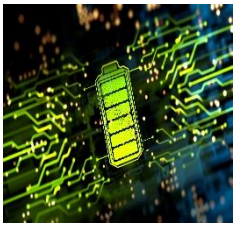
HORIBA

XGT

Using micro-XRF for Al, Fe and Cu particle detection on a cathode sheet of lithium ion battery



Application Note

Energy
XGT32

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Abstract: Analyzing foreign matter on batteries is important to maintain performance and safety. We analyzed a Nickel Manganese Cobalt (NMC) cathode simulation sample using a HORIBA XGT-9000 X-ray analytical microscope, and performed foreign matter analysis with a software function called the “Particle Finding Module”.

Keywords: Energy, battery, EDXRF, micro-XRF, foreign matter, metal contamination

Introduction

Foreign matter on a lithium-ion battery may cause an internal short circuit. Foreign matter contamination affects not only battery performance, but also safety.[1]

Energy dispersive X-ray fluorescence (EDXRF) is an elemental analysis method which is widely used for foreign matter on batteries, because of its non-destructive approach and less sample pretreatment. In this application note, we made a NMC cathode simulation sample and added Al, Fe and Cu particles on the sample as simulated metal foreign matter. We analyzed the sample using the HORIBA XGT-9000 X-ray analytical microscope.

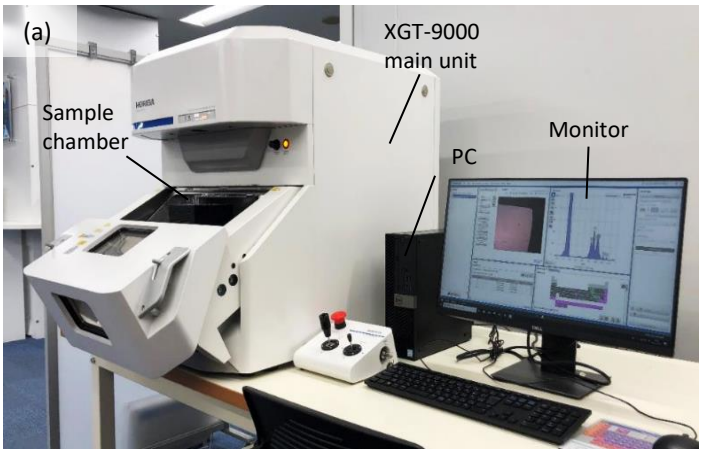
Figure 2. Image of the NMC cathode simulation sample we analyzed (Al, Fe and Cu particles added).

The XGT-9000 X-ray Analytical Microscope

The XGT-9000 X-ray analytical microscope (Figure 1) is an energy dispersive X-ray fluorescence microscope (micro-XRF) offering an upper irradiation with multiple-spot size selection including a 15 µm ultra-high intensity probe and a 100 µm ultra-high intensity probe.

Sample information

We made the simulated NMC cathode sample of approximately 11 cm x 11 cm in size, and randomly added three types of particles, Al, Fe and Cu, with a mode diameter of less than 100 microns for commercial use on the sample, as simulated metal foreign matter (Figure 2).



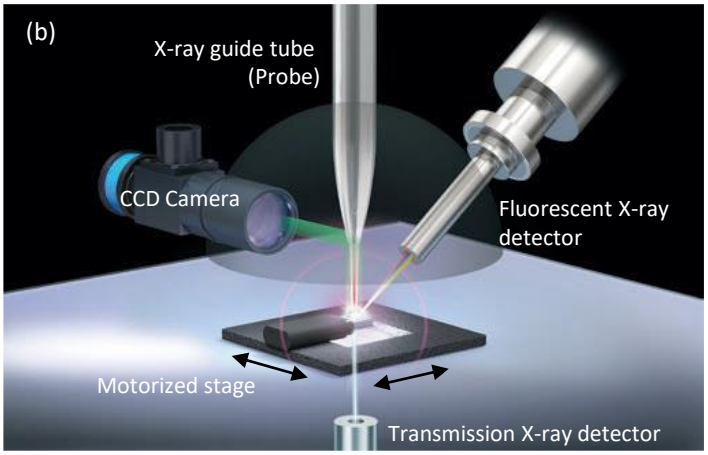


Figure 1. (a) The installation setup of XGT-9000 X-ray analytical microscope (b) Schematic diagram of the optics of the XGT-9000.

Measurement & Result

We placed the sample in the chamber of the XGT-9000 without any sample pretreatment and analyzed it under partial vacuum condition (Figure 3). The foreign matter on the sample may float and contaminate the optical components in full vacuum condition, so conventionally, it must be analyzed in air condition. The XGT-9000 can analyze foreign matter under partial vacuum condition. Partial vacuum condition can protect optical components from contamination and provide higher sensitivity than air condition. We carried out mapping analysis on the sample using a 100 µm ultra-high intensity probe.

