

Lithium-Ion and Sodium-Ion Battery Performance at Elevated Temperatures

Maverick Clar, Electrical Engineering
Nicholas Rolston, Assistant Professor
School of Electrical, Computer, Energy Engineering



Background

- Lithium-ion batteries are the powerhouse of everyday electronics and EV's
- Sodium-ion batteries are emerging as a sustainable alternative, but their high-temperature behavior is largely unexplored
- Arizona's climate makes thermal stability especially important for stationary storage and industrial applications

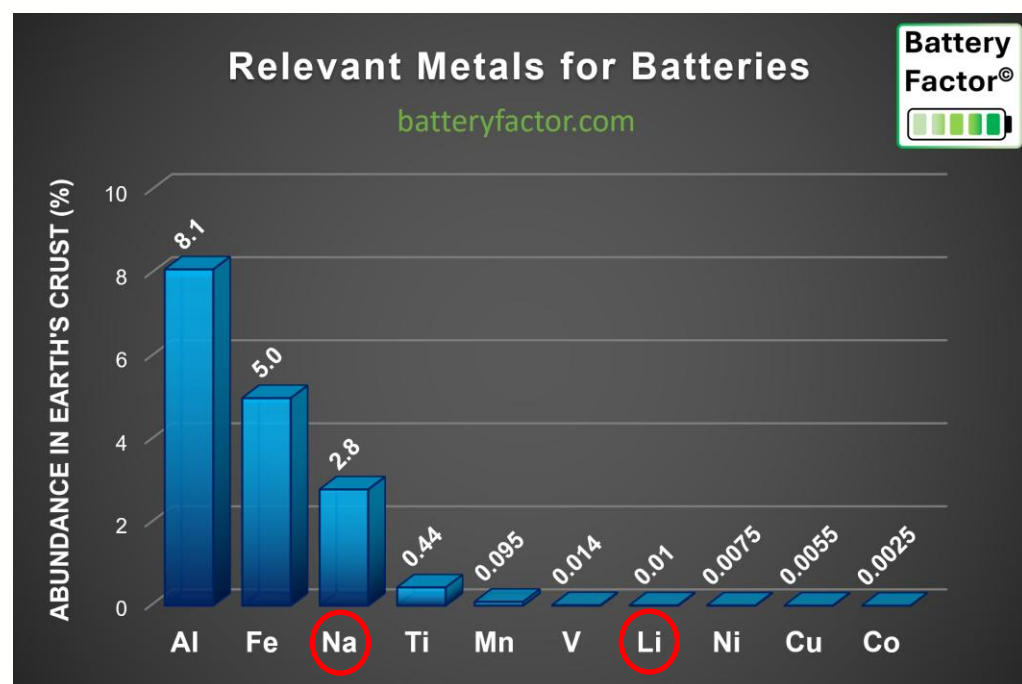


Fig.1

Cost Between Li and Na

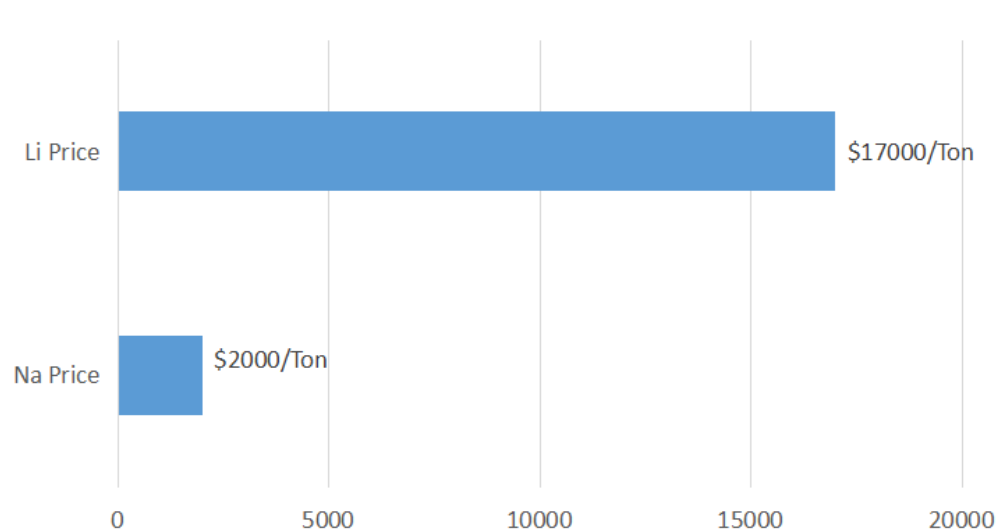


Fig.2

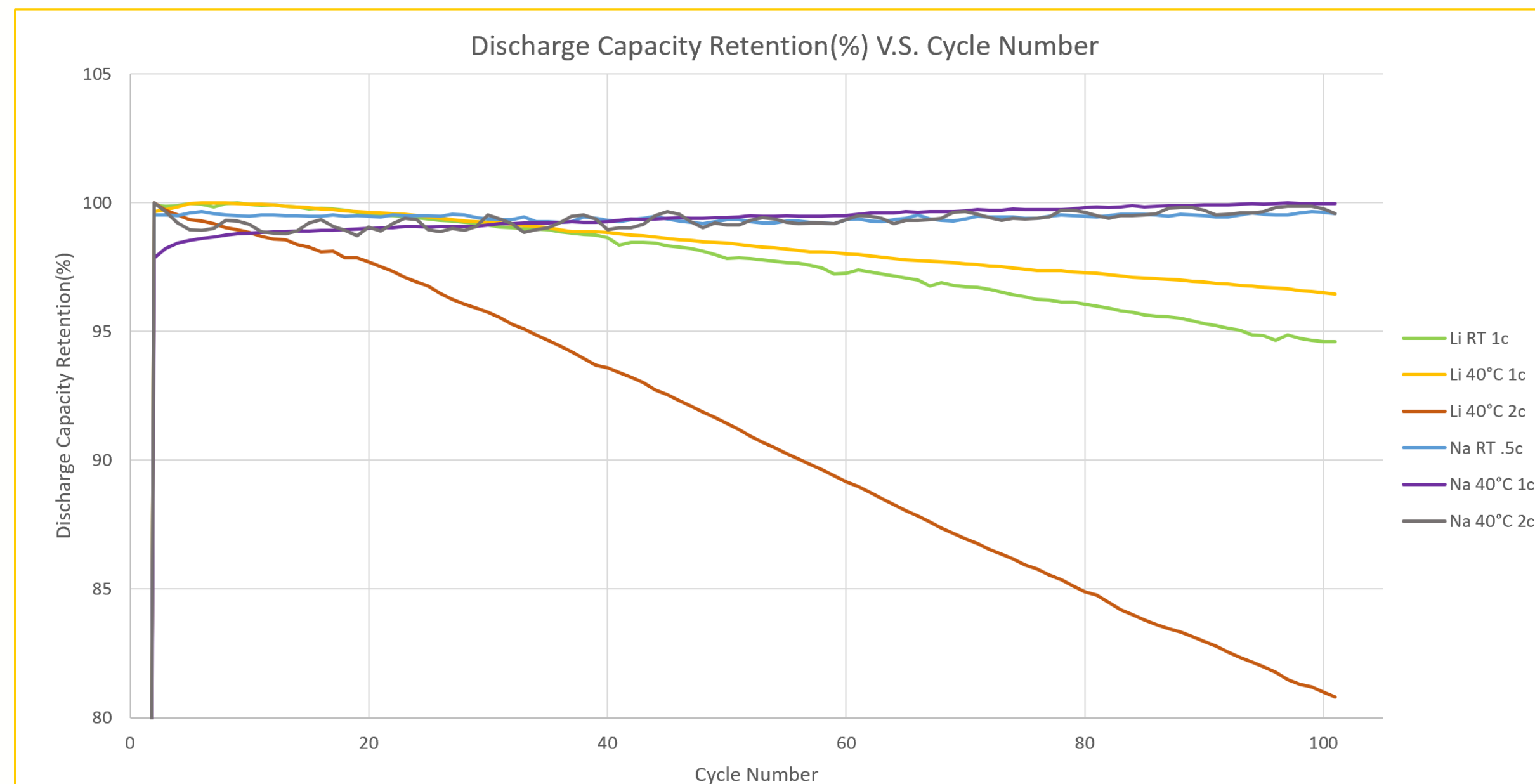
Abstract

The purpose of this research is to investigate the electrochemical properties of commercial sodium-ion and lithium-ion batteries when cycled under prolonged periods of intense heat

