sensibat

D6.5 – II SENSIBAT ADVISORY BOARD WORKSHOP

LC-BAT-13-2020 - Sensing functionalities for smart battery cell chemistries

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Summary

Within SENSIBAT, an Advisory Board ("AB") has been established to provide critical thinking and analysis, and advise the consortium. Two AB-workshop have been organized, the objective of this deliverable D6.5 - II SENSIBAT AB Workshop is to provide an overview of the second Advisory Board workshop. This second SENSIBAT AB-workshop took place on 5th of October 2023 at the Flanders Make facilities in Lommel, Belgium.

During the workshop, SENSIBAT partners presented the general project overview, the two sensor technologies that have been developed, the module design and the results of the cost-benefit analysis. In addition, presentations have been given by several external parties; two young researchers, the partner project Spartacus (same HORIZON2020 call topic) and BEPA (Batteries European Partnership Association). The workshop participants also got a tour through the Flanders Make facilities with as highlight the SENSIBAT module with the integrated temperature and pressure sensor matrices (Level 1 sensors).

In the workshop, the AB-members commended the project for its significance and aspiration. Additionally, they highlighted points that could be taken into account throughout the last months of the project and also came with suggestions for further research after the project.

There are no differences compared to what is defined in Annex I of the Grant Agreement.

Table of Contents

Table of Figures

Abbreviations

Symbol / Abbreviation	
AB	*Advisory Board*
BMS	*Battery Management System*
CEO	*Chief Executive Officer*
CFD	*Computational Fluid Dynamics*
GA	*General Assembly*
R&D	*Research and Development*
SOX	*Battery states consisting of at least but not limited to State Of Charge, State Of Health and State Of Power*

1 Introduction

The deliverable D6.5 is the final outcome of "Task 6.1 - Communication and dissemination strategy" and the "Subtask 6.1.1 Communication and dissemination tools and materials". The aim of deliverable D6.5, titled "II SENSIBAT AB Workshop" is to present a summary of the second Advisory Board meeting, including the discussions that took place. This workshop took place on 5th of October 2023, at the Flanders Make facilities in Lommel, Belgium.

The primary objective of the Advisory Board is to offer critical thinking and analysis, thereby bolstering the confidence of project representatives in their decision-making. The AB comprises relevant external experts, who are tasked with the following responsibilities:

- Support SENSIBAT and its activities actively, inter alia by giving feedback on questions asked by SENSIBAT team members,
- Participate in Advisory Board workshops, and
- Provide feedback, advice, and support to SENSIBAT on the exploitation.

The second AB workshop gave the opportunity to summarise and discuss all results achieved, as well as to show the developed module with the temperature and pressure sensor matrix (level 1 sensors).

2 Advisory Board description

A more detailed description of the Advisory Board and its responsibilities can be found in deliverable D6.4 - 1st SENSIBAT Advisory Board Workshop. In addition, to address the following recommended change in the SENSIBAT project review report "*Due to the challenging tasks and issues in the project, it is strongly recommended to consider increasing the number of the experts' members of the Advisory Board to support the project. For example, by increasing by 2 more members being proficient in the issues that the project has identified as the most problematic*", the AB has been extended with the following members:

<u>Daniela Fontana – COMAU</u>

Daniela Fontana obtained her degree in Chemical Engineering with specialisation in Environmental Processes and Plants and her PhD in Chemical Engineering with specialisation in Fluid Dynamics at Politecnico di Torino. She has 18 years of experience in R&D activities, focusing on wet chemistry, CFD and lithium-ion technology. Since January 2021 she works as Electrification – Solution Development Manager at Comau International Center of Competence on Battery Cell Manufacturing. Before that, she was the R&D Manager at Lithops, responsible for the R&D Centre for lithium-ion technology, developing lithium-ion battery cells for different applications and the respective production process.

<u>Javier Olarte - CIC energiGUNE</u>

Currently Javier Olarte holds the position of Technology Transfer Director at CIC enegiGUNE. He also is the CEO of BCARE, a tool for turning CIC enegiGUNE's knowledge and capacity into business for companies. Their mission is to create solutions to maximize the sustainability of innovative storage systems as the energetic alternative of the future. Javier Olarte brings over 30 years of experience in design, development, production, marketing and after-sales service of battery systems, energy storage and power electronic. He has a background in R&D, operations, and engineering management.

<u>Carlo Novarese – Sunlight Group Energy Storage Systems</u>

Carlo Novarese is currently serving as Director of Lithium Cell Engineering for Sunlight Group Energy Storage Systems. Before that, he worked as Head of the Comau Global Center of Competence on Battery Cell Manufacturing and as Program Director for a new li-ion cell production plant. He is also the founder of Lithops, the first Italian integrated Li-Ion Technology Developer and Provider where he managed the first Italian lithium-ion cell pilot line set-up. Carlo has a strong background in Lithium-ion cells manufacturing process, R&D, supply chain (from raw materials synthesis to the complete battery) and market. He has a master's degree in aerospace engineering at Politecnico di Torino.

