Failure Analysis of Particle Contamination in Battery

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ABSTRACT

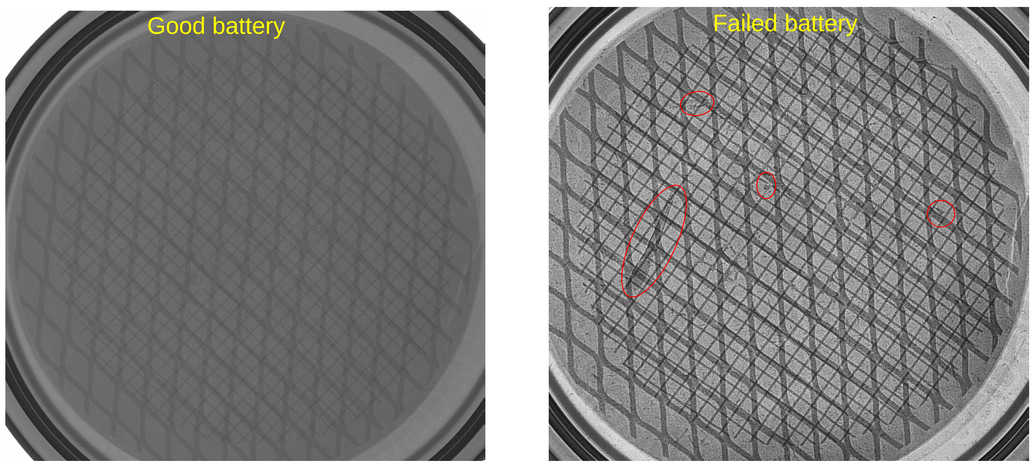
In this paper, a battery failure analysis process was conducted to identify the root cause of a failed battery. Initially, a 2D X-ray imaging was employed to detect anomalies in the sample. Subsequent disassembly in an argon glove box of the battery facilitated the recovery of particle contaminants. Finally, airless transfer to SEM/EDS allows imaging and elemental analysis of these contaminants revealed the underlying failure mechanism.

INTRODUCTION

Battery failures can lead to significant property damage or personal injuries, such as those involving EV battery packs or cell phone batteries. Understanding the various mechanisms behind battery failures is a critical issue, not only for the battery industry but also for any sector that relies on batteries. Failure analysis is a foundational aspect of battery R&D that supports the creation of safer, more efficient, and longer-lasting battery technologies. Failure analysis provides critical insights that drive innovation and improve the overall quality and reliability of battery systems.

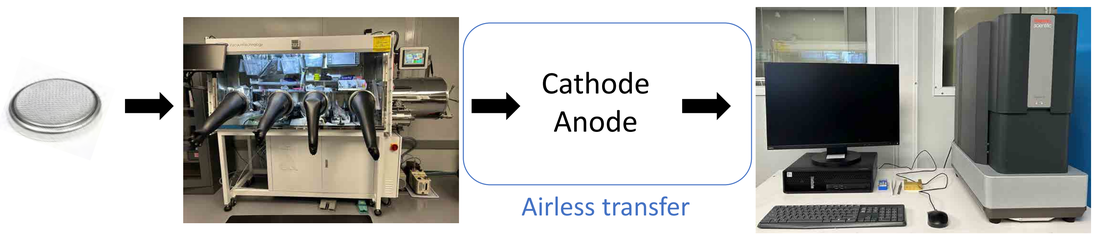
EXPERIMENTAL & RESULTS

2D X-Ray:



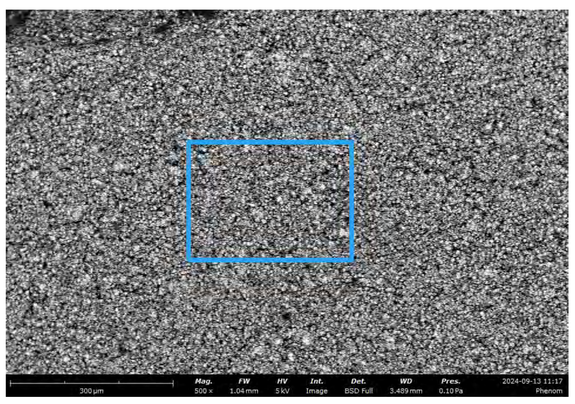
The failed battery contains lots of impurity particles.