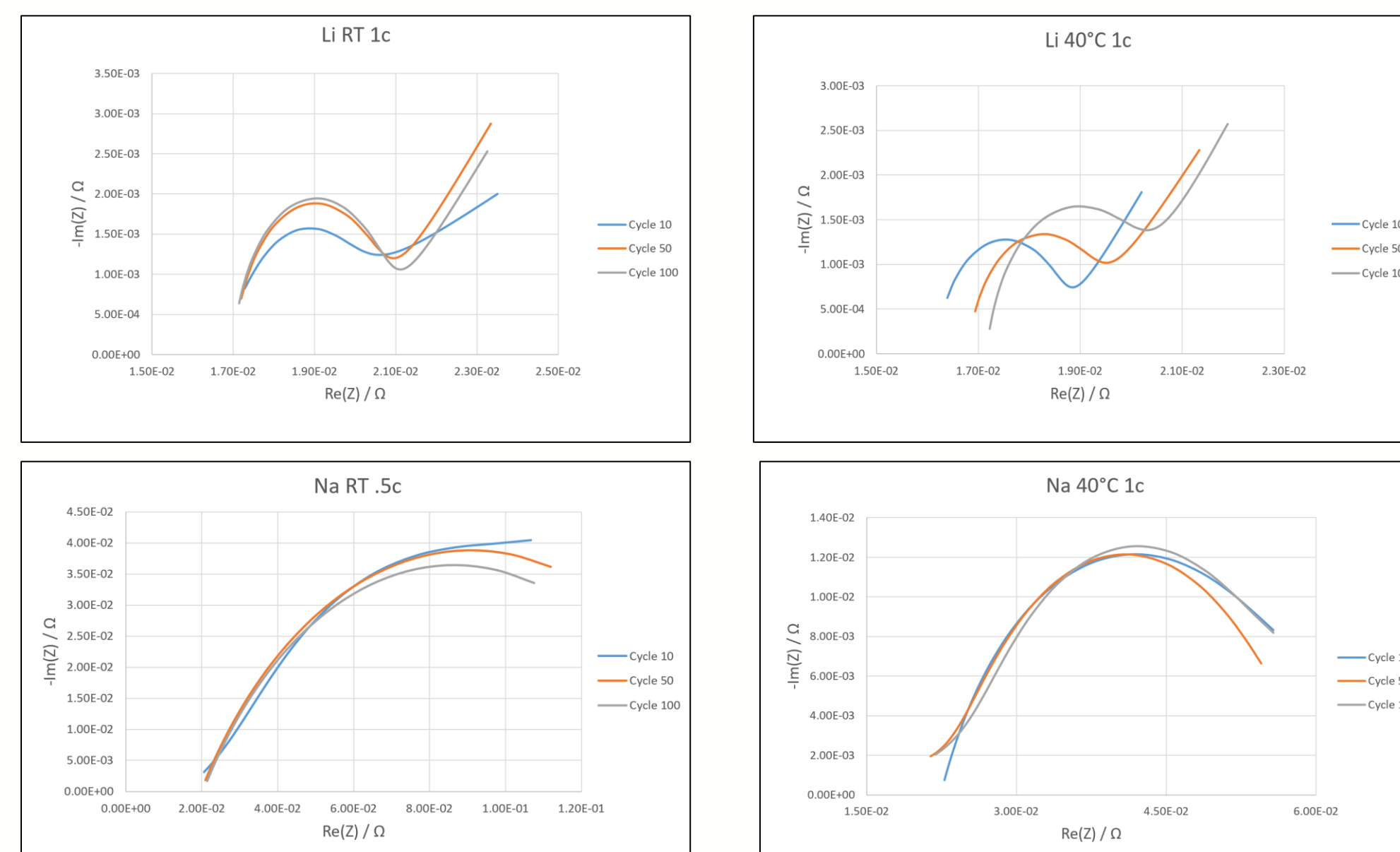
Experimental Method

- Batteries are cycled at 1c and 2c rates to evaluate charge/discharge capacity retention over 100 cycles
- Electrochemical impedance Spectroscopy (EIS) is conducted every 10 cycles to monitor changes in internal resistance
- Testing is performed on a temperature-controlled heating pad under a polycarbonate box to simulate extreme operational climates

Results



EIS



Conclusions

- Elevated temperatures accelerated capacity fade much more rapidly in Lithium-Ion batteries than Sodium-Ion batteries
- EIS data reveal that Sodium-Ion batteries exhibit minimal shifts in impedance compared to the substantial increases seen in Lithium-Ion batteries
- Sodium-ion batteries demonstrate enhanced thermal stability compared to lithium-ion batteries at all tested temperatures



Fig.3

Future Work

Address the second-life capabilities of Li-ion and Na-ion batteries at elevated temperatures & Experimentally examine battery performance when directly exposed to infrared radiation and ultraviolet rays from the sun

References:

- Fig.1: Author-BatteryFactor. 2023 Nov 30. Sodium-Ion vs. Lithium-Ion Battery: What Will Be The Future? - batteryfactor.com. batteryfactor.com. <https://batteryfactor.com/battery-factor-blog/sodium-ion-battery/>.
Fig.2: ELB. 2022 May 14. Sodium Ion Battery: The Definitive Guide. ELB Energy Group. <https://www.ecolithiumbattery.com/sodium-ion-battery/>.

Acknowledgments:

I would like to extend my sincere thanks to Nick Rolston and Harshitha Marikundam for their invaluable support and guidance; this work would not have been possible without them. I am also grateful to the FURI program for this opportunity; it has been an honor to participate.