To familiarize these AB-members with the project and to also have the input from these members during the project, these new members have been present at the 5th General Assembly of SENSIBAT on 17 and 18 October 2022 in San Sebastian at the Ikerlan facilities.

Figure 1 SENSIBAT consortium with AB-members at GA05 in San Sebastian.

3 Second AB Workshop

3.1 Description of the workshop

The second SENSIBAT AB-workshop took place on 5th of October 2023 at the Flanders Make facilities in Lommel, Belgium. The workshop has been organised by Flanders Make, Ikerlan, Uniresearch and Politecnico di Torino,

The agenda of the workshop is shown in Figure 2. To offer the attendants a varied programme, the agenda not only contained talks by SENSIBAT, but also invited talks by two young researchers, BEPA, the sister project SPARTACUS and an introduction to Flanders Make. The invitation to the the young researchers follows the young scientists engagement underpinning all projects in the Battery2030+ community. Both young researchers were involved in writing the Battery 2030+ Young Scientists' Manifesto.

In the first talk, the SENSIBAT coordinator Iñigo Gandiaga (Ikerlan) introduced the SENSIBAT-project, including the partners, objectives, targeted impact and updated work plan including the achieved milestones. In the second talk, Wouter de Nijs, Research Manager of Flanders Make, explained among others the structure, research activities and facilities of Flanders Make. After that, Martin Wenger (Fraunhofer IISB) presented the SENSIBAT-developments and results for the L1-sensors (cell internal temperature and pressure sensors with spatial resolution) followed by a presentation from Sebastiano Bellani (BeDimensional) on the L2-sensors (third electrode printed on separator).

After the coffee break, the young scientist Marta Mirolo from ESRF (The European Synchrotron), introduced the audience to Synchrotron and the possibilities this facility offers in fast battery characterization with high resolution. Subsequently, Joris de Hoog (Flanders Make) explained the design process and considerations of the SENSIBAT battery module consisting of 6 in series connected SENSIBAT L1-5Ah cells, cooling system and BMS (Battery Management System). This session was concluded by a talk from Bozorg Khanbaei who explained the goals and structure of BEPA with several working groups.

The next point in the programme was the visit to the FM testing facilities in which various rooms and equipment was shown and explained. The highlight was the SENSIBAT-module including six 5Ah cells with integrated L1 sensors, the read-out circuit and the cooling/heating architecture. Due to the open casing, the module allowed an detailed insight on the module components (Figure 3).

After lunch, Xia Zeng (VuB) gave an insight into the most recent developments in the SPARTACUS-project regarding the developed cell level external sensor. This was followed by a presentation from the second young scientist, Piera di Prima (Politecnico di Torino), who showed her work on SoX-modelling based on the measurements given by a third electrode. The last presentation was by ABEE and gave an overview of the performed cost analyses for batteries including the SENSIBAT sensors. After the last presentation, there was a lively discussion which has been summarized in the next section.

Figure 3 shows gives an impression on the AB-workshop and also shows the module. The list of participants can be found in Annex 1.

Meeting	Final AB-Workshop
Date	5 October 2023
Time	08:30 – 15:30
Location	Flanders Make offices in Lommel, BE
Meeting organiser	Flanders Make

AGENDA AB-WORKSHOP

Agenda 5TH October 2023 | Final workshop			
Item	Start-end time	Topic	Presenter
1	08:30 – 09:00	Arrival and welcome	-
2	09:00 – 09:15	SENSIBAT project presentation	Iñigo Gandiaga (Ikerlan)
3	09:15 – 09:30	Flanders Make presentation	Wouter de Nijs (Flanders Make)
4	09:30 – 10:00	Temperature and pressure sensors	Martin Wenger (Fraunhofer IISB)
5	10:00 – 10:30	Impedance sensor	Sebastiano Bellani (BeDimensional)
6	10:30 – 11:00	Coffee break	-
7	11:00 – 11:15	Young scientist 1 (Synchrotron light meets real devices: advanced characterization tools to look inside batteries)	Marta Mirolo (ESRF - The European Synchrotron)
8	11:15 – 11:45	Module development	Joris de Hoog (Flanders Make)
9	11:45 – 12:15	BEPA presentation on technology uptake taskforce	Bozorg Khanbaei (BEPA)
10	12:15 – 13:00	Visit FM laboratories and show L1 SENSIBAT Module)	-
11	13:00 – 14:00	Lunch	-
12	14:00 – 14:15	Understanding the battery dynamics based on SPARTACUS sensor	Xia Zeng (Vrije Universiteit Brussel)
13	14:15 – 14:30	Young scientist 2 (modeling SoX estimation)	Piera Di Prima (Politecnico di Torino)
14	14:30 – 15:00	SENSIBAT Cost-benefit and recycling	Rahul Gopalakrishnan (ABEE)
15	15:00 – 15: 30	Report from AB and open discussion	Iñigo Gandiaga (Ikerlan)

Figure 2 Agenda of second AB-workshop

Figure 3 Impression of the second AB-workshop

3.2 Summary of discussions during AB-workshop

In this section, a summary is given of the discussions during the AB-workshop that related