Technical paper

Seeing beyond

Accelerated analysis through connected microscopy

ZEISS Industrial Quality Solutions

Accelerated analysis through connected microscopy

Connecting different microscope types opens up completely new possibilities in quality assurance. In this way, the combination of light, X-ray, and scanning electron microscopes allows batteries for electric vehicles to be efficiently and accurately analyzed for faults. ZEISS solutions with coordinated hardware and inter-compatible data sets play a pioneering role here – and reduce previously time-consuming analysis workflows to just a few iteration steps.

Electric mobility is becoming increasingly more important and popular worldwide. This presents car manufacturers with completely new challenges. The battery replaces the fuel tank as the primary energy storage unit, which significantly increases the requirements for storage capacity, performance, and longevity. Car manufacturers respond by building up their expertise and technological infrastructure for battery production. There is also the need for additional electronic and semiconductor components, for example for highly automated driving, the increasingly digital interior or advanced assistance systems such as lidar (Light Detection and Ranging) for optical distance and speed measurement.

Innovation requires sustainable quality assurance

Even though the automotive industry is undergoing a profound phase of innovation and change, manufacturers still want to offer customers the same quality and reliability that they are used to, especially in Germany. This is why quality assurance retains its great importance in the transition to electric mobility and, like the automotive industry as a whole, is faced with new tasks that will grow with increasing innovation. Solutions that not only meet the current requirements but are also future-proof by being able to flexibly master new tasks and work flows are therefore highly sought after. ZEISS microscopy solutions work exactly according to this principle.

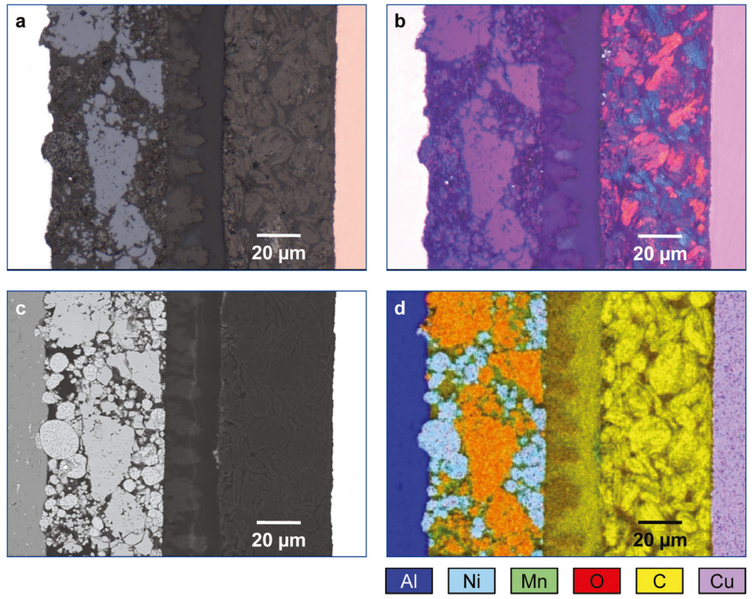
Battery testing with ZEISS Crossbeam

With models such as the BMW i3 and i8, BMW Group in Munich is a pioneer in premium electric vehicles. The Munich-based company is therefore also tackling new quality assurance tasks in this context with premium standards. This is how the Technology department combines material and process analytics with several ZEISS microscope types to examine components such as battery modules and cells as well as circuit boards for electronic components down to the nanometer and to eliminate possible failures before the car even covers the first few kilometers. The department checks the chemical composition of these components as well as material changes during use by carrying out random examinations. However, failure analysis and preventing errors are only one aspect: the results of the tests also provide a sound basis for negotiations with suppliers about the quality of the components and materials they supply.

ZEISS Crossbeam for the analysis of material properties in the nanometer range.

The ZEISS Crossbeam scanning electron microscope (SEM) lies at the core of these processes, a variant in which an additional ion beam (FIB) is integrated for structuring samples. This variant was chosen, as the relevant areas of interest for batteries are below the surface. The focused ion beam (FIB) can specifically expose these, the SEM analyzes them in the nanometer range, all using the same device.

ZEISS Crossbeam combines various systems to achieve this goal: This includes an EDX system, which enables statements to be made about the concentration of certain elements in a sample. It also has an EBSD system that shows which crystal structures are present in the sample, how large they are and how they are oriented. Last but not least, it offers a combination of time-of-flight mass spectrometry and secondary ion mass spectrometry: This is particularly relevant for the testing of lithium-ion batteries, since this combination is capable of characterizing lithium.



Correlative analysis of the microstructure of an aged lithium-ion battery.
Above: Light microscopy (a. Bright field; b. Polarized light)
Below: Scanning electron microscopy (c. EBSD; d. EDX elemental analysis)
Courtesy of Aalen University

Efficiency thanks to connected microscopy
Using a scanning electron microscope alone would pose a problem when faced with this task. A battery cell is between 10 and 20 cm long, but an SEM characterizes items on a nanometer scale. Localizing an error would be such a tedious task. BMW therefore also relies on light and X-ray microscopes from ZEISS to prepare the analysis. Using a ZEISS Xradia X-ray machine, the test engineers can X-ray the battery and, in this way, determine the area of interest on the basis of the X-ray image.

The data obtained in this way can then be imported into the ZEISS SmartSEM and ZEISS Atlas software of the ZEISS Crossbeam, whereby the relevant sample areas can immediately be prepared specifically by the FIB and examined by the SEM. This avoids a lengthy search and manual preparation of the desired examination section. Furthermore, there is no damage to the sample, which can occur during manual grinding and falsify the result of the analysis. The unique correlation of microscopy data, which only the ZEISS networked portfolio can offer, therefore allows for a significant reduction in working time and at the same time increases the quality of the analysis results.

Data correlation enables cross-site collaboration
However, not all sites allow the installation of a ZEISS Crossbeam. The inter-compatibility of the ZEISS software of different microscope types enables efficient collaboration. This means that test engineers at other sites can use a light microscope and the ZEISS ZEN core software to perform a preliminary analysis and label areas of interest. They can continue to use the data sets in the ZEISS SmartSEM and ZEISS Atlas software and perform the detailed analysis with the ZEISS Crossbeam here as well.

The option to compare electron, element, and X-ray images directly with each other, as well as the option of loading the ZEISS data sets into external software, ensure maximum flexibility.

Flexible use even in the future
The combination of various analysis tools that this process makes possible is also appreciated by other manufacturers. They use similar setups to analyze the quality of the leather or fabric for seat covers or corrosion under the paint, for example. The electronic and semiconductor components mentioned above will also be investigated efficiently and purposefully in this way. Whatever microscopic tasks users may face in the future – the networked microscopy solutions from ZEISS offer the efficiency and flexibility required in today's industrial 4.0 environment.

ZEISS customers benefit from integrated solutions that are specifically tailored to their current requirements and can also be adapted for other uses. Lastly, the upgrade and update capability of all ZEISS solutions ensures sustainability so that users do not have to constantly purchase new devices when they need to expand their applications. This ensures that ZEISS customers are always at the cutting edge of technology – both now and in the future.

Connected Microscopy

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