

[View on rigaku.com](https://www.rigaku.com)

BATT1019 - Valence Analysis for Ni, Co, and Mn in NCM Cathodes

Introduction

Synchrotron radiation XAFS is generally used in valence analysis for transition metal elements in NCM cathodes. However, similar assessments can be performed with X-ray emission spectrometers (XES) as well. Changes in bonding state can be assessed based on chemical shifts in the XES spectrum for Ni, Co, and Mn.

Chemical state analysis

- **Analysis:** Cathode material
- **Analysis method:** Quantification of valence state
- **Use:** Optimizing electrochemical performance
- **Analyzed materials:** $\text{Li}(\text{Ni}_x\text{Co}_y\text{Mn}_z)\text{O}_2$

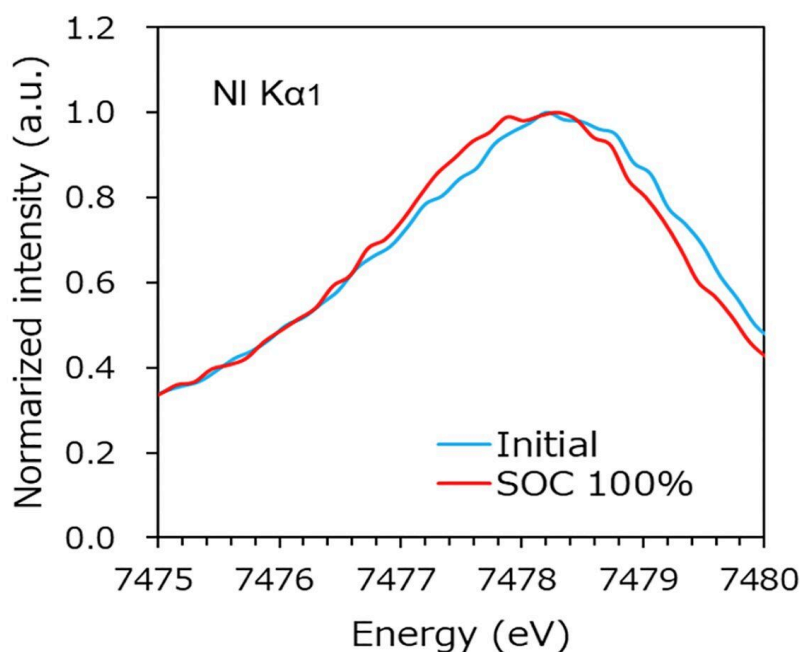


Figure 1: Ni Kα1 spectrum before and after charging for $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ (NCM(111)) cathodes

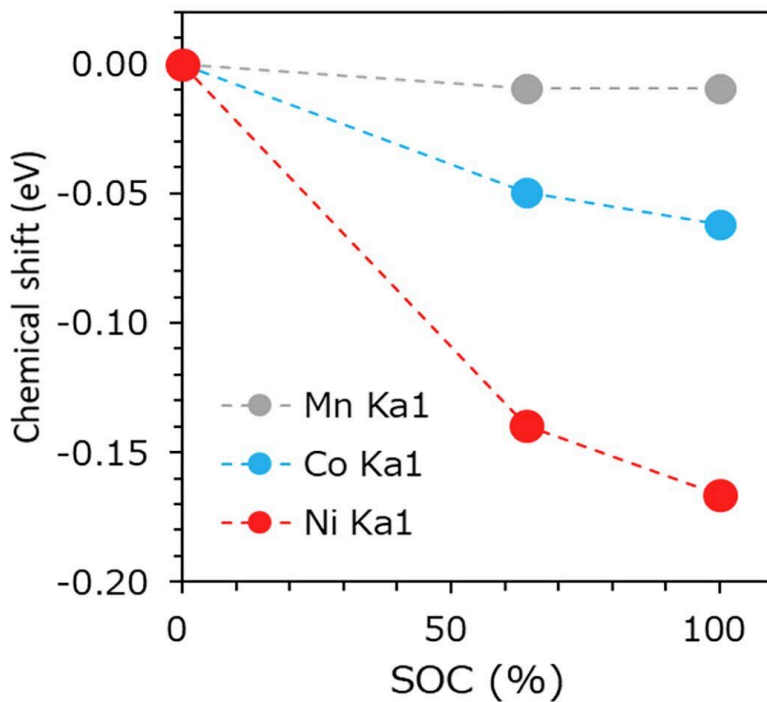


Figure 2: Correlation between chemical shifts and state of charge for Ni Ka1, Co Ka1, and Mn Ka1

Conclusion

Figure 1 illustrates the changes in the XES spectrum for Ni Ka1 before and after charging. Figure 2 shows changes based on the state of charge in chemical shifts for Ni Ka1, Co Ka1, and Mn Ka1. This correlation between chemical shifts and the state of charge can be used to estimate valence changes. As this shows, valence analysis is also possible using the XES method with laboratory instruments. Additionally, while only certain information on the surface can be analyzed with XPS, the XES method makes it possible to analyze up to a depth of several dozen μm with an analysis diameter of 10-20 mm.