SPINMATE

Scalable and sustainable Pilot line based on INnovative MAnufacturing TEchnologies towards the industrialisation of solid-state batteries for the automotive sector

SPINMATE 2ND NEWSLETTER

October 2023

This newsletter will keep you informed about the project progress, research findings, and upcoming events. We will also share initiatives performed by the project partners to present their institution and role in the project, as well preseting the impact of our work on the broader scientific community.

SPINMATE CONSORTIUM

SPINMATE is a Horizon Europe project with 13 partners distributed among 7 countries, together with a mission to demonstrate a scalable, sustainable, safe, and cost-effective digital-driven proof-of-concept pilot line, at a Technology Readiness Level 6, as a first step towards the large-scale manufacturing of generation 4b (Gen 4b) SSB cells and module, to support the electrification of the automotive sector.

LATEST UPDATES

Approved deliverables

The first 6 deliverables of **SPINMATE** project were already successfully approved and can be consulted in the project website (https://www.spinmate.eu/deliverables):

D1.1 Management Handbook (**INOVA+**)
D1.2 Data Management Plan (**ABEE**)
D1.4 Gender Equality Action Plan (**ABEE**)
D2.1 TD2.1 Technical requirements for small (1Ah) and large (10Ah) battery cells and protocols for testing (**TME**)
D3.2 Report on the conclusions of the dedicated workshops (**ABEE**)
D91 Plan for Dissemination and Exploitation of Results - PDER (**INOVA+**)

Project General Assembly

The **2nd General Assembly** took place on July 5 and 6, 2023, at **CIC energiGUNE** in the lovely city of **Vitoria Gasteiz** in Spain.
During this gathering, we explored project's overall progress, meticulously assessing critical task milestones and strategizing for the road ahead.
One of the main focus of the meeting was to discuss and agree the technical requirements for small (1Ah) and large (10Ah) battery cells and protocols for testing in the EV sector

Clustering with European Initiatives and projects

The first webinar organized by **SOLID4B** cluster and coordinated by **SPINMATE** project took place on June 26, 2023 with the title: *"Lithium metal anode production methods: State of the Art, challenges, and future perspectives"*.

During the webinar, representing **SPINMATE**, *Joel Omale* (**ABEE**) talked about "*Evaporation and Sputtering Processes for the Deposition of Lithium Metal and its Protective Coatings*".

Solid4B cluster works to enhance research synergies among the European-level projects working on solid state batteries, translating research data into valuable knowledge for diverse stakeholders. This cluster was built to synchronize and conjointly promote the R&D topics in the electric vehicle field.

SEMESTRAL HIGHLIGHTS

Components for solid-state batteries

SPINMATE partners are developing components for solid-state batteries (cathode, anode, electrolyte). **CIC energiGUNE**, in collaboration with **ARKEMA** and **CIDETEC**, has developed high-performance, PVDF-based gel polymer electrolytes (GPEs, **Figure 1a**) with high ionic conductivity (ca. 1 mS/cm at room temperature, **Figure 1b**), and high electrochemical stability (ca. 4.5 V vs. Li/Li+, **Figure 1c**) and, allowing room temperature operation with high-energy cathode active materials. Preliminary results in Li||Li symmetric cells (**Figure 1d**) show excellent plating/stripping behavior, indicating high resistance against lithium dendrites growth. Electrolytes membranes have been implemented in full cells with high-voltage cathode materials, showing promising cycling behavior at room temperature.

