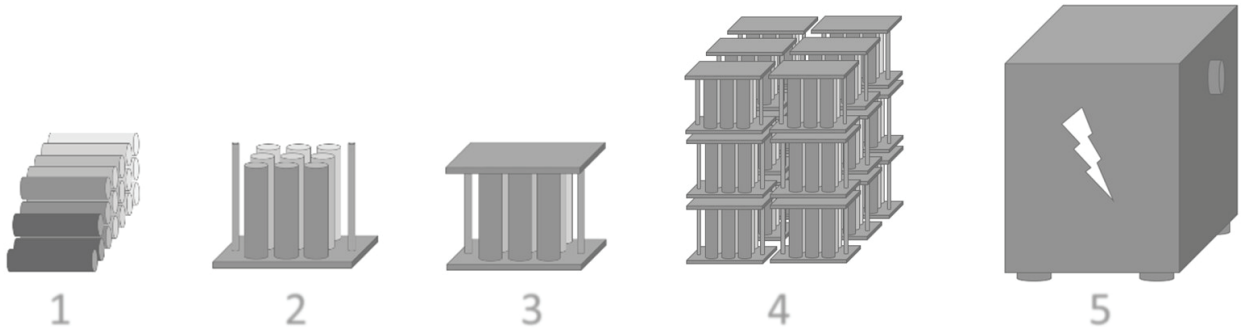
The assembly process for a 9.2 mWh pack, where a single central cell is removed.

Visually from the outside they are nearly identical.

With the exception of large automotive manufacturers, this process is increasingly manual due to the new nature of this market with semi-automatic assembly cells through the production process. This semi-automatic process requires continuous identification and inspection for verification and traceability, as well as HMI/controllers for work order presentation, and pick-to-light systems for cell assembly.

We will explore solutions that can be offered by ifm within this market space in this document.

General Process Overview

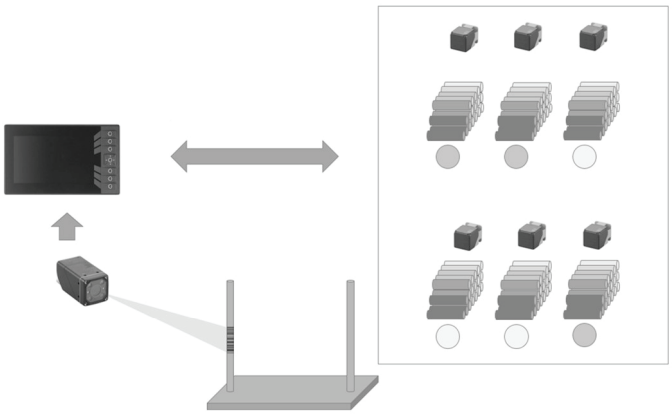


Prefabrication

Cells arrive in bulk from the manufacturer. Each cell must undergo a voltage test for quality assurance. The voltage test has also another important purpose. Due to the chemical nature, the inaccuracies from pre-charging and manufacturing process, each cell has a variance in mV and potential that must be accounted for in the assembly process.

Following testing, each cell is assigned a voltage class and separated into production batch containers (bins). This is where our Track and Trace (TT) journey begins. The variances in voltage have to be tracked and sequenced during the assembling.

1. Bulk cell management



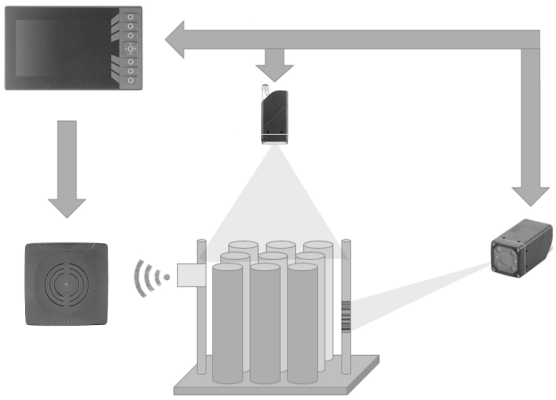
After voltage testing, the cells are separated into serialized production batches. The batches must retain the manufacturer and lot information through the production process. To achieve this, the bins are tracked with HF RFID, enabling a pick-to-light system for the assembler based on the presented work order.

Following this process, the module is assembled and the lot, manufacturer and assembled voltages are tied to the barcode engraved on a support rod (required in case of a "thermal event"). This allows tracking of the module as an entire unit and of the individual serialized cells within the module for the remainder of the production process.

2. Inspection and final module assembly

There is a separate set of assembly instruction for each required voltage of the module. The variables are: the number of cells included in each module (voltage variance taken into account automatically with pick to light), their location within the module, and the orientation of positive and negative poles of the cells within the assembly.

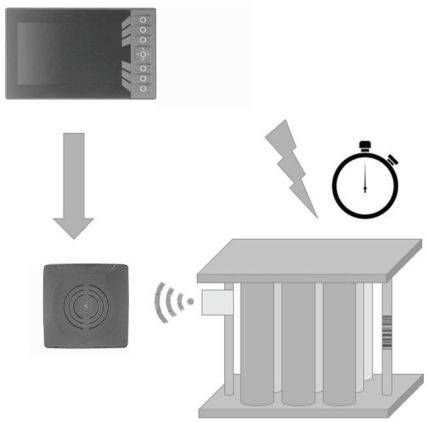
The module is placed into an inspection station in order to verify that the cells are in the correct orientation and location through a contour inspection.



