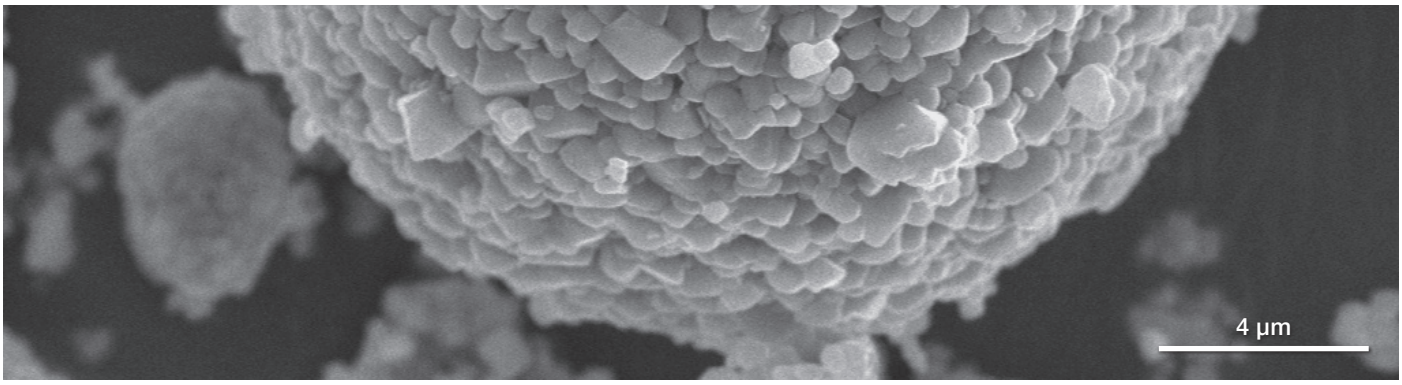
Datasheet

Phenom ParticleX Battery Desktop SEM

Automated structural and chemical analysis of battery materials using SEM and EDS

thermo scientific



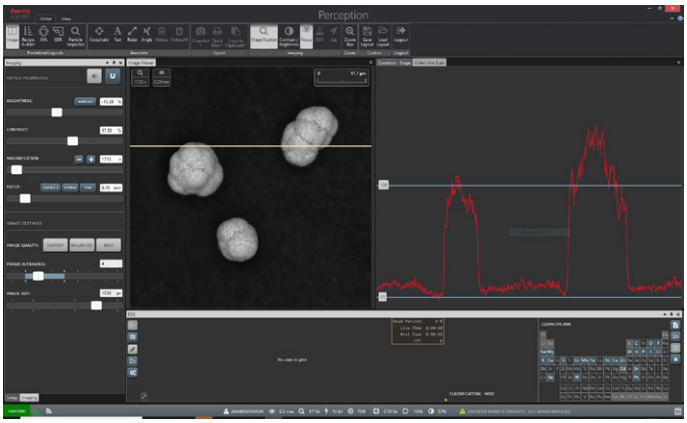
SEM image of battery cathode particles.

A growing number of manufacturing companies are establishing scanning electron microscopy (SEM) systems in-house. This trend, from outsourcing to in-house analysis, is growing, and the benefits, such as the ability to perform a broad range of automated desktop analyses, chemical classification, and verification according to specific norms, are clear. Timely and accurate quality control is a prerequisite for today's manufacturing.

Introduction

The Thermo Scientific™ Phenom™ ParticleX™ Battery Desktop SEM is a versatile desktop SEM solution for high-quality, in-house analysis. It gives you the ability to carry out speedy analysis, verification, and classification of materials, supporting your production with fast, accurate, and trusted data. The system is automated and offers analysis of multiple samples, making testing and classification up to 10 times faster. Outsourcing typically takes up to 10 working days, whereas the Phenom ParticleX Battery Desktop SEM gives you certainty within one day. The instrument is simple to operate and fast to learn, opening up the use of particle and material analysis to a wider group of users in-house.

In addition to eliminating the need to outsource, the Phenom ParticleX Battery Desktop SEM's ease-of-use and automation allow you to offload sample analysis from other SEMs in your laboratory.



ParticleX Desktop SEM user interface with line scan threshold.

The NCM powder (nickel, cobalt, manganese or Ni-Co-Mn) is a very important ingredient for batteries. The most common ratio is 8:1:1 (8 parts Ni, 1 part Co, and 1 part Mn). The particle size and exact chemistry of the powder influence the final battery performance, but even more important are the contaminations in the powder, as a single metal particle can have disastrous results in the battery. Finding these contaminations and classifying them is like trying to find a needle in a haystack.

