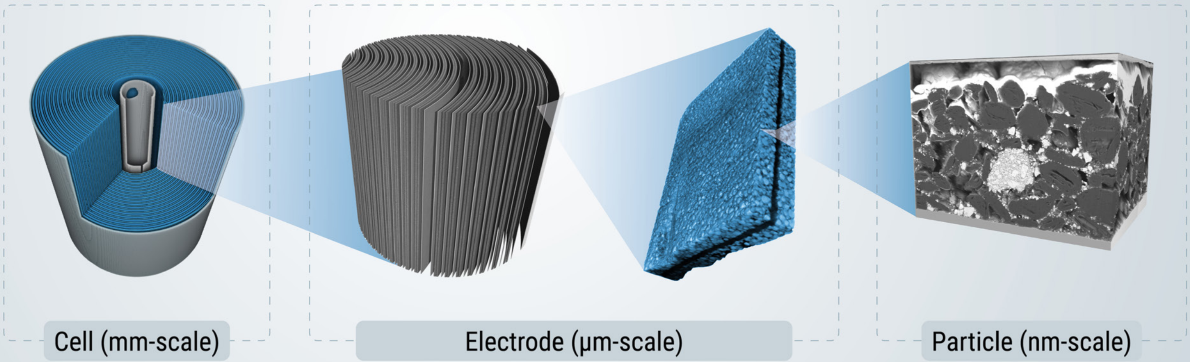
TESCAN's Analytical Solutions for Battery Research and Quality Control

A powerful suite of microscopy solutions to tackle development needs across the entire battery value chain, from upstream to downstream

TESCAN Solutions for Multiscale and Multimodal Characterization of Lithium-Ion Batteries

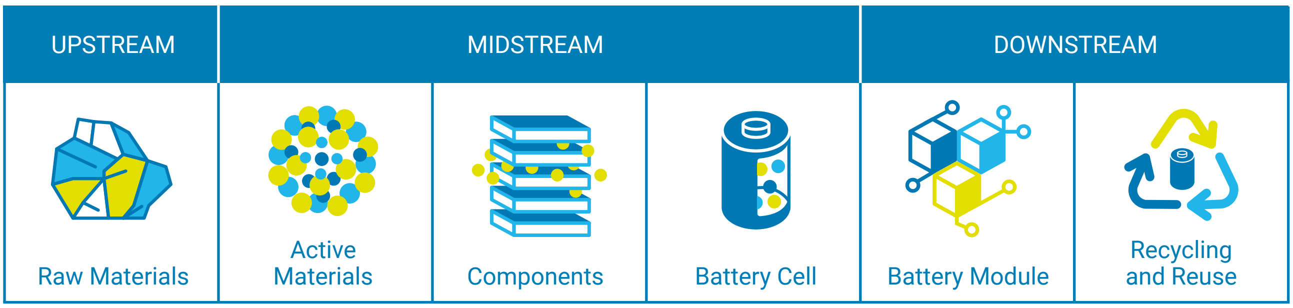


Analytical Solutions designed for Multiscale and Multimodal Characterization of Battery Materials

With the push to meet objectives for a fossil fuel-free future, battery manufacturers are faced with the need to better optimize production processes, enhance the performance of existing battery technologies, all while developing new energy storage solutions that provide sufficient capacity, long lifespans, fast charging rates, and eco-friendliness. Battery innovation relies heavily on comprehensive structural and chemical data from the materials used for generating and storing energy, to ensure safe and stable operation and performance. Multiscale and multimodal characterization deliver the most comprehensive data to support research and development as well as quality control.

TESCAN offers solutions tailored to characterization of battery materials and meeting the analytical requirements unique to each stage of the battery production value chain (Fig. 1). Our multimodal and multiscale analytical workflow incorporates SEM, FIB-SEM, and micro-CT microscopy systems and proprietary analytical techniques that all provide valuable data for improved battery designs and definitive quality control. Each microscopy system delivers capabilities that are carefully aligned with the specific needs of each segment in lithium-ion battery production. This ensures unequivocal results, with valuable insights for researchers and industry professionals alike.

▼ **Fig. 1:** The structure of the battery production value chain.



