Study of the structural, morphological, and electrochemical properties of $LiNi_{0.8}Mn_{0.1}Co_{0.1}O_2$ (NMC811) doped with copper for applications in energy storage material

Rethabile Phokojoe
Prof. L.F. Koao
Prof. M.A. Kebede

T: +27 60 571 5135 | E: rphokojoe@gmail.com | **www.ufs.ac.za**

Joint Institute for Nuclear Research

JINR Association of Young Scientists and Specialists

VISION 130
Renew and Reimagine for 2034

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS

Overview

- Introduction
- Applications
- Aim
- Experimental
- Results
- Conclusion

Introduction

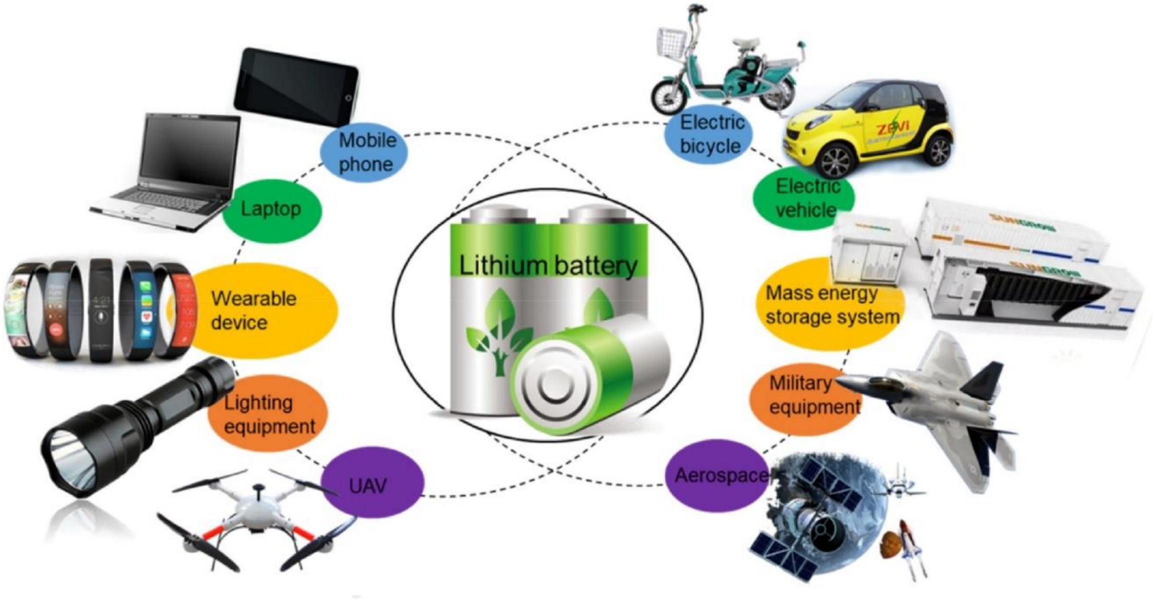
Lithium-ion batteries (LIBs)

- Better cyclability
- High voltages
- negligibly low self-discharge rates

Why dope NMC811 with Copper?

- Increase capacity
- Increase stability
- Enhance conductivity

Applications



Niu, H. et al, 2021. Recent Advances in Application of Ionic Liquids in Electrolyte of Lithium Ion Batteries. *Journal of Energy Storage*, 40, p.102659.

Aim

To improve NMC811 cathodes' capacity and mitigate its drawbacks

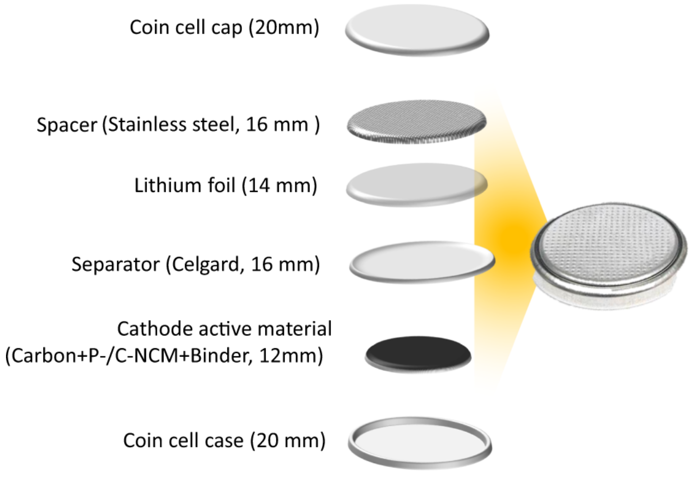
Thus far there are no reports on Cu doped NMC811