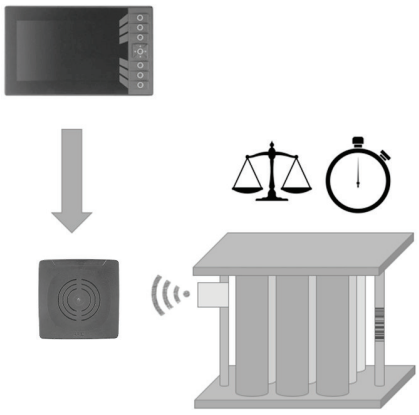
The code read initializes the correct inspection program. Upon passed inspection, the barcode identification is written to the UHF RFID tag. The UHF tag will be used in all future assembly steps as the engraved code rotates until assembled into the pack and no longer reliable.

UHF offers one additional extremely beneficial feature. When the final pack is assembled, the entire inventory will be scanned and compiled into a single unit code for the assembled pack.

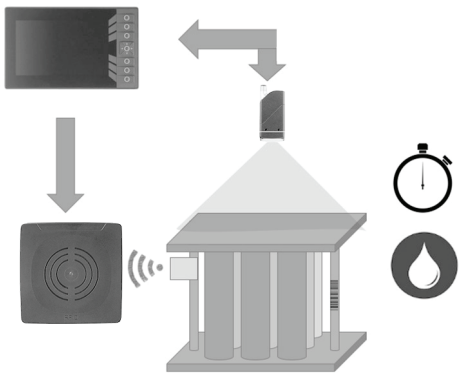
3. Once verified and inspected the cover/body of the module is applied. From here it moves through several quality check stations.



The unit is placed in a voltage testing machine to ensure that it has been assembled correctly according to the final build instructions. To track the efficiency of the line, the time within the testing cell is monitored, and the results of the test are tied to the UHF identifier for later traceability.



After that, the unit is weighed and the result serves as a baseline for later production steps and to verify again that the correct number of cells are present. This weight information is tied to the unique identifier within the database. Efficiency of the cell is tracked by enter/exit time.



The module then moves to the adhesive cell – time is critical here and is tracked for each step. An inspection camera verifies the positive/negative side of each module. Each of them has independent adhesive gluing patterns. Time of enter and completion is tracked to ensure that the epoxy received the correct treatment.

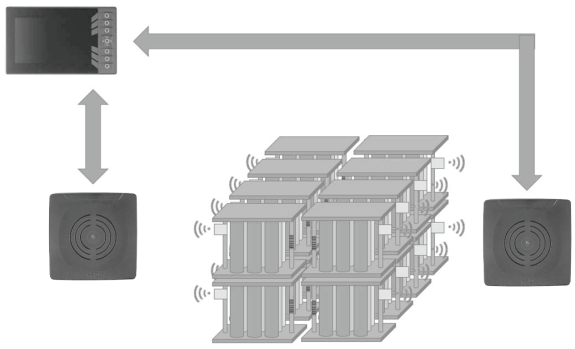
The modules are weighed after each adhesive cell to ensure that the correct amount of adhesive has been applied. For each adhesive cell and weight station an UHF antenna conveys the identification information back to the central database.

Following the adhesive phase, each module enters a laser cleaning station (one for each the top and the bottom) where the UHF tag identifies the module start/stop and pass/fail information, and inspection cameras capture images of both the top and the bottom for later verification that the process was completed.

From there the cell enters a final weigh station, again identified by UHF scan, to confirm that it is within tolerance for added adhesive compared to the initial weight at the beginning of the process. This station also includes a final voltage/battery test – if all tests are passed it is added into WIP inventory with a unique UHF serial number.

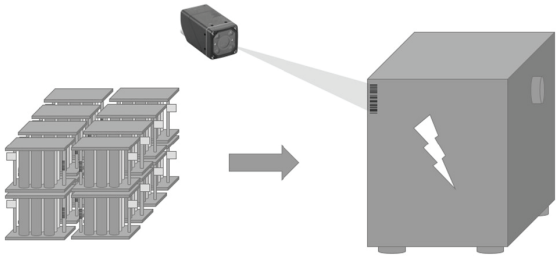
4. Battery pack assembly

Final pack assembly is done to order according to the overall size requirement. Work orders are presented by HMI/Controller for assembly instruction. Once the final pack is assembled it passes through a UHF portal gate on the conveyor. A list of all submodules that were used in the packs construction is created. This list serves as a verification of used modules and is used for the final release to finished goods inventory. Upon the release to finished goods inventory, the production and tracking information will be tied to a single barcode residing on the exterior of the pack casing.



Eventually this station will be expanded to include UHF identifiers on wiring harnesses as well as to create an entire sub-component list before boxing.

5. Final pack creation and master identifier



Following the pack creation, and a subsequent voltage check on the unit as a whole to ensure proper operation, a cover is placed on the entire pack, which contains a unique barcode for tracking throughout the warehouse and in the future.

Future opportunities

The above represents a semi-automatic assembly process, which by nature requires fewer locations for identification and inspection than a fully automatic assembly line. Image based code reading, HF, UHF, and Inception systems all work hand in hand to verify the manual assembly process – as the process become more autonomous, an increased number of stations such as these will be required to ensure correct assembling of the product.

With the addition of the CR in assembly automation, ifm now has the capability of offering complete tracking and inspection systems blending all ifm technologies to support the assembly and inspection process. With capability of direct connection to higher-level controls, SCADA systems, and cloud databases, an ifm solution has never been easier to integrate into an existing as well as new production process.

The Display Controllers offer a unique opportunity for semi-automate processes such as these with pick to light functionality and the capability to display work orders and build instructions at each station.

The intent behind this document is to serve as a baseline for picturing what ifm can offer in the realm of Track and Trace as an entire solution integrated into the customers existing software.

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