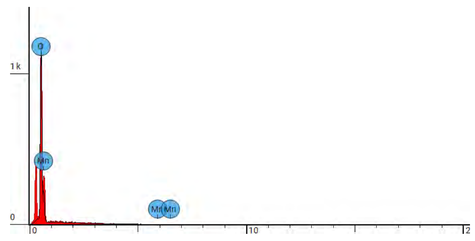
Battery Disassemble:



The two coin cells were disassembled in an argon glove box. Cathode and anode films were isolated from the cells and washed with dimethyl carbonate (DMC) a few times to remove electrolyte before being mounted on an airless transfer container for SEM/EDS imaging. .

SEM/EDS of Cathode in the Failed Battery:

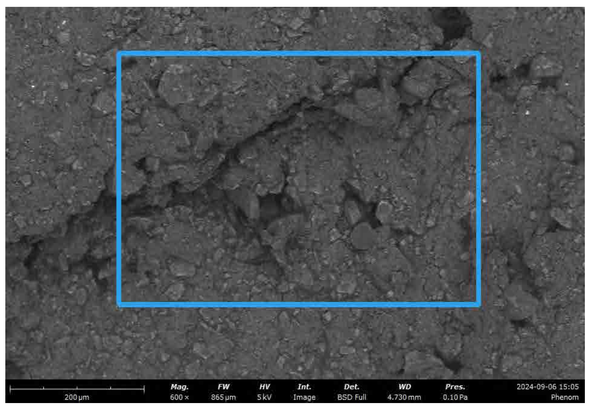




Element Symbol	Element Name	Weight Conc.
O	Oxygen	33.8
Mn	Manganese	66.2

The cathode film from the failed coin cell did not display any visible impurities or defects.

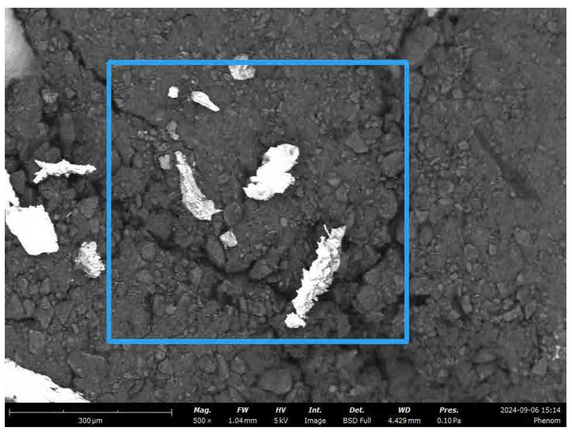
SEM/EDS of Cathode in the Good Battery:



Element Symbol	Element Name	Weight Conc.
C	Carbon	40.4
O	Oxygen	49.2
F	Fluorine	10.4

Good battery anode does not show any impurities.

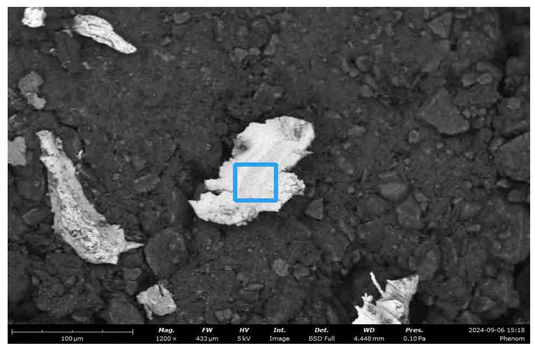
SEM/EDS of Anode in the Failed Battery:



Element Symbol	Element Name	Weight Conc.
C	Carbon	36.3
O	Oxygen	42.8
F	Fluorine	11.3
Cu	Copper	9.6

The failed battery anode contains irregularly shaped impurities.

Element Symbol	Element Name	Weight Conc.
O	Oxygen	3.8
Cu	Copper	96.2



Element Symbol	Element Name	Weight Conc.
Fe	Iron	100.0

The impurity particles are composed of either Cu or Fe.

CONCLUSIONS

A failure analysis was conducted on a failed coin cell battery using several techniques, including 2D X-ray imaging, disassembly in a glove box, and airless transfer for SEM imaging with EDS analysis. The investigation revealed the presence of multiple metal particles within the anode of the failed battery, which were determined to be the cause of its failure.