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GRANT AGREEMENT No. 963542

SIMBA – Deliverable Report

<< D2.6 – Round robin test with developed electrodes, electrolyte and cell process showing stability > 300 cycles >>

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Publishable summary

SIMBA aims to develop a highly cost-effective, safe, and all-solid-state sodium-ion battery using single-ion polymer as an electrolyte for large-scale stationary applications. Single-ion polymer electrolytes (SIPEs) are novel solid-state electrolytes where the anion is bonded covalently to the polymer backbone, and the cation is the only mobile species. Therefore, the anion polarization is avoided, improving the sodium ion transference number close to one and enhancing the electrochemical stability window and ionic conductivity at room temperature.

D2.6 is the last deliverable associated with Work Package 2 (WP2: Lab scale material and process development) and allows us to achieve milestone two (MS02: The laboratory cell fabricated from optimized materials meets the performance target). The activities summarized in D2.6 consists of manufacturing all-solid-state polymer-based sodium-ion batteries at lab-scale with the selected electroactive materials in M23, such as Prussian white (PW) from Altris as a cathode, sawdust-derived hard carbon (sd-HC) from IFE and upscale by Elkem as an anode and sodium polysiloxane (Na-PSiO) from KIT as a SIPE with cycling stability of > 300 cycles (see MS01: Selection of the electroactive materials and the corresponding deliverables D2.1[1]-D2.5[2] submitted in M20-M23[3-5]).

The cycling stability of both studied SIPEs (3D networking Na[STFSI]:PETMP:PET4A:PVDF-HFP and Na-PSiO, see D2.5 for more details)[2] was investigated first in Na|SIPE|Na symmetric cells, exhibiting excellent compatibility against Na metal with a cycling stability of > 300 cycles. Later, half- and full-cells were studied by incorporating the polymer electrolyte into the cathode and anode electrodes (more details in D4.4)[6]. The PW|SIPE|Na metal all-solid-state sodium half cells deliver similar and stable capacities as in liquid baseline cells when low current densities are applied. However, their performance at high current densities should be improved. The sd-HC:Na-PSiO|Na-PSiO|Na metal all-solid-state sodium half cells deliver lower specific capacity than liquid electrolytes upon cycling. However, they achieved the target of D2.6, stability of more than 300 cycles.

The all-solid-state sodium full cells are still under optimization. A huge capacity decay is observed in the initial cycles by increasing the current density, probably due to the high polarization, hindering the determination of the proper N/P ratio. Incorporation of polymer electrolyte into the cell is challenging, and moving from liquid to polymer electrolyte cells is not straightforward. Indeed, a few reported full cells using sodium-based polymer electrolytes could be found in the literature due to the system's difficulty. Nevertheless, the all-solid-state sodium cells show acceptable cycling stability within the target; however, the delivered specific capacity should be enhanced upon cycling, mainly at relatively high current densities.