Figure 4 (a) - (c) shows mapping results of Ni, Mn and Co. It can be seen that the matrix materials are uniformly distributed on the sample surface. We used the Particle Finding Module to detect Al, Fe and Cu particles from the image like Figure 4 (d). The Particle Finding Module can automatically analyze elements, positions, quantities, sizes and aspect ratios of particles. It not only saves time on foreign matter analysis, but also reduces errors in manual analyses. Figure 4 (d) shows the result of the detected foreign matter using the Particle Finding Module. It can be seen that there are 64 particles on the sample ((Al, Fe, Cu) =(18, 18, 28)). Due to the large mapping area and small particle size, we randomly selected one Al, one Fe, and one Cu particle each and enlarged the image for ease of viewing.

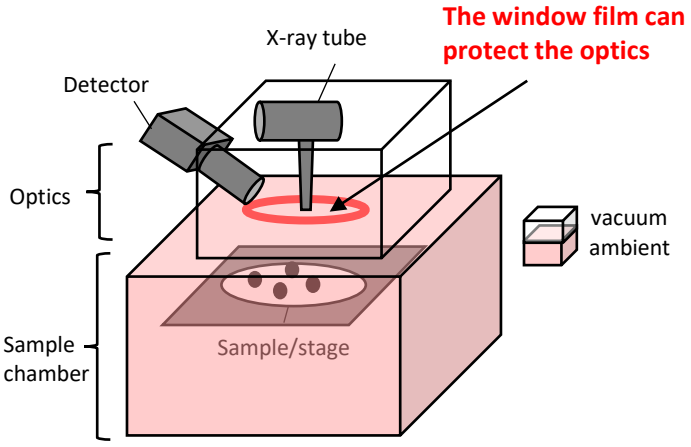


Figure 3. Internal schematic diagram of XGT-9000 under partial vacuum condition.

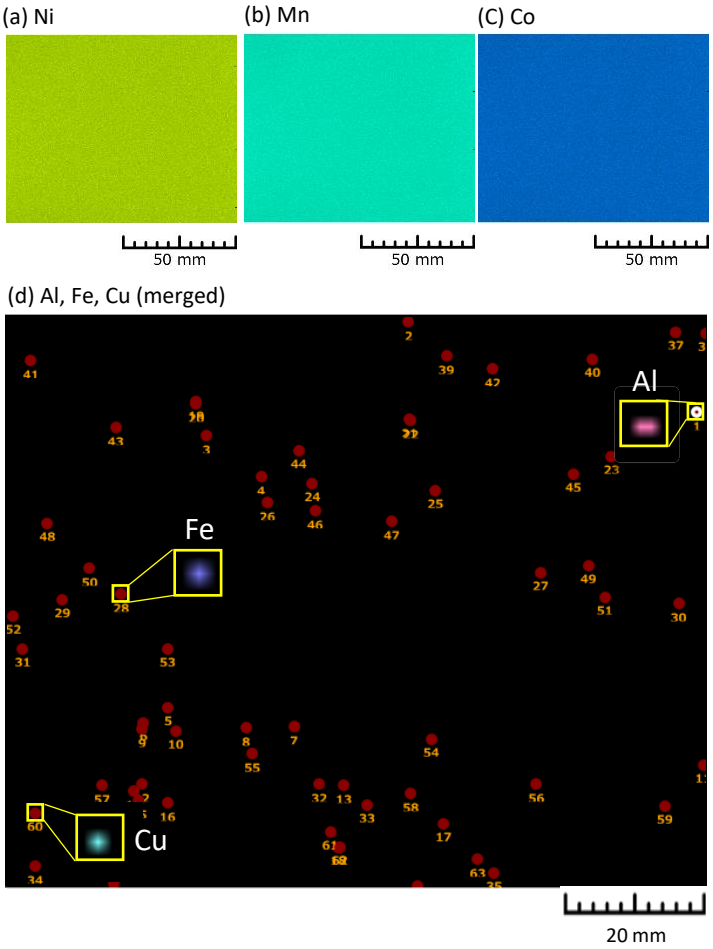


Figure 4. Elemental mapping results (a) Ni (b) Mn (c) Co (d) Particle finding module result of simulated metal foreign matter.

Conclusion

The XGT-9000 is the latest micro-XRF system from HORIBA, equipped with a high sensitivity detector with micro spot size. It can analyze foreign matter on batteries, and it can even detect light elements, such as Al particles. The Particle Finding Module can automatically analyze foreign matter, which not only saves time, but also reduces human error.

Reference

[1] Xiangdong Kong et al. “Foreign matter defect battery and sudden spontaneous combustion“ *eTransportation* Volume 12, 2022, 100170.

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