HORIBA Scientific

JOBIN YVON Technology

Batteries characterization

A Full Range of Solutions

The extraordinary growth of the batteries business sector lead all players to identify, test, control processes and performances of the batteries they are developing or /and making. Evaluations and analyses are required to specify characteristics at every stage. HORIBA Scientific, international company is well known to develop, make and distribute characterization tools for materials, fitting with these needs in batteries. Benefits of these techniques are then presented through some typical applications – non exhaustive list.

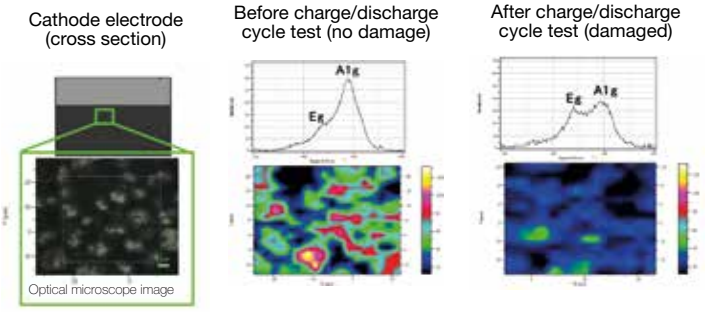
Benefits of HORIBA Scientific instruments for batteries

	Causes of Deterioration	HORIBA Scientific Analyzers
Cathode	• Crystallinity and crystal structural change based on Li-ion insertion and removal	Raman Spectroscopy
	• Reactivity influence by particle size	Particle Distribution Analyzer
	• Oxygen generation in high-temperature environment	Oxygen Analyzer
	• Elution of manganese ions	ICP-OES
	• Li Stoichiometry anomaly , deficient oxygen, degradation with charge/discharge cycle, surface oxidation, corrosion evaluation	GD-OES
	• Foreign material incorporation, moisture absorption, oxidation into active materials	X-ray Fluorescence Analyzer
	• Uneven distribution and gaps in active material	X-ray Fluorescence Analyzer
Anode	• Crystallinity evaluation of carbons by insert and desorption Lithium-ion	Raman Spectroscopy
	• O reactivity influence by particle size	Particle Distribution Analyzer
	• Hyporeactivity by formulation of Seprator Electrolyte Interface (SEI)	GD-OES
	• Foreign material incorporation, moisture absorption, oxidation into active materials	X-ray Fluorescence Analyzer
	• Uneven distribution and gaps in active material	X-ray Fluorescence Analyzer
Binder	• Abnormal value of pH	pH, Particle Distribution Analyzer
	• Uneven size of active materials in the process of slurry in anode	Particle Distribution Analyzer
	• C identification type	Raman Microscopy
Separator	• Separator damage by metallic foreign materials (dusting, burr)	X-ray Fluorescence Analyzer
	• O reactivity with C based material, porosity of membrane	Oxygen Analyzer
Electrolyte	• Monitor the reaction of LiPON with air, homogeneity of the coating thickness	Spectroscopic Ellipsometry

Examples of results obtained using HORIBA Scientific instruments

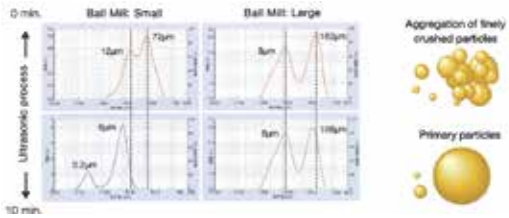
Crystallinity evaluation of cathode with charge/discharge cycle by Raman microscopy

A1g and Eg peaks represent some C crystalline structure.
Colored band indicate the intensity of A1g/Eg ratio. The higher the ratio, the higher the crystallinity.



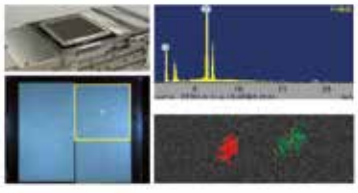
Mapping shows the degradation of the cristallyne structure to an amorphous one with charge/discharge cycle through ratio A1g/Eg ratio. Mapping of the intensity ratio gives the effect over the cathode surface thus related to the optical image.

Particle Size distribution analysis in cathode materials



The particle size distribution differences between two crushes methods are seen. The result shows that the status of the particles differs when distributed in a solution of anhydrous NMP, depending on the diameters of the ball mills.

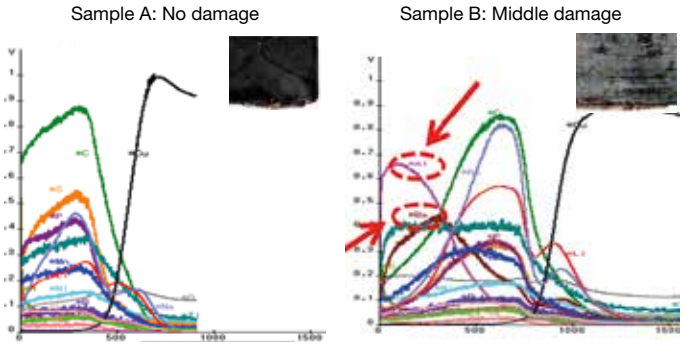
Foreign metal analysis on Li-ion battery separator by X-Ray fluorescence



X-ray analytical microscope enables the elemental mapping with a 100 µm probe for wide area in a short time, identifying the metallic contaminant. It also provides zoomed-in mapping analysis when used with a 10 µm microprobe as shown here below.

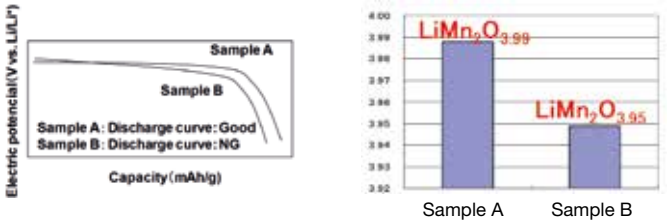
Degradation evaluation of cathode materials by elemental composition depth profiling using Glow Discharge Spectroscopy (GDOES)

Sample A is a new cathode. Sample B same after some running time cycles of charge/discharge. Figures shows the elemental depth profiles from surface to the Cu collector.



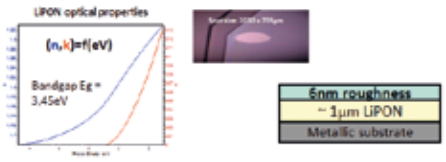
Ba and Al appear on sample B. These elements may come from the degradation of the anode with reaction of cathode active material.

Analyzing deficiency of oxygen



This method can determine the stoichiometry of oxides in this spinel type Lithium Manganese ($LiMn_2O_{4-x}$).
We can see on the discharge curves how they can be affected by tiny variation of Oxygen.

LiPON solid electrolyte analysis by spectroscopic ellipsometry



Ellipsometry will give optical constants and control thickness. Measurements allow to follow the reaction of the LiPON with air through the variation of the optical constants.

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