

INSIGHTS ON STATE-OF-THE-ART QUALITY CONTROL

Learn how to determine the characteristics of the microstructural elements in automotive Lithium-ion batteries.

By Birgitte Nielsen, BSc, Application Specialist, Struers



LITHIUM-ION BATTERY

PREFACE

Quality assurance is a critical process in automotive manufacturing. Quality control ensures customers receive products that meet their needs and are free from defects. If quality assurance processes are not supported by appropriate quality control procedures or these are done insufficiently or in the wrong way it potentially can put customers at risk.

Manufacturers are under constant pressure to meet market demands for safety, operational stability, environmental standards, and durability while at the same time improving productivity and remaining competitive in a global market.

At Struers, we aim to support manufacturers in meeting these demands in the global marketplace.

Our range of technology and expertise helps manufacturers prepare, analyse and ensure the highest quality of raw and processed solid materials in the manufacturing process.

In this materialographic report, we describe the procedure used to inspect the characteristics of microstructural elements on large surfaces of Lithium-ion batteries. These characteristics can affect a battery's lifetime and operational performance. The results of this procedure can be used to optimise production process parameters and derive manufacturing tolerances.



Birgitte Nielsen
BSc, Application Specialist, Struers

THE FIELD OF STUDY

The lifetime of a Lithium-ion battery is dependent on microstructural elements like particle size and layer thickness fluctuations. The microstructural elements of a battery must be evaluated in a systematic way in order for manufacturers to derive manufacturing tolerances and optimise production process parameters.

For this study, we examined and analysed the quality of a large-sized (2x14cm) Lithium-ion battery.

The battery had the following specifications:

- Anode – Al / Li-Alloy
- Cathode – Cu / Graphite
- Separator – ceramic / PA (poly amide)

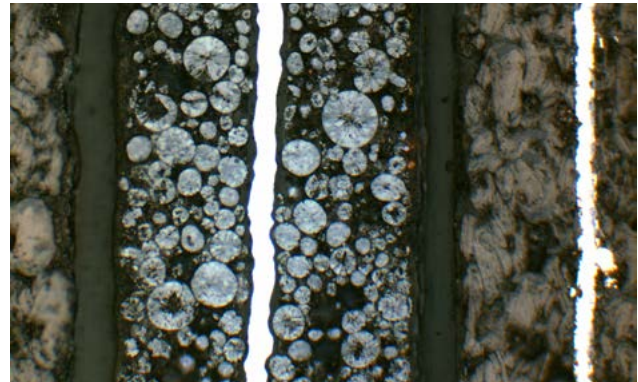


Exhibit 1: The end-result from inspecting the microstructural elements in a Li-battery.

Solution



REPRODUCIBLE PROCESS FOR MICROSTRUCTURAL INSPECTION OF LARGE SURFACE AREAS IN LITHIUM-ION BATTERIES

We created a reproducible process to evaluate the microstructural elements used to determine the characteristics of the electrodes in Lithium-ion batteries. Using highly-automated equipment and processes we are able to examine large, elongated, multi-layered, and water-sensitive battery-samples.

Cutting:



- Equipment: Discotom-100
- Cut-off wheel: 10S30
- Feed-rate: 1.0 mm/s
- Clamping tool: Vertical clamping tool 12 mm T-Slot

Using a [Struers Discotom-100](#) with cut-off wheel 10S30 and a final feed-rate of 1.0 mm/s, the bottom of the Lithium-ion battery is cut with minimal risk of delamination. Clamping setup (Cat. No. 05046904) and feed speed is important in this process.

The feed speed was slow to start (0.1-0.2 mm/s) and increased steadily to the final rate with acceptable deformation rates.



Exhibit 2: Clamping setup.

Mounting:



- Equipment: CitoVac
- Resin: CaldoFix-2
- Resin add: EpoDye

Using [Struers CitoVac](#) and CaldoFix-2 resin and EpoDye resin-add consumables, we used a vacuum to remove air from the microstructures in the sample. We then impregnated and re-impregnated the sample to keep the microstructures in place before and during the grinding and polishing process.

CaldoFix-2 was heated to 75 °C for 10-15 min in an oven before use - this makes the resin-mix very thin/flowing.

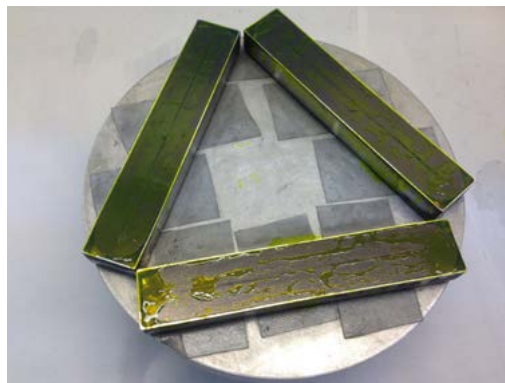
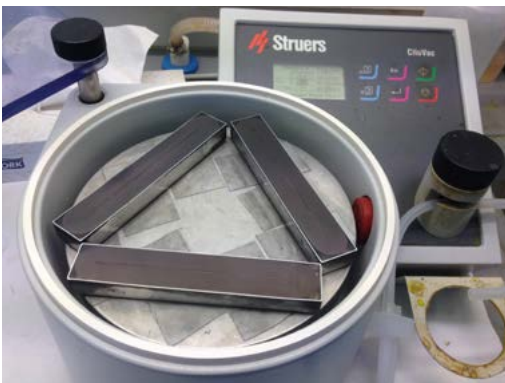


Exhibit 3: Battery samples are fixed to the holder using double adhesive tape and is both impregnated and re-impregnated during the preparation process. Air from microstructures is removed by using a vacuum.