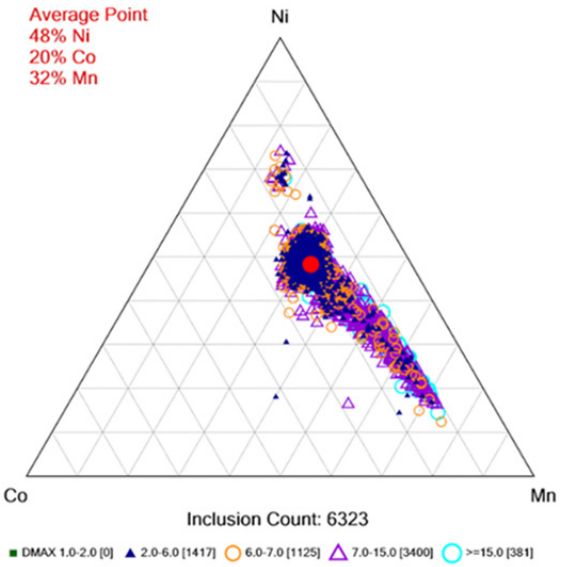
Particle results

Size class		B	C	D	E	F	G	H	I	J	K
Size range (µm)	Total	5 ≤ X < 15	15 ≤ X < 25	25 ≤ X < 50	50 ≤ X < 100	100 ≤ X < 150	150 ≤ X < 200	200 ≤ X < 400	400 ≤ X < 600	600 ≤ X < 1000	1000 ≤ X
Iron	1		1								
Aluminium	443	256	167	19	1						
Other	272	123	115	32	2						
Salts	8	1	6	1							
NCM	99286	37745	43173	17398	960	8	1	1			
Total counts	38125	38125	43462	17450	963	8	1	1	0	0	0

Results on a battery sample. The colors indicate the conductivity of the particles.

Automated SEM EDS analysis helps with this challenge. When the thresholds are set high, it will quickly find only the contaminant and report the chemistry and size of the particles. But if the makeup of the general powder is of interest, it can also be done by analyzing many NCM particles automatically.

Thanks to the recipes used in the Phenom ParticleX Battery Desktop SEM's software, the analysis can be completely standardized, with the highest repeatability in the market. This standardization and repeatability are important, but just as important is that the software allows for customization. Not all batteries are the same, not all ingredients are the same, and not all manufacturers use the same process, so the software can be adapted individually to fit each case.



Ni-Co-Mn ternary diagram with the particle population showing a large spread in Mn-Ni ratio.

Features

Conductance classifications: Each particle class can be labeled with a conductance of the particles, allowing for appropriate sorting. This also allows you to asses the impact of contamination much more accurately since a small organic contamination is not as severe as a metallic conductive contamination.

Ternary diagram: To view the overall chemistry of the particle population, a ternary diagram can be generated where all particles are represented. With Ni, Co, and Mn on each axis, the outyears and general trends can be seen instantly.

Perception software
Automated particle analysis for battery cleanliness
Intuitive user interface limits training time
Run your SEM day and night to enhace efficiency
Automated reporting with dedicated report templates
Compliant with GB/T 41704
Reclassification and requantification of results
High speed analysis, while maintaining accurate and repeatable results
Versatile output formats: PDF, Word, Excel, CSV

General usage

The Phenom ParticleX Battery Desktop SEM features a chamber that includes an accurate and fast motorized stage that allows analysis of samples of up to 100x100 mm. In spite of this larger sample size, a proprietary loading shuttle keeps the vent/load cycle to an industry-leading sample loading time of 40 seconds or less. In practice, this improves the throughput factors more so than other SEM systems.

The user interface is based on the proven ease-of-use technology applied in the successful line of Phenom Desktop SEMs. The interface enables both existing and new users to quickly become familiar with the system with a minimum of training.

The standard detector in the Phenom ParticleX Battery Desktop SEM is a four-segment backscattered electron detector (BSD) that yields sharp images and provides chemical contrast information. It works together with a fully integrated energy dispersive X-ray (EDS) system that allows you to obtain detailed chemical composition of your samples from a micro volume via spot analysis. Elemental distribution can be visualized with the elemental mapping option. A secondary electron detector (SED) for surface-sensitive imaging is optional.

Elemental mapping and line scan

It is simply one click and go to work with the elemental mapping and line scan functionality of the Phenom ParticleX Battery Desktop SEM. The elemental mapping functionality visualizes the distribution of elements throughout the sample. The selected elements can be mapped at a user-specified pixel resolution and acquisition time. The real-time mapping algorithm shows live buildup of the selected elements. The line scan functionality shows the quantified element distribution in a line plot. This is especially useful for coatings, paints, and other applications with multiple layers for analyzing edges, coatings, cross sections, and more. Results of both the elemental mapping and line scan functionality can be easily exported by using an automated report template.

Secondary electron detector

A secondary electron detector (SED) is optionally available on the Phenom ParticleX Battery Desktop SEM. The SED collects low-energy electrons from the top surface layer of the sample. It is therefore the perfect choice to reveal detailed sample surface information. The SED can be of great use for applications where topography and morphology are important, which is often the case when studying microstructures, fibers, or particles.

Imaging	
Detection modes	
Light	Magnification range: 3–16x
Electron	Magnification range: 160–200,000x
Illumination	
Light	Bright field / dark field modes
Electron	• Long lifetime thermionic source (CeB_6) • Multiple beam currents
Acceleration voltages	• Default: 5 kV, 10 kV and 15 kV • Advanced mode: adjustable range between 4.8 kV and 20.5 kV imaging and analysis mode • Perception: 15 kV
Vacuum levels	Low - medium - high
Resolution	<10 nm
Detector	
Standard	Backscattered electron detector, and energy dispersive spectroscopy detector
Optional	Secondary electron detector
Digital image detection	
Light optical	Proprietary high-resolution color navigation camera, single-shot
Electron optical	High-sensitivity backscattered electron detector (compositional and topographical modes)
Image formats	
JPEG, TIFF, PNG	
Image resolution options	
960 x 600, 1920 x 1200, 3840 x 2400 and 7680 x 4800 pixels	
Data storage	
USB flash drive, Network, workstation with SSD	
Sample stage	
Computer-controlled motorized X and Y	

EDS	
Detector type	• Silicon Drift Detector (SDD) • Thermoelectrically cooled (LN_2 free)
Detector active area	25 mm^2 or 70 mm^2
X-ray window	Ultra thin silicon nitride (Si_3N_4) window allowing detection of elements B to Am
Energy resolution	Mn Kα ≤132 eV
Processing capabilities	Multi-channel analyzer with 2048 channels at 10 eV/ch
Max. input count rate	300,000 cps
Hardware integration	Fully embedded
Software	
• Integrated in Phenom user interface • Integrated column and stage control • Auto-peak ID • Iterative strip peak deconvolution • Confidence of analysis indicator • Export functions: CSV, JPG, TIFF, ELID, EMSA	
Report	
DOCX format	

Elemental Mapping & Line Scan	
Elemental mapping	
Element selection	Individual user-specified maps, plus backscatter image and miximage
Backscatter image and mix-range	
Selected area	Any size, rectangular
Mapping resolution range	32 x 20 to 960 x 600 pixels
Pixel dwell time range	1–500 ms
Line scan	
Line scan resolution range	16–512 pixels
Line scan dwell time range	10–500 ms
Report	
DOCX format	

SED	
Detector type	Everhart Thornley

System	
Dimensions & weight	
Imaging module	316(w) x 587(d) x 625(h) mm, 75 kg
Diaphragm vacuum pump	145(w) x 220(d) x 213(h) mm, 4.5 kg
Power supply	260(w) x 260(d) x 85(h) mm, 2.3kg
Monitor (24”)	531(w) x 180(d) x 511(h) mm, 5.6kg
Workstation	• Powerful workstation including SSD storage • 93(w) x 293(d) x 290(h) mm, 5.6 kg
Sample size	
• Max. 100 mm x 100 mm (up to 36 x 12 mm pin stubs) • Max. 40 mm height (optional up to 65 mm)	
Scan area	
100 mm x 100 mm	
Sample loading time	
Light optical	<5 s
Electron optical	<60 s
Site requirements	
Ambient conditions	
Temperature	15°C ~ 30°C (59°F ~ 86°F)
Humidity	Between 20% and 80% RH
Power	Single phase AC 100–240 Volt, 50/60 Hz, 163 W average, 348 W max
Recommended table size	
150 x 75 cm, load rating of 150 kg	
Sample holders and inserts	
• Manual-Z sample holder • 4 x 47 mm filter insert (optional) • 9 x 25 mm filter insert (optional)	

Learn more at **thermofisher.com/phenom-particle-x-battery**