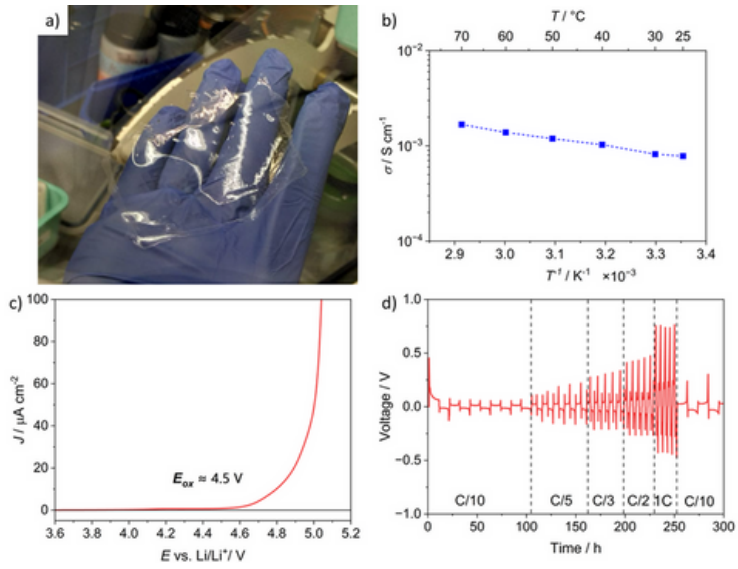

Figure 1.
a) Image of a GPE membrane developed in SPINMATE project;
b) ionic conductivity as a function of the inverse of the temperature;
c) oxidative stability of SPINAMTE GPE membranes;
d) plating/stripping in Li||Li symmetric cells at room temperature and with a fixed capacity of 2 mAh/cm2, at various C-rates.

ONCE PREPARED, THE CATHODES WILL BE CHARACTERIZED AND VALIDATED BY PHYSICOCHEMICAL AND ELECTROCHEMICAL TECHNIQUES TO GUARANTEE THE ELECTROCHEMICAL PERFORMANCE AND REPRODUCIBILITY.

Optimisation and development of positive electrode

During **SPINMATE** project, **CIDETEC -** in collaboration with **ARKEMA** and **CERPOTECH -** will develop a NMC811 positive electrode using solvent casting method, which will contain carbon additive and a catholyte (a solid-like electrolyte contained within the active layer) based on a PVdF polymer used for the solid electrolyte development. Also, **CIDETEC** will be responsible for the scale-up and manufacturing of the developed positive electrode for its further integration in coin cells and single-layer pouch cells.
In this first phase of the project, the positive electrode formulation was optimized and characterized in solid-state coin cells (Li/GPE/NMC811), obtaining relevant discharge capacity and high coulombic efficiency values at room temperature (**Figure 2**).

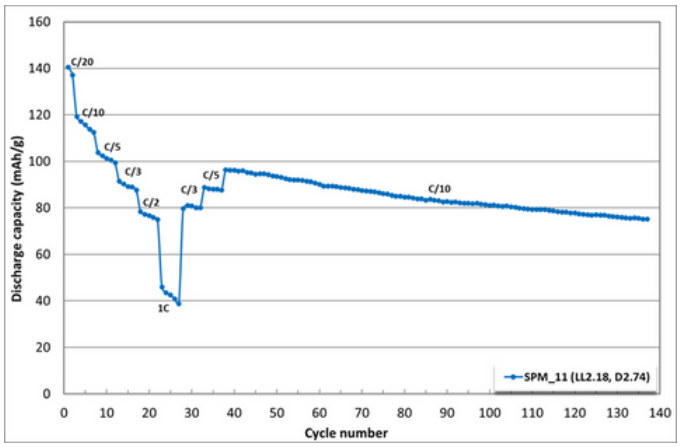

Figure 2. Electrochemical performance (C-rate capability and cyclability) of "Li/GPE/NMC811" coin cells with developed solid-state cathode. Testing conditions: C/10 (charge), 3.0-4.3V, 25 °C.