Experimental

Two step synthesis method

- Co-precipitation
- Solid state

Characterization
TGA, XRD, XPS, SEM, FTIR and electrochemical performance



Negi R.S., Elm M.T., 2022. Reproducible long-term cycling data of Al_2O_3 coated $LiNi_{0.70}Co_{0.15}Mn_{0.15}O_2$ cathodes for lithium-ion batteries. *Sci Data 9*, 127.

Results

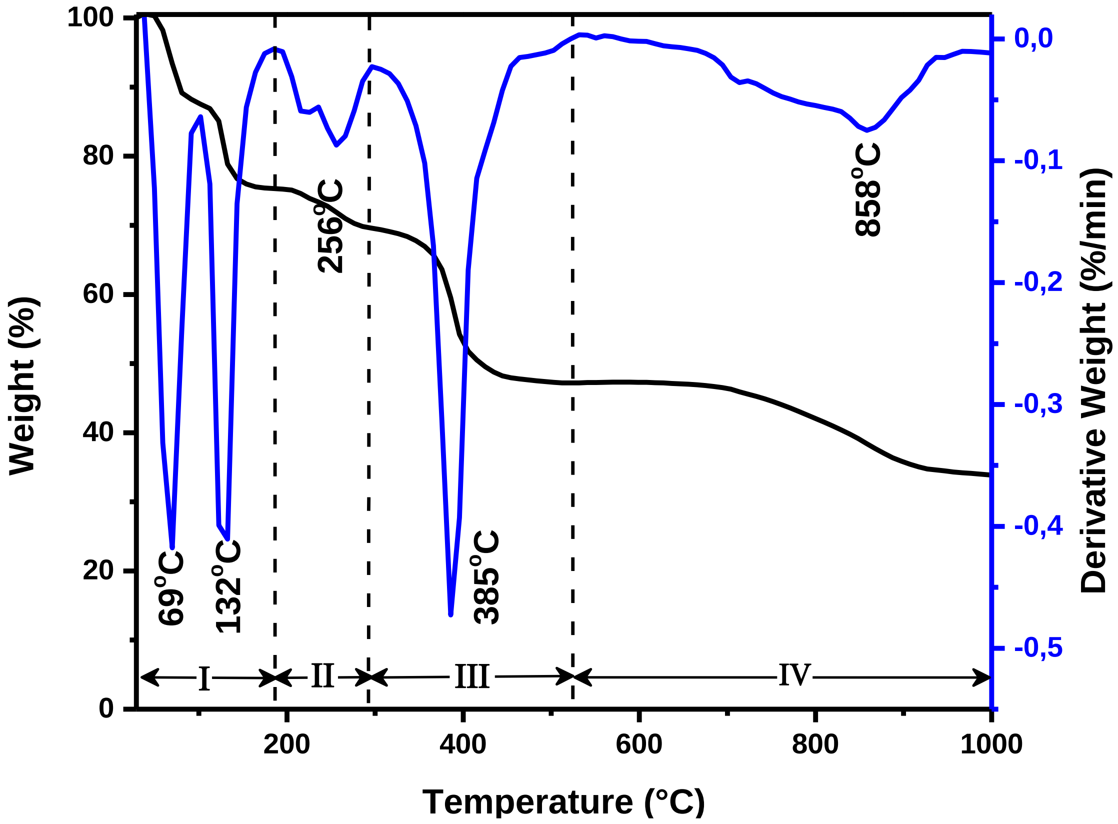


Fig. 1: The TGA and DTG curve of the as-prepared host (NMC811) sample.

