Application Note EDXRF3150

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EDXRF3150 - Analysis of Black Mass for Lithium Battery Recycling

Scope

The analysis of black mass powder is demonstrated using NEX QC+ QuantEZ, which features Rigaku RPF-SQX Fundamental Parameters (FP) for semi-quant standardless screening and user-defined Matching Library to optimize accuracy.

Background

Lithium batteries have many uses, from regular batteries to cell phones, tablets, computers, and electric vehicles. At end-of-life, the batteries can be recycled to ensure a sustainable, environmentally friendly use of the raw materials. The devices are collected, disassembled, and the batteries are then shredded and ground. During the process, the plastics are separated and removed leaving a powder called black mass, rich in the cathode metals Co, Mn and Ni, base metals Cu, Fe and Al, as well as the graphite from the anode.

Recovering and repurposing the metals reduces the need to mine fresh raw materials and allows for a sustainable circular economy in the lithium battery industry. Rigaku offers the NEX QC+ QuantEZ EDXRF analyzer for the analysis of black mass during the recycling and recovery of the raw materials to make new, fresh batteries.

Rigaku RPF-SQX fundamental parameters (FP)

Rigaku RPF-SQX FP software estimates elemental concentration based on XRF theory called Fundamental Parameters (FP). Rigaku Profile Fitting (RPF) automatically deconvolutes spectral peaks and models the sample matrix using fundamental XRF equations to provide semi-quantitative measurements of elemental concentrations without the need for any known standards.

Results: FP standardless semi-quant for screening

In this example the semi-quant analysis of a typical black mass sample is shown. The method set-up is based on the FP Powder template adjusted for black mass with the balance of the material defined as graphite. Standardless FP is excellent for screening to measure the overall elemental composition of the black mass.

Typical black mass sample

Element	Result (mass%)	Stat. error
Co	13.556	0.008
Mn	9.963	0.008
Ni	16.163	0.008
Al	6.156	0.009
Cu	6.605	0.009
Fe	2.104	0.003
Si	0.7577	0.0020
P	2.099	0.002
S	0.1275	0.0004
Cl	0.0317	0.0002
K	0.2074	0.0067
Ca	0.4066	0.0050
Ti	0.4774	0.0030
V	0.0527	0.0012
Cr	0.0382	0.0008
Zn	0.3678	0.0013
As	0.0028	0.0002
Zr	0.1358	0.0003
Ag	0.0026	0.0001
Cd	0.1214	0.0004
Sn	0.0766	0.0003
Sb	0.0256	0.0003
Ba	0.0248	0.0006
Pb	0.0528	0.0005

Rigaku user-defined matching library

The user can easily tune the semi-quant results using a Matching Library by measuring one or more samples of the material with known elemental assay values. In this way, the XRF is tuned specifically to the black mass and referee values to ensure optimum accuracy and reliable, high-quality data without the need for a large set of assayed standards for calibration.

Results: Rigaku FP with matching library for improved accuracy

In this example the semi-quant accuracy is improved using a 2-point Matching Library for the main metals Co, Mn, Ni, Al, Cu and Fe. Accuracy can be further improved by simply adding a few more samples with ICP numbers to the Matching Library.

Typical Black Mass Sample

Element	ICP value (mass%)	NEX QC+ QuantEZ result Semi-quant Screening (mass%)	NEX QC+ QuantEZ result using Matching Library (mass%)
Co	11.94	13.56	12.16
Mn	8.87	9.96	8.47
Ni	14.58	16.16	14.09
Al	5.28	6.16	4.63
Cu	7.30	6.61	7.53
Fe	1.34	2.10	1.49

Conclusion

The Rigaku NEX QC+ QuantEZ offers excellent performance for the elemental analysis of black mass. The powerful combination of Rigaku RPF- SQX FP and Matching Library yields accurate and reliable results, making NEX QC+ QuantEZ an excellent tool for the elemental identification, screening, and characterization of black mass during the recycling process.

Related products

NEX QC II Series

Compact, intuitive benchtop EDXRF for everyday elemental testing