BATTERY 2030+

Newsletter
December, 2022

The vision for BATTERY 2030+ is to invent the batteries of the future, providing European industry with disruptive technologies and a competitive edge across the full value chain, that will enable Europe to take the lead in battery science and technology.

This newsletter gives you an update on what's going on within the initiative. Enjoy your reading!

A moment with Kristina Edström,

Coordinator of BATTERY 2030+

What a productive year we have had!

The six R&I projects: Bat4Ever, BIG-MAP, Hidden, Instabat, Sensibat and Spartacus are starting to generate results. We were able to meet physically at our annual meeting at VUB in Brussels. We co-organised the Battery Innovation Days in Brussels with Batteries Europe, BEPA and the ICPEI's.

We have hosted seven excellence seminars with top scientists from all around Europe. You can watch them all on our website.

The application for the next CSA has also been submitted and during spring we will arrange a number of what we hope to be inspiring workshops, educational efforts, and seminars about scientific results.

This newsletter will shine a light on Battery 2030+ achievements this past year.

A recap of the year 2022 in BATTERY 2030+ footprints

This is the year we started traveling again after the Covid pandemic and it was great for all of us to meet face to face again even though we still appreciate digital meetings nothing can replace networking in person. All of the projects have had great success and the technical results are coming along. Below each project will individually give you an update on where they're at and what collaborations they have been part of this past year. For the initiative as a whole we have completed seven Excellence seminars which have all been transcribed and you can find them **here**.

We went to Brussels for our midterm review and received some great feedback on what we are performing well in and a few areas that we need to adjust and work on. We have a follow up plan that we are already engaging in for the minor adjustments we have to attend to. In May we were featured in Advanced Energy Materials and you can read the article **here**. This year we also completed the Young Scientist Event that took place at four different Universities in Europe simultaneously. The young scientist produced a manifesto which has been presented to the commission and you can find it **here**.

We had our annual meeting in Brussels with almost a 100 participants and insightful panel discussions from our projects and industry. At our annual conference we also had guest speakers and other involved organisations present. We co-organised Battery Innovation Days with BEPA, Batteries Europe and IPCEI. BID followed our annual conference and many of our attendees also made a visit there. So far this year we have also completed three out of our four regional meetings we committed to in WP4. The Eastern regional meeting in Brno you read about in our last newsletter and below you will find the articles from our Western and Northern regional meetings.

In 2023 we are looking forward to collaborate on a few workshops together with M.ERA- Net and ERA-MIN in the beginning of the year as well as planning our fourth regional meeting in the southern region. Our annual conference will take place on the 9-10th of May in Uppsala so mark your calendars, you do not want to miss that! Looking forward to another eventful year!

Nordic and Baltic countries Summary regional meeting October 25

At the end of October, the Nordic and Baltic regional meeting took place in conjunction with the Nordbatt conference at Chalmers University of Technology in Sweden.

The **Baltic countries** have a long experience in the field of electrochemistry and an industrial base in its manufacturing. This is nowadays being complemented by a lively start-up scene, Dr. Linas Vilčiauskas at the Center for Physical Sciences and Technology (FMTC), Vilnius, Lithuania, told us.

Norway is not streamlined in EV manufacturing, despite having the highest proportion of EVs in the world, and a strong process industry, according to Anita Fossdal, senior advisor at Enova SF. In June Norway presented its battery strategy, with the vision that "Norway will develop a battery value chain, stretching from sustainable mineral extraction to recycling."

Finland's national agenda "National Battery Strategy 2025" leans toward the European agenda, Ilkka Homanen, from Business Finland said. When it comes to battery research Aalto University has a main profile for raw materials and recycling. University of Oulo focus on sustainable battery chemicals and pouch cells for Li-ion and Na-ion materials, while University of Turku concentrates on flow batteries and more applied aspects.

Denmark has no long history in battery research, but has stepped up during the last ten years, according to Lars Barkler, battery product director at Fluence in Denmark. DTU is the main actor for implementing machine learning models and AI to accelerate materials discovery while Aarhus University focuses on different battery electrodes, solid state electrolytes and flow batteries.

Sweden has a long history of battery research, and on the industrial side Northvolt has emerged as a strong player. Uppsala University and Chalmers are at the forefront of battery research, but also other universities like KTH, Lund's and Linköping's universities are involved in different research projects. The Ångström Advanced Battery Centre (ÅABC), is the largest battery research group in the Nordic countries.

There are raw materials in the ground, a tradition of mining, refining and a strong process industry in the Nordics, said Ilka von Dalwigk from Innoenergy. Furthermore, we have a high level of educated people, relatively inexpensive energy, and stable conditions for investment.

Europe has just started to journey to take back production. The Nordics are a frontrunner!

An update from our projects

The **SENSIBAT** project continues to advance in the development of intelligent sensors to introduce into lithium-ion cells.

In the first months of the year, the system developed in 1 Ah cells was validated, confirming that the developed Sensibat sensor does not affect the electrochemical behaviour of the lithium ion cells. Currently, the project is in the last phase of the

integration of the temperature and spatial pressure sensors for 5 Ah cells (attached an image of the Level 1 sensor).

The Sensibat Level 1 and Level 2 sensors (Third electrode based) are providing the project with new metrics for the development of novel methods of battery state estimation. In particular, the new metrics seems to be very promising for innovative State of Safety evaluation. All the HW and SW control systems to handle these intelligent sensors which are going to be implemented in a module built with six 5 Ah series connected cells are in the last phase of developed.