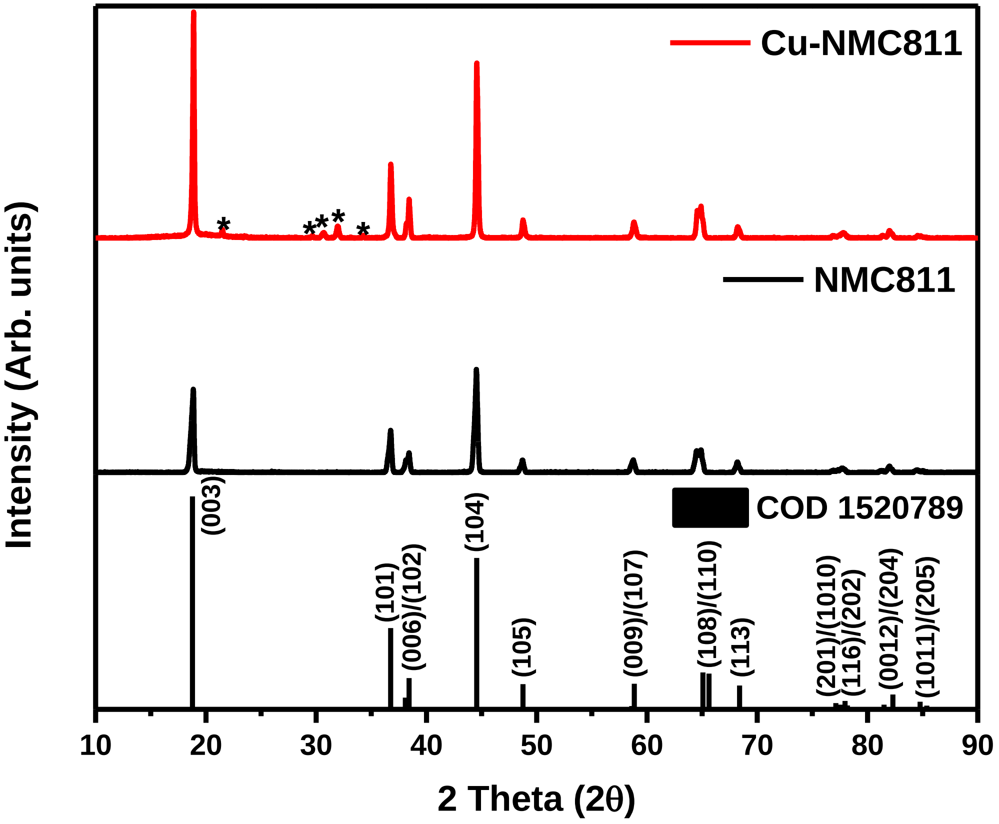


Fig. 2: The diffraction pattern for the NMC811 and Cu-NMC811 samples.

