From Eye to Insight

Leica MICROSYSTEMS

Analysis of Separators for Secondary Lithium-Ion Batteries using LIBS

ENABLE IN-LINE CHEMICAL QA/QC FOR BATTERY MANUFACTURING

Introduction

Lithium-ion batteries are the standard power sources for portable electronics devices. Metal particles in the electrodes, fuel-cell separators, and other parts of Li-ion rechargeable batteries can lead to internal short circuits. They can cause overheating and a decrease in the battery capacity and lifetime or, in extreme cases, even result in a fire [1].

Difficulty setting up in-line QC method

Energy dispersive x-ray spectroscopy (EDS/EDX), done with a scanning electron microscope (SEM), cannot be used to detect one of the most important elements for rechargeable battery technology: lithium (Li) [2]. Instead, methods like x-ray fluorescence (XRF) or inductively coupled plasma optical emission spectrometry (ICP- OES), which are not capable of microscopic visual analysis, are used by Li-ion battery researchers. Because of their complexity, it is often problematic to incorporate these techniques directly into the production line or QC environment where fast, accurate results are required.

The Leica solution

The DM6 M LIBS is a 2-methods-in-1 system for visual and chemical analysis from Leica Microsystems. It utilizes laser induced breakdown spectroscopy (LIBS) for chemical analysis. Your benefits when using this 2-in-1 solution for QC of Li-ion batteries are:

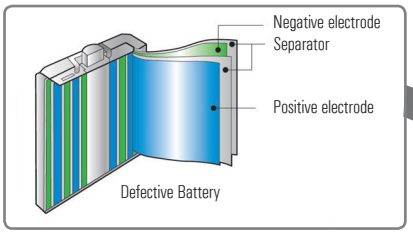
- Reveal difficult to see features when inspecting samples - optical microscope with different magnifications and contrast methods
- No time-consuming sample preparation required
- Results obtained quickly and conveniently as samples are analyzed in air (no vacuum)
- Reliable detection of Li along with other elements

With the DM6 M LIBS 2-in-1 solution, a wide range of applications concerning Li-ion battery component analysis are possible. It can help you to develop innovative materials more efficiently and improve the manufacturing process.

PRACTICAL LI-ION BATTERY MATERIAL ANALYSIS WITH DM6 M LIBS SYSTEM

LIBS can detect key elements directly in the battery components without the need for special sample preparation. It can also be used for elemental depth profiling of solid-state materials, such as Li-ion battery device structures. Furthermore, LIBS can be exploited for microdrilling so that layer analysis can be done. LIBS is highly complementary to other analytical techniques commonly used by Li-ion battery researchers.

Inspection workflow: Checking for defective batteries

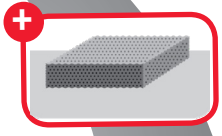


Sample preparation

Separator removed and placed onto the XY stage

Visual inspection

Examining surfaces with different magnifications and contrast methods

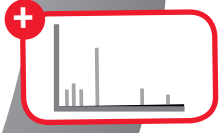


Find region of interest for analysis

Center and adjust focus

Chemical inspection

Carry out the elemental analysis within a few seconds



Compare element peaks

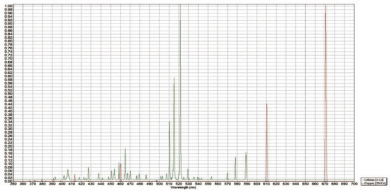
Chemical analysis identifies materials and helps in deciding if the conductivity poses a risk

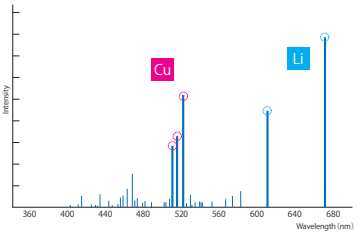
Results

LIBS chemical analysis enables the straightforward detection of both Li and metal inclusions (containing mainly Copper [Cu]).

Substance	Quality of Match
Li	587
Cu	428

Identification and clarification





References

1. X. Feng, M. Ouyang, X. Liu, L. Lu, Y. Xia, X. He, Thermal runaway mechanism of lithium ion battery for electric vehicles: A review, Energy Storage Materials (2018) vol. 10, pp. 246-267, DOI: 10.1016/j.ensm.2017.05.013.
2. P. Hovington, V. Timoshevskii, S. Burgess, H. Demers, P. Statham, R. Gauvin, K. Zaghib, Can we detect Li K X-ray in lithium compounds using energy dispersive spectroscopy? Scanning (2016) vol. 38, iss. 6, pp. 571-578, DOI: 10.1002/sca.21302.

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