The Sensibat project with the help of the Battery 2030+ Research Initiative is also working on the dissemination of the work developed at different technical levels, from basic courses for students or radio programs to participation in conferences and scientific journals.

2022 has been an intense year for **INSTABAT** but very rich in results.

Sensors,

1- Fibre Bragg grating (FBG) optical sensor based on new technology was successfully developed and tested in cells to measure temperature and strain independently. 2-Two new concept of optical sensor based on luminescence was also developed and patented for temperature measurement and lithium ion concentration. The optical sensors (luminescent and FBG) was integrated in the cell to monitor internal parameters (temperature and strain).

3- An integrated reference electrode sensor was also developed, integrated and tested in pouch cell under cycling.

4-Virtual sensor T-Base and E-base has been developed by reducing physical model to monitor temperature and electrochemistry properties in real-time. Ageing campaign with instrumented cells was started for study ageing detection by sensors.

A mutlisensor platform was already developed and tested on instrumented cell with two physical sensors in cycling condition at high loading. Theses first proof of concept will be completed by integration of the other sensors and functionality.

We can also highlight two collaborative action: 1- INSTABAT and BIGMAP teams are collaborating in a joint experiment for in situ operando measurement with instrumented cells at ESRF for X-ray diffraction analysis. 2- Several meetings with SENSIBAT and SPARTACUS for collaborative actions on the sensing activities.

In conclusion, we have a good progress of the project with some of the objectives was already achieved. However, the project has been impacted by the COVID pandemic and we are in discussion with the project officer for an extension.

This year **BAT4EVER** project accomplished several tasks in the frame of the project, among which:
• Technical requirements, significant process and safety test parameters are defined and reported
• Conditions for the self-healing battery prototypes are defined
• Polymerized ionic liquids and integrating self-healing functionality are successfully developed
• Main parameters for the synthesis of the core/shell (NMC based, Ni-rich core and Mn rich shell) cathode powder material are established
• Self-healable polymeric binders for Si anodes and core/shell cathodes are optimized
• Self-healable ionogel binders are synthesized.
• Electrochemical validation of self-healable battery components is started
• Data management
• Dissemination in scientific and social platforms
• IPR management

Upcoming tasks:
• Proof of Functionality of Self-Healing components and battery cells
• Stepwise Manufacturing of prototypes with new-type of Self-Healing components
• Safety and performance tests
• Real-time mobile phone tests
• Atomistic modelling of materials and simulation of cell behavior
• Environmental impact assessment using LCA methodology
• Exploitation of results

The **HIDDEN** consortium has developed the two selected self-healing methods, thermotropic ionic liquid crystal (TILC) and piezoelectric separator, further during year 2022. Both are targeting to prevent dendrite growth in Li-metal batteries.

With TILC, we have improved the melt infiltration process and found additives, which together help to enhance the wetting of the cathode material. Initial proof of concept results about the self-healing effect were also just reached.

With the piezoelectric separator, we have seen the first improvements in lifetime, compared to a reference cell with a standard separator. Also, the first steps towards pilot scale processing of the piezoelectric separator have been taken. It looks promising that we can modify the process so that it can be upscaled to roll-to-roll scale.

It is also important to understand how the self-healing methods work, and how to integrate them into the battery management system. Our first scientific paper, titled "Non-Invasive Detection of Lithium-Metal Battery Degradation" was just published. The battery management system work has also started, having e.g., a goal to trigger the self-healing reaction with a printed heating element, which was developed in the project.

The **SPARTACUS** team has been very busy this year with the successful completion of upcoming tasks and milestones, e.g. regarding the further development of sensor technologies for the PVDF-TrFE and PZT based acoustic sensors, the rubber and temperature sensors and the ORP-EIS based impedance spectroscopy sensors. The development of the sensor-based CMS and the production of battery cells integrating sensors for acoustic measurements (PVDF-based and PZT), temperature sensors, compression sensors and ORP-EIS technology was also advanced and initial tests were carried out. The modeling for the Life Cycle Assessment started with the life cycle inventory based on lab scale data from the partners. The first results will be used to support the reduction of impacts in the manufacturing phase of smart cells.

The activity within **BIG-MAP** has consolidated several milestones within the past year, including a versatile electronic online laboratory notebook, and standardized workflows and procedures, those dealing with multi-modal characterization being especially relevant. On the modelling side, the AI-accelerated methodologies developed during the first year have been verified and validated, and efforts are currently directed to achieving a set of key demonstrators integrating experimental data. Hardware and software have been designed for automated synthesis and the process for improving advanced electrolytes has been optimized. Last but not least, the second framework for laboratory automatization and orchestration (FINALES) is now almost ready, as well as several other apps (some of them the result of joint stakeholder initiatives), which are already available within the BIG-MAP App Store. Besides dissemination of results achieved, interactions with other BATTERY 2030+ projects are also in course to promote the use of the BIG-MAP archive and infrastructure by others, while also helping to exploiting their data to train the AI models developed in BIG-MAP.

Happy New Year! Join us in celebrating that the next phase of

our EU initiative BATTERY 2030+ is granted!

From left: Maciej Smoliński, Maria Kochaniec, M. Stanley Whittingham

The Young Scientist Manifesto is getting noticed

Stan Whittingham receiving the manifesto from two of our Young Scientist Event participants, Maria Kochaniec and Maciej Smolinski at Warsaw University of Technology on November 22nd where he was awarded a honoris causa doctorate from the Warsaw University of Technology.