Fisika - Physics

UFS

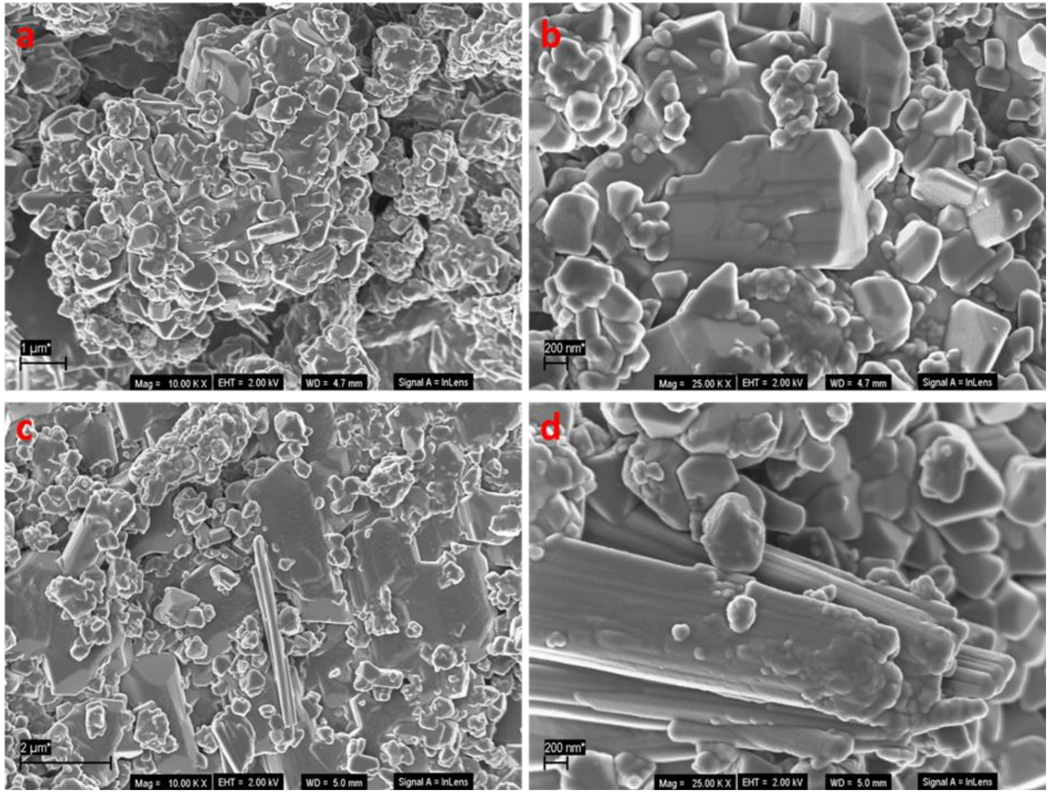


Fig. 3: The surface SEM images of (a, b) NMC811, (c, d) Cu-NMC811 at low and high magnification, respectively.

Fisika - Physics

UFS

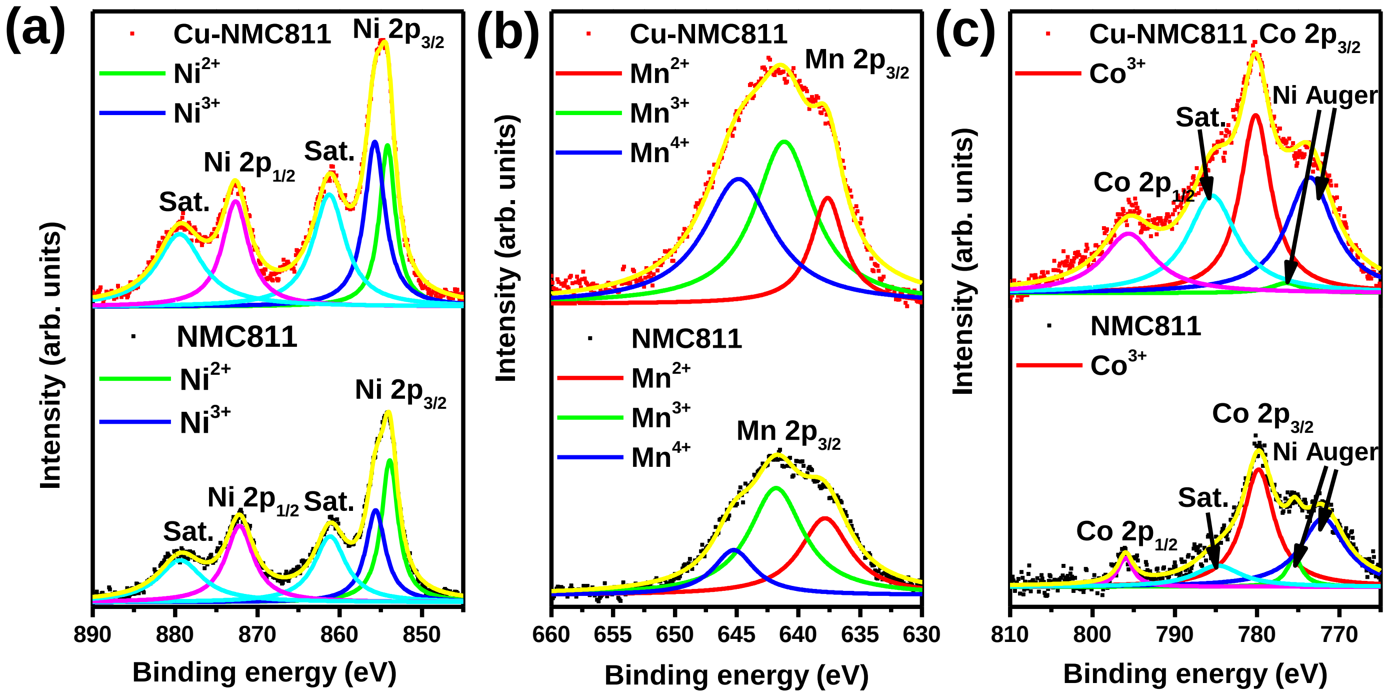


Fig. 4: The XPS spectra for (a) Ni, (b) Mn and (c) Co 2p of the NMC811 and Cu-NMC811.