- **Drive battery performance improvements and innovation** with comprehensive structural and chemical evaluations of electrodes, separators, and their interfaces using high-resolution 3D tomography on a FIB-SEM or X-ray tomography on a micro-CT.
- **Improve battery lifespan and (dis)charge rate** by gaining insights into Li trapping, Li movement, and intercalation processes by utilizing TESCAN's integrated ToF-SIMS, EDS, and Raman spectroscopy on a TESCAN FIB-SEM with inert gas transfer.
- **Enhance your quality control capabilities in both 2D and 3D** by detecting impurities and determining their impact on battery cell properties by performing structural analysis of battery components using TESCAN plasma FIB-SEM equipped with ToF-SIMS and EDS.
- **Optimize your battery value chain's downstream activities and prolong battery cell lifespan** by assessing the complete battery cell through efficient, non-destructive analysis of electrode cracking and delamination with TESCAN UniTOM HR micro-CT.
- **Enhance the quality control of your processed materials and battery components** using ultra-high-resolution SEM imaging, EDS elemental analysis, and automated imaging routines on TESCAN CLARA.
- **Optimize your battery value chain's upstream operations** through accurate mineral identification in ore or recycled battery components using TESCAN Integrated Mineral Analyzer (TIMA).

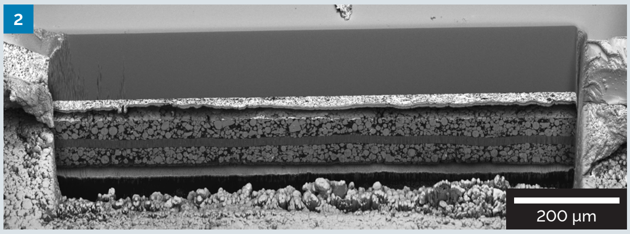


Fig. 2: 1 mm wide site-specific cross section through the entire electrode depth, prepared and imaged with TESCAN AMBER X for subsurface analysis. The ability to prepare a high-quality cross section through the electrodes or the complete primary battery cell is important for understanding the battery's inner processes and structuring.

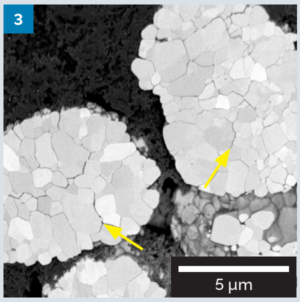


Fig. 3: High-resolution BSE image of the NMC particles imaged using TESCAN AMBER X. The lithium-ion battery lifespan is influenced by electrode particle degradation that is caused primarily by fracturing and fragmentation during the cycling process.

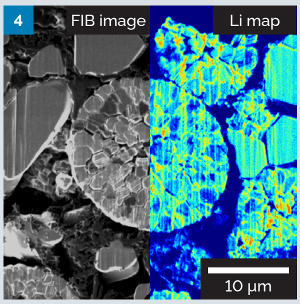


Fig. 4: Lithium map created using a FIB-SEM image acquired on TESCAN AMBER X equipped with ToF-SIMS. Battery performance is highly dependent on lithium mobility and intercalation. The ToF-SIMS technique on the FIB-SEM allows high-sensitivity detection and mapping of light elements including lithium.

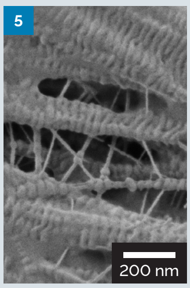


Fig. 5: Ultra-high-resolution SEM image of the PP separator. The porosity of a separator influences lithium mobility during the cycling process and plays a role in battery lifespan.

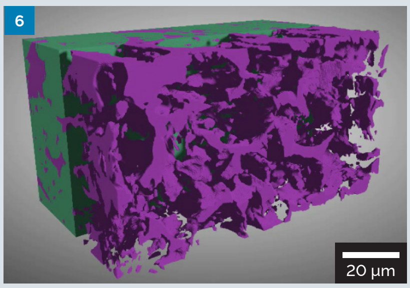


Fig. 6: 3D FIB-SEM tomography of a graphite anode. Battery energy density and charging characteristics are influenced by electrode material porosity, which affects electrolyte distribution and lithium mobility. FIB-SEM permits high-resolution 3D tomography for calculating porosity. Porosity of the visualized volume is 20%.

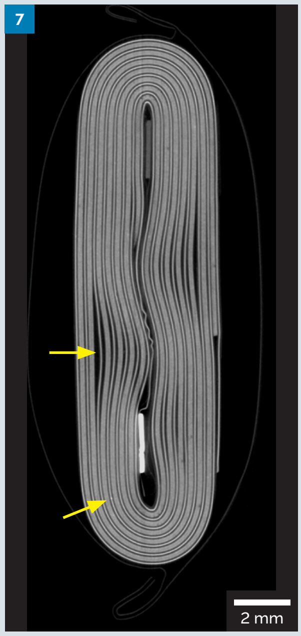


Fig. 7: Image from a TESCAN UniTOM HR micro-CT showing a failed battery cell with various defects and faults. Battery capacity and lifespan are reduced by the presence of defects within the battery cell. Non-destructive X-ray tomography with micro-CT can identify localized electrode delamination and contaminants (indicated by the arrows).

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