Polishing:



- Equipment: AbraPol-30
- Disc diameter: 350 mm / 14"
- Specimen holder: 02606927 - MAXON

An eight-step grinding and polishing process is performed using the [Struers AbraPol-30](#) with a disc diameter of 350 mm / 14". Ideal for large elongated specimens, which in this case are fixed to the specimen holder (02606927 – MAXON) using double adhesive tape.

In the final polishing step – step 8 - AP-D powder 0.05 µm was mixed by hand with DP-Yellow lubricant. It is dosed as lubricant on AbraPol-30 in the final step of the process in order to minimize reaction to water and maintain sample flatness in end polishing.

Step	1	2	3	4	5	6	7	8
 Disc / Cloth	SiC Foil #220	SiC Foil #500	SiC Foil #1000	SiC Foil #1200	MD-Largo	MD-Dac	MD-Dur	MD-Chem
Speed [rpm]	300	300	300	300	150	150	150	150
Dressing [μm]								
 Cooling								
 Suspension					DP-Susp. A. 9 μm	DP-Susp. A. 3 μm	DP-Susp. A. 1 μm	
Pre-dosing					2	7	7	
Dosing					11	17	17	
 Lubricant	Water	Water	Water	Water	DP-Yellow	DP-Yellow	DP-Yellow	
Pre-dosing					2	3	3	7
Dosing					12	17	20	20
 Force [N] Single/Holder	/ 90	/ 120	/ 90	/ 60	/ 200	/ 120	/ 120	/ 90
Holder speed	150	150	150	150	150	150	150	150
 Rotation direction	>>	>>	>>	>>	>>	>>	>>	>>
 Time [min]	2:00	2:00	2:00	0:05	8:00	4:00	8:00	4:00
Stock removal [μm]								
Pause between steps	No	No	No	No	No	No	No	No

Exhibit 4: The settings for the 8-step grinding & polishing process. Lubricant mix is used. Alcohol is used for cleaning in the steps from 5-8.

RESULT AND OVERVIEW

Using three types of equipment during this process, we were able to determine the microstructural elements and characteristics of the Lithium-ion battery samples, which are large, elongated, multi-layered and water-sensitive.

During cutting focus was on clamping and feed speed. Vacuum mounting in a special holder enabled maximum fixation of the specimens during grinding and polishing. Grinding and polishing focused on specimen flatness and water free lubrication and cleaning.

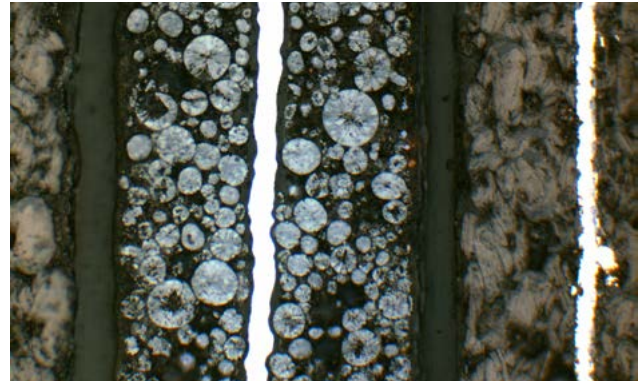
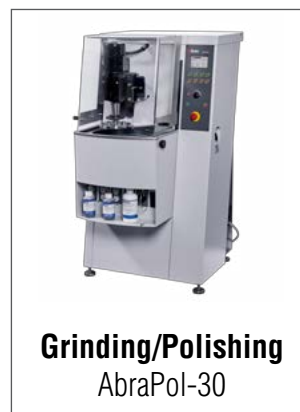


Exhibit 5: Microstructure of a Lithium-Ion battery.

This process can be reproduced to optimize production process parameters and derive manufacturing tolerances for production of high-quality Lithium-ion batteries in the automotive industry.

Solution



REACH OUT TO LEARN MORE

Concerned about Quality Control in the automotive industry?

[Feel free to reach out to me or other application specialists](#) for more information about this particular report or other quality control themes that might concern you.

[Visit us here](#) for more information about Struers and quality control in the automotive industry.



APPLICATION SPECIALISTS

Based on years of experience and expertise from a wide variety of industries, the Struers Applications Specialists team enables our customers all over the world to discover new opportunities for enhancing quality control, failure analysis and productivity, and to develop new applications and methods in order to meet evolving needs.