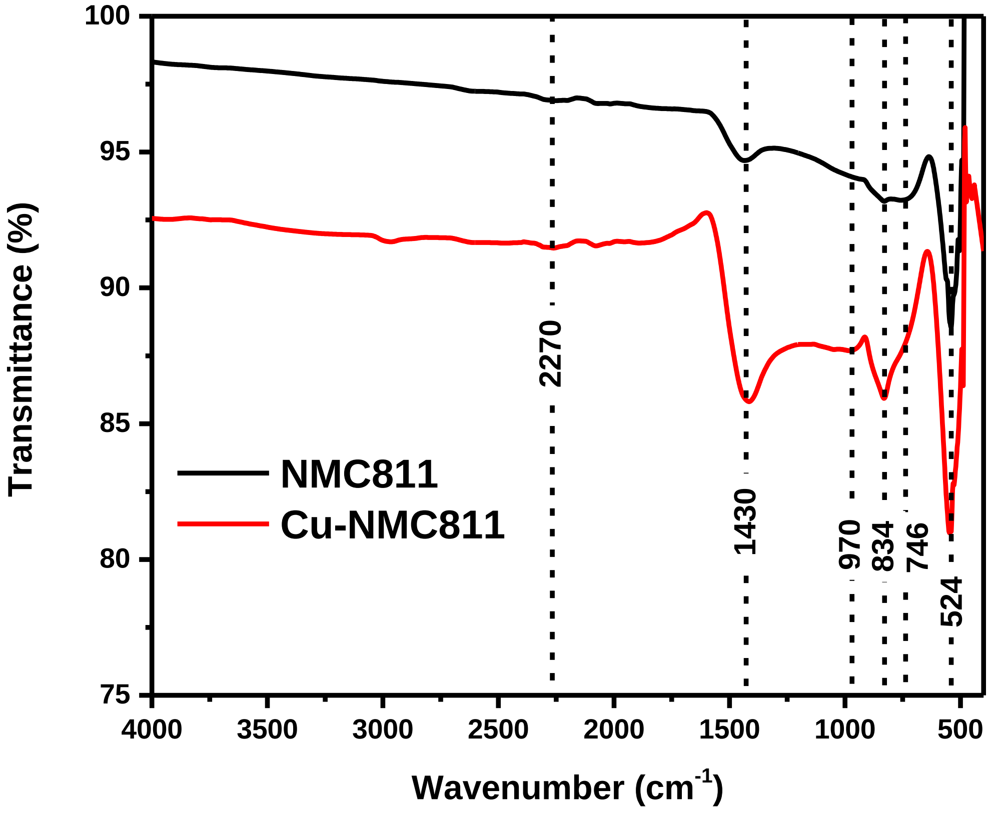


Fig. 5: The FTIR spectra of the NMC811 and Cu-NMC811.