SEMESTRAL HIGHLIGHTS

Upgrading NMC811 material with O2 calcination

In our pursuit of achieving the desired performance for the NMC811 cathode material within the **SPINMATE** project, **IREC** conducted a series of experiments to enhance its capacity, employing various strategies.
One of these strategies involved testing different calcination gases. This choice was made after we observed the presence of carbonates on the material's surface through FT-IR analysis. These carbonates were anticipated to form during the air-based calcination process and are known to have a detrimental effect on the material's electrochemical properties. To mitigate this impact, we employed an oxygen-rich calcination atmosphere. Additionally, the use of an oxygen-rich atmosphere during calcination reduced the presence of Ni2+ ions within the NMC811 material, minimizing Li/Ni cation mixing, which negatively affects the material's electrochemical properties.
These combined improvements resulted in an average 40% increase in capacity and a capacity retention increase from 60% to 72% during the first 50 cycles (C10). These findings highlight the importance of the chosen calcination atmosphere in optimizing NMC811 properties.

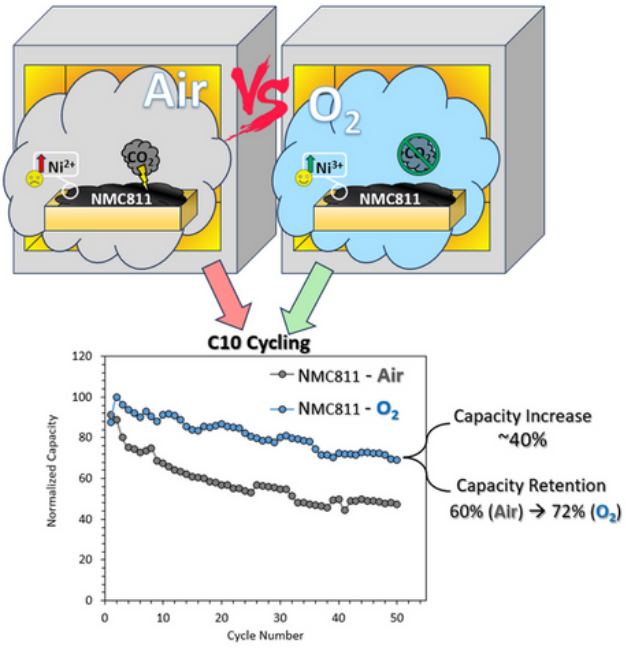

Figure 3. Influence of the calcination atmosphere on NMC811 cycle capacity

WITHIN THE SECOND YEAR OF THE PROJECT, THE COMPLETION OF THE DATA COLLECTION IS EXPECTED. THE AIM IS TO HAVE, BY THE END OF THAT PERIOD, A DATASET THAT SHOULD BE REPRESENTATIVE OF A WIDE SCENARIO, CHARACTERIZED BY AN HETEROGENEOUS LARGE DATA VOLUME.
ONCE PREPARED, THE CATHODES WILL BE CHARACTERIZED AND VALIDATED BY PHYSICOCHEMICAL AND ELECTROCHEMICAL TECHNIQUES TO GUARANTEE THE ELECTROCHEMICAL PERFORMANCE AND REPRODUCIBILITY.

Development of Machine Learning algorithms: Dataset creation

COMAU, with the support from **SPINMATE** partners, is currently leading the collection of data for anode and cathode electrode preparation and for the electrolyte membrane production processes. In a second step, data collection about cell assembly and cell formation will be performed. Since the beginning of **SPINMATE**, a list of the data needed for each single process of the entire cell manufacturing line has been created and shared, in order to permit the partners to provide the required input and output information. To collect the data, an experimental planning with the help of a DoE strategy was designed.

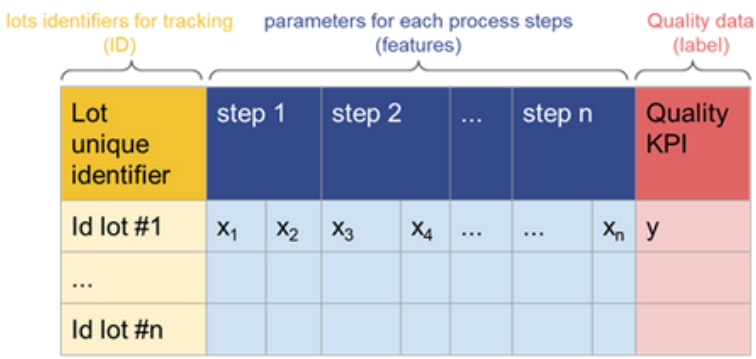

Figure 4. Optimized dataset to be created

WANT TO KNOW MORE?

