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Sodium-Ion and sodium Metal BAtteries for efficient and sustainable next-generation energy storage

GRANT AGREEMENT No. 963542

SIMBA – Deliverable Report

<< D4.1 – Baseline cell, electrochemical and physical characterisation >>

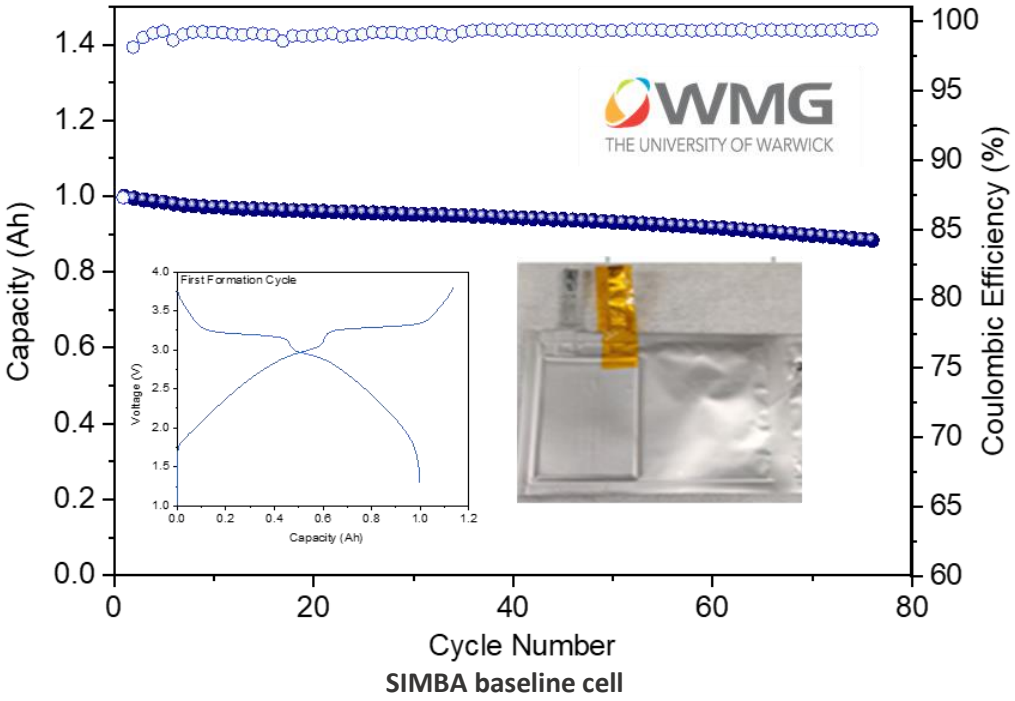
Publishable summary

The SIMBA project aims at developing a highly cost-effective, safe, all-solid-state-battery with sodium as mobile ionic charge carrier for stationary energy storage applications. Although in many ways sodium-ion batteries (SIBs) are similar to lithium-ion batteries (LIBs), there are still a number of persistent scientific and technical challenges to be addressed in understanding electrochemical processes and degradation mechanisms, electrode, solid-state electrolyte and cell manufacturing.
The overall concept and approach of SIMBA comprises the development of two anode and two cathode materials and a novel Solid-State Electrolyte (SSE). Together with new modelling and characterisation techniques, as well as electrochemical methods and manufacturing processes developments the main challenges of SIBs will be addressed effectively.
To achieve the specific objectives of the SIMBA project a four-step plan has been proposed including:
Step 1: Develop a baseline cell to easily compare development and progress of the project.
Step 2: Characterise, model, understand, predict, and improve the SIMBA materials.
Step 3: Scale-up materials and develop electrode manufacturing processes.
Step 4: Design cell and BMS design, testing, validation, and recycling.

This document, corresponding to Deliverable 4.1 (D4.1), is associated with Task 4.1 (T4.1) of Work Package 4 (WP4) i.e., “Development of a baseline cell”.
The activities carried out within T4.1 focus on the development of a baseline cell which constitutes a robust performance comparison for the final solid-state SIMBA cell. To accurately record the technical advances toward the final goal, it is first necessary to baseline what is currently achievable. For this reason, the SIMBA project envisions the design and manufacturing of a baseline sodium-ion cell at pouch cell level, using materials available within the consortium. All the advances made over the course of the project will be documented and assessed against the performance of the baseline cell. All further iterations will then be quoted, in terms of electrochemical performance, against this. Thus, the main objective of this deliverable and its corresponding milestone (M06) verified through completion of D4.1 is the creation of a robust baseline cell achieved collaboratively, utilising materials, processing and testing available among the partners early in the project.

The baseline cell has been entirely manufactured in WMG by using a Prussian white (PW) cathode developed by Altris, a hard carbon anode and a liquid carbonate-based electrolyte solution. All electrodes produced within T4.1 have been obtained through an aqueous process eliminating the use of toxic solvents such as N-Methyl-2-Pyrrolidone (NMP). This represents a step towards more environmentally friendly electrode processing methods, in line with the sodium-ion technology philosophy and the SIMBA project values. Materials, received in Kg batches have been processes at pre-prototyping scale at the Battery Scale Up (BSU) facility at the Energy Innovation centre in WMG.
Electrode formulation studies, mixing and coating trials and optimization of full cell parameters have been carried out within the collaborative framework of all the partners involved in T4.1. The activities carried out within T4.1 are the results of a continuous and efficient collaboration among the SIMBA project partners. Over the first 8 months of the project, several progresses have been made toward a better understanding of the SIMBA baseline cell chemistry and the processability of its components. The PW cathode represents a very promising cathode material for application in sodium-ion batteries especially in terms of sustainability, cost, and electrochemical performance. However, beside the advantages, there are still some challenges to address when moving from lab scale to upscaled cell formats. A7 multilayer pouch cells have been manufactured and tested electrochemically with defined protocols. After the aging process cells have been discharged and shipped for recovery and recycling studies in WP6. Several 1Ah A7 pouch cells have been manufactured successfully with optimal electrochemical performance.
Within T4.1, a great deal of results and knowledge has been gained to properly address these challenges. After only 8 months from the start of the project 1Ah SIMBA baseline A7 pouch cells have

been manufactured, showing satisfactory cycling behaviour at 0.2C and 1C. Thus, it can be stated that the first Milestone (M06) of the project which is demonstrated through D4.1 has been successfully achieved. The figure below reports the electrochemical performance of the "SIMBA baseline cell" against which future cell generations over the duration of the SIMBA project will be compared.



SIMBA baseline cell

Appendix B- Acknowledgement

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

Project partners:

#	Partner	Partner Full Name
1	TUDa	TECHNISCHE UNIVERSITAT DARMSTADT
2	UU	UPPSALA UNIVERSITET
3	UBham	THE UNIVERSITY OF BIRMINGHAM
4	WMG	THE UNIVERSITY OF WARWICK
5	KIT	KARLSRUHER INSTITUT FUER TECHNOLOGIE
6	CEA	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES
7	IFE	INSTITUTT FOR ENERGITEKNIKK
8	SAS	USTAV ANORGANICKEJ CHEMIE SLOVENSKA AKADEMIA VIED (Institute of Inorganic Chemistry, Slovak Academy of Sciences)
9	FHG	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.
10	JM	JOHNSON MATTHEY PLC
11	Elkem	ELKEM AS
12	YUN	YUNASKO-UKRAINE LLC
13	SAFT	SAFT
14	Altris	ALTRIS AB
15	Recupyl	TES RECUPYL SAS
	UNR	UNIRESEARCH BV

Appendix D – Disclaimer/Acknowledgement

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