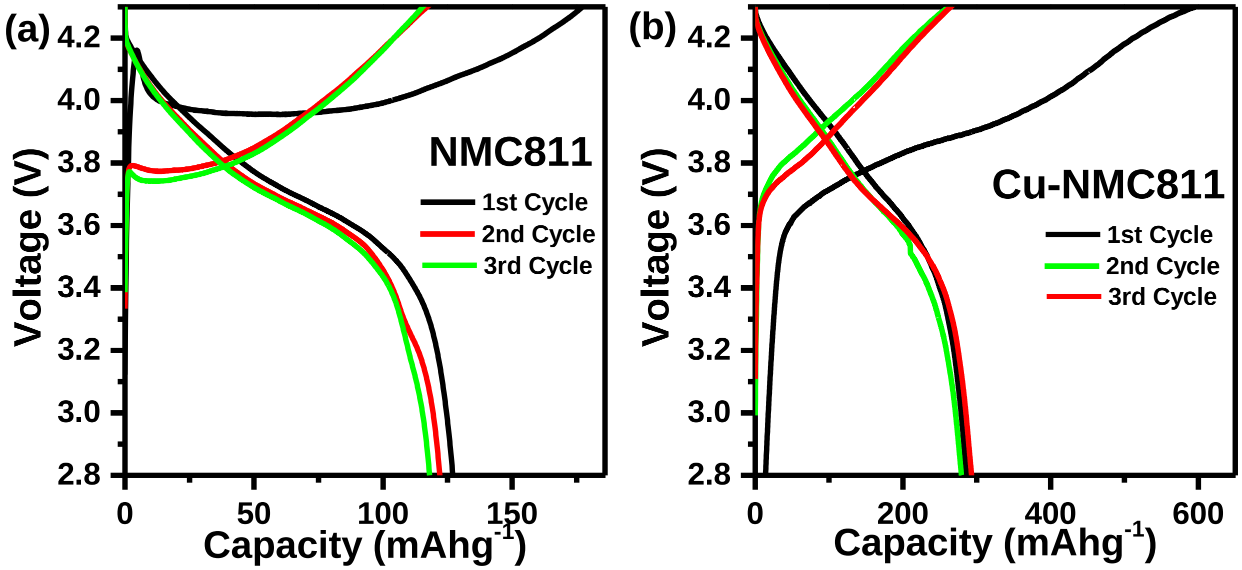


Fig. 6: The voltage profiles of (a) NMC811 and (b) Cu-NMC811 cycled at the rate of 0.1 C.

Fisika - Physics

UFS

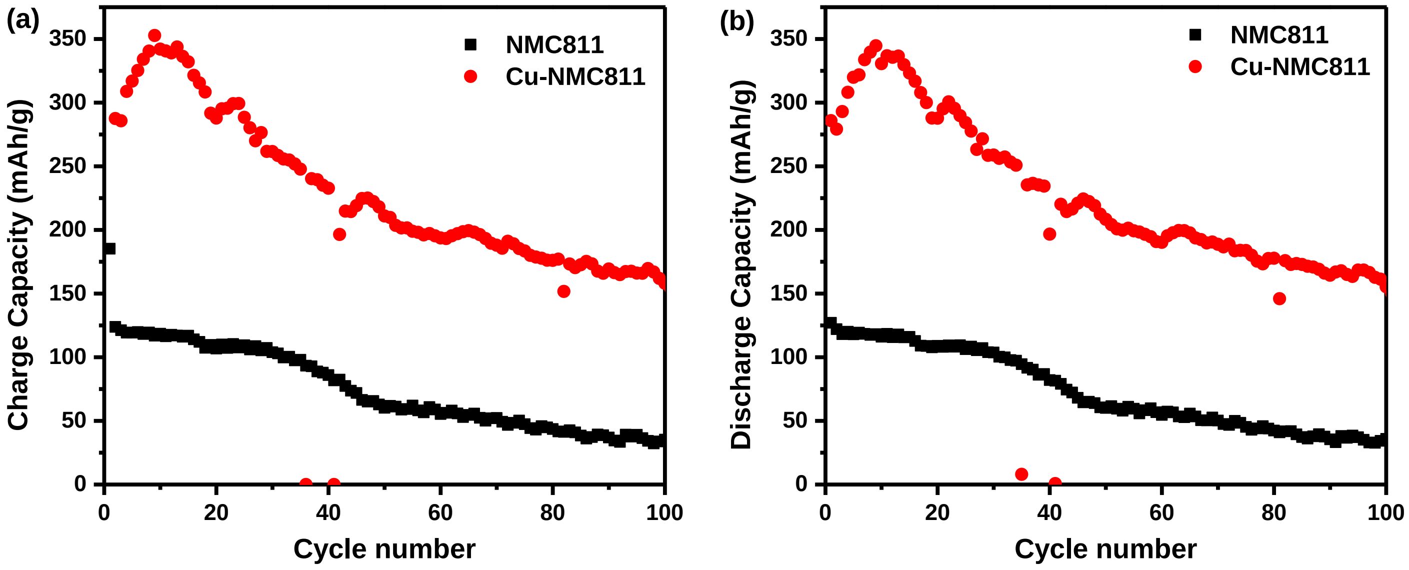


Fig. 7: The galvanostatic (a) charge and (b) discharge of the NMC811 and Cu-NMC811 samples at 0.1 C.

