Battery research and production

Materials, parameters and methods to analyze them

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Metrohm

A comprehensive portfolio

Battery research encompasses the development process from theory and concept validation of new materials to characterization and quality control of raw materials and finished batteries. Progress in the quest for higher energy, power density, and more efficient energy storage depends on sophisticated instrumentation for the characterization of materials

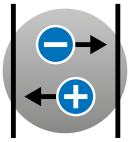
Sample	Parameter of interest
Anode (raw materials)	Water content
	Eluated anions and cations
Cathode (raw materials)	Purity of lithium salts (LiOH, Li_2CO_3, $LiNO_3$, LiCl)
	Impurities in lithium salts (e.g., sodium, ammonium)
	Ni, Co, Mn content in solution for cathode material production (single metal or mixture)
	Cobalt, nickel, iron, manganese in various cathode material
	Water content
	Eluated anions and cations
	Through-plane tortuosity
Electrolytes, electrolyte additives, and electrolyte solvents	Water content
	Cations and anions in electrolyte (e.g., $LiPF_6$)
	Decomposition products of $LiPF_6$
	Electrolyte resistance
	Solid electrolyte interface investigation
	Diffusion coefficient
	Lithium ion transference number
	HF content in electrolyte
Separators	Water content
	Eluated anions and cations
	MacMullin number
Finished batteries	Voltage characteristics upon charge and discharge
	Cycling performance and coulombic efficiency
	Cycle and calendar life evaluation
	Battery capacity and power
	State of charge, depth of discharge, and state of health
	Internal battery resistance
	Charge transfer resistance
	Diffusion coefficient (GITT and PITT)
	Eluated anions and cations

and cells. Metrohm provides you with top-quality analytical instruments, know-how, and first-class, on-site service to enable and support your research.

Our White Paper WP-052 «A Guide to Li-ion Battery Research and Development» gives your a comprehensive overview of the electrochemical analysis of batteries and raw materials. The table below gives you an overview, which parameters of interests can be analzyed by which method using Metrohm instrumentation. Feel free to get more detailed information from the corresponding and linked Metrohm appplication documents.

Analysis technique	Metrohm Application Documents
Karl Fischer titration	AB-434
Ion chromatography	
Titration	AN-T-215, AN-T-216, AN-T-181
Ion chromatography	AN-C-189
Titration, Voltammetry	AN-T-218
Titration	
Karl Fischer titration	AB-434
Ion chromatography	
Electrochemistry	AN-BAT-011
Karl Fischer titration	AB-434
Ion chromatography	AN-C-037, AN-CS-011, AN-N-012
Ion chromatography	AN-S-372
Electrochemistry	
Electrochemistry	AN-BAT-010
Electrochemistry	AN-BAT-009
Electrochemistry	AN-BAT-012
Titration	
Karl Fischer titration	AB-434
Ion chromatography	
Electrochemistry	AN-BAT-006
Electrochemistry	AN-BAT-001, AN-BAT-002
Electrochemistry	WP-052
Electrochemistry	
Electrochemistry	
Electrochemistry	
Electrochemistry	
Electrochemistry	
Electrochemistry	AN-BAT-003, AN-BAT-004
Ion chromatography	

Analysis techniques



ELECTROCHEMISTRY – IDEAL FOR STUDYING THE PERFORMANCE OF BATTERIES AND BATTERY MATERIALS

Our specially designed potentiostats/galvanostats are used for the characterization of battery raw materials as well as finished batteries. Electrochemical measurements are based on a highly accurate control and measurements of voltage, current, electrical charge, or impedance.

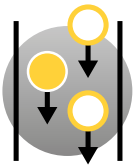
Voltammetry is a highly sensitive method (LODs in the ppb range) for the analysis of electrochemically active substances, such as inorganic or organic ions. For example, voltammetry allows the simultaneous determination of nickel, cobalt, and manganese in cathode materials. This technique combines a wide range of applications, short analysis times, and high precision with comparatively low costs of the required instrumentation.

TITRATION – SPECIFIC, ACCURATE, AND RELIABLE

Potentiometric titration is ideally suited for determining the purity of lithium salts or metals used in cathode materials, such as cobalt, nickel, manganese, or iron. It is applied to analyze standard solutions used for the preparation of cathode materials or finished cathode materials. Unlike competing methods such as ICP-MS or AAS, titration does not require dilution of such samples. Hence, results obtained by titration are more reliable and accurate. Furthermore, running and maintenance costs are considerably lower compared with ICP-MS or AAS.

KARL FISCHER TITRATION – THE PREFERRED METHOD FOR WATER DETERMINATION

Lithium-ion batteries must be completely free of water (concentration of H_2O < 20 mg/kg), because water reacts with the conducting salt, e.g., $LiPF_6$, to form hydrofluoric acid. Sensitive coulometric Karl Fischer titration is the ideal method for determining water content at trace levels. Water determination for solids is carried out using the Karl Fischer oven method, where residual moisture in the sample is evaporated and transferred to the titration cell where it is subsequently titrated.



ION CHROMATOGRAPHY – HIGHLY EFFICIENT MULTI-PARAMETER ANALYSIS OF ELECTROLYTES AND METALS SALTS

Ion chromatography (IC) is an efficient and precise multi-parameter method to quantify impurities in lithium salts, decomposition products in electrolytes, as well as anions and cations in eluates of various battery raw materials.