Cell targets

In Work Package 2, **SPINMATE** determined different specifications to ensure the achievement of **SPINMATE**'s targets in a proper and timely manner. Using a dynamic Python code it has been estimated key unit cell parameters such as volumetric and gravimetric energy densities. These calculations showed that only a capacity of active material from 190 mAh/g and a minimum thickness of the positive electrode of 100 µm are needed to achieve the target of 450 Wh/kg. Furthermore, considering these values, it showed that a loading of the positive electrode superior to 6 mAh/cm2 leading to a volumetric mass of the positive electrode of 3.5 g/cm3 is thus needed. These values are very challenging target in terms of processability of the positive electrode and on ionic conductivity too requested for electrolyte because of the tortuosity that need to keep at a high value.

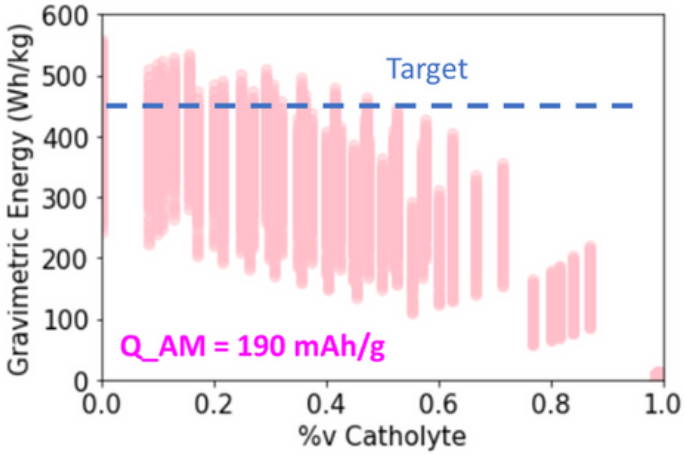

Figure 5. Gravimetric energy calculation obtained according to volumic percentage of electrolyte (catholyte) used in positive electrode.

MEET US!

MEET the PARTNERS

"Next-generation batteries will use lithium metal as one component in the cell. One problem is the immediate formation of blocking surface species due to reaction with water or air. We are therefore using a patented sandblasting technique, similar to the one your dentist uses to clean your teeth, to clean the surface of the lithium metal. For validation, we integrate the freshly cleaned lithium into the batteries. This optimization step increases the performance of the batteries.."

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"Definition of the pilot line requirements based on the KPIs the battery cells will achieve is essential to ensure a proper industrialization process of cell manufacturing. Optimization of all SPINMATE pilot line parameters from the beginning based on a well-designed battery cell will allow to align all the different cursors on the right position and provide an accurate control of the battery cells production in the road of industrialization..."

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***INOVA+** IS RESPONSIBLE FOR IMPLEMENTING THE COMMUNICATION AND DISSEMINATION ACTIVITIES IN SPINMATE – CONDUCTED A SERIES OF INTERVIEWS TO THE SPINMATE PARTNERS.*

"I am very happy to contribute to the development of an innovative battery altogether with all the partners of the project. Each partner has a very strong knowledge, and we are going to share and learn many things. I am waiting impatiently for the first cells to know their performances. In SPINMATE, we have the chance to develop very concrete products: cells, a pilot line, a module tested in representative conditions. Additionally, what is extremely important to me, is that the technology that we are going to develop will also be assessed on the environmental part: a life cycle analysis will be done, and recycling will be studied. I feel this is essential to give sense to our work and be convinced of our new technology."

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AHEAD OF THE CURVE

First SOLID4B cluster workshop

The first SOLID4B Hybrid Workshop, "*SOLID STATE LI-METAL BATTERIES TOWARDS A CIRCULAR ECONOMY: POTENTIALS VS. CHALLENGES*," is set to take place on December 12, 2023, in the "fervent city" of Liège, Belgium. We are delighted to welcome you in person at the venue or virtually through an online platform. This workshop will explore the vast potential and challenges associated with solid-state Li-metal batteries in the context of fostering a circular economy. We are also very excited to invite you to our panel on the New Battery Regulation, moderated by BEPA, and bringing the perspectives of end users, policymakers, and industry.
Secure your spot! Register now!

SOLID4B
Going solid for safer batteries

https://be.linkedin.com/company/solid4b-cluster

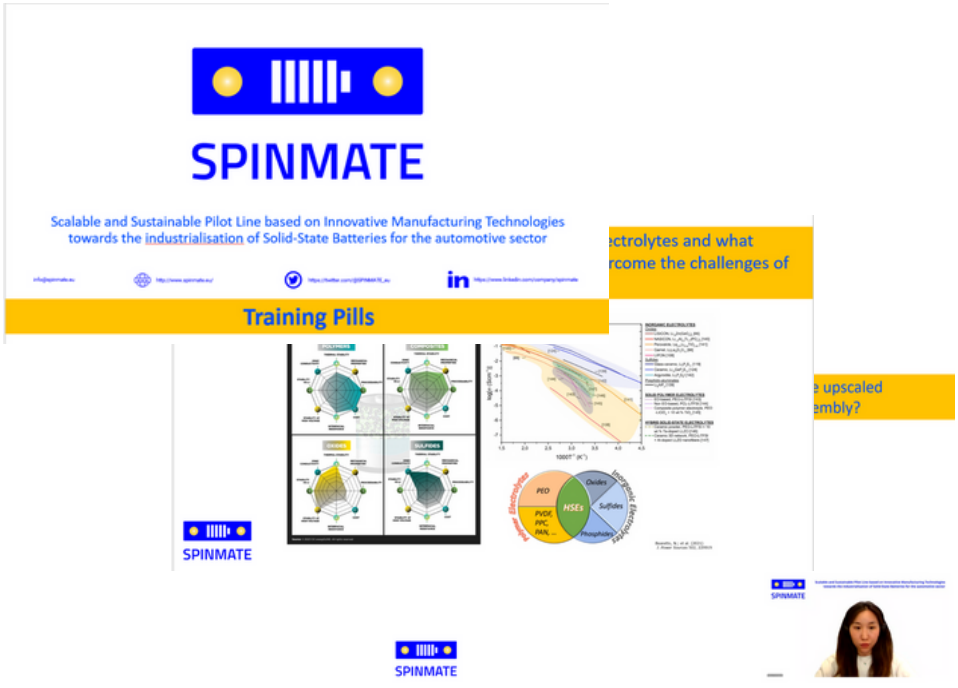
ADVAGEN AM4BAT HIDDEN
PULSELION SEAT BELT SOLID SPINMATE

Second SOLID4B cluster workshop

The second SOLID4B Hybrid Workshop is being planned for April 2024 in Brussels, Belgium.

Training pills

The first training pill was already designed and will be online in November 2023, disseminated throughout all **SPINMATE** channels and will also feed the SOLID4B channels.
This first training pill was focused on 6 main topics:
1. Battery Materials
2. Manufacturing of cell components
3. Production Tools
4. Testing Batteries
5. The future of the technology



SPINMATE* training pills *are specific communication and dissemination actions, carried out in WP9 to attract the interest of key industrial stakeholders and end users of the battery, EVs and related sectors. Therefore, this training activity aims to facilitate the acquisition of skills by industrialists and research infrastructures for exploiting the project results beyond the boundaries of the consortium. During SPINMATE life cycle 3 training pills targeting the workers of the battery industry and research infrastructures will be developed for reskilling and upskilling them in the new SPINMATE solutions.

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CONTACTS

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One step forward to a greener and safer driving

SPINMATE project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101069712