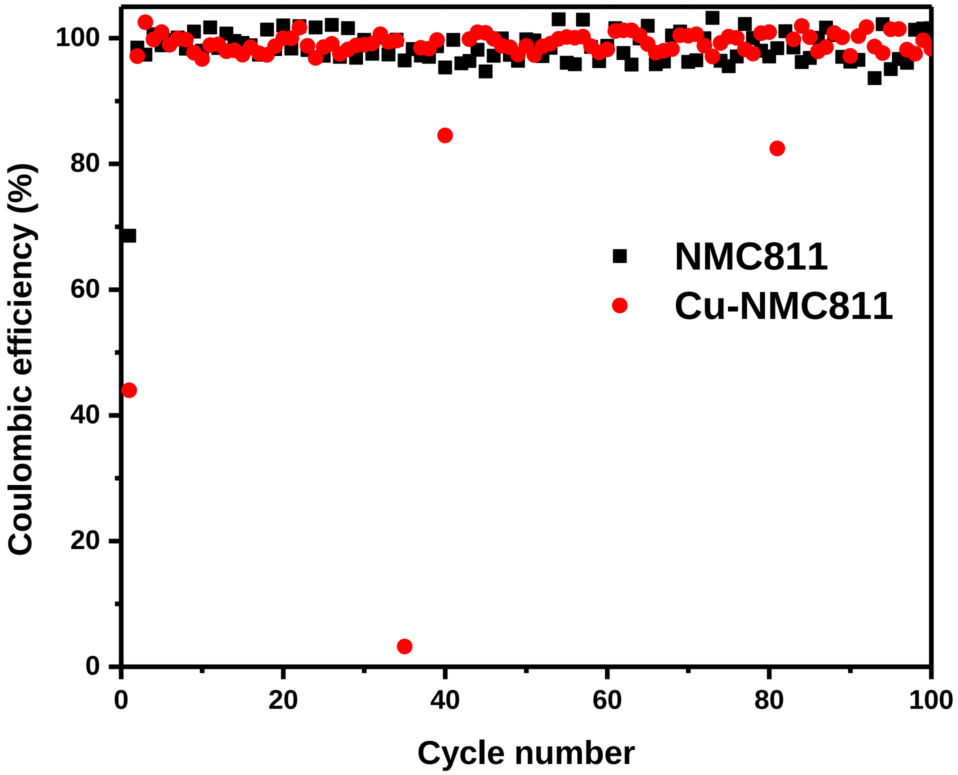


Fig. 8: The Coulombic efficiency versus cycling number for the NMC811 and Cu-NMC811 nanopowders.

Conclusion

- TGA/DTG curves confirmed the formation of NMC811 with annealing temperature of 850 ℃.
- The XRD results showed that the NMC811 and Cu-NMC811 corresponded to hexagonal α-$NaFeO_2$ structure with R- $\bar{3}$m space group.
- XPS revealed the oxidation states on the surface of the nanopowders.
- SEM showed the morphology of polyhedron-like for NMC811 and rock-like particles for Cu-NMC811.
- FTIR displayed vibration bands belonging to NMC811.
- The electrochemical performance of Cu-NMC811 improved the compered to NMC811.

Fisika - Physics

UFS

This work is based on the research supported by the South African Research Chairs Initiative of the Department of Science and Technology and the National Research Foundation of South Africa.

National Research Foundation

science & technology

Department: Science and Technology REPUBLIC OF SOUTH AFRICA

Thank you

T: +27 60 571 5135 | E: rphokojoe@gmail.com | **www.ufs.ac.za**

Inspiring excellence, transforming lives through quality, impact, and care.

VISION 130 Renew and Reimagine for 2034

UNIVERSITY OF THE FREE STATE UNIVERSITEIT VAN DIE VRYSTAAT YUNIVESITHI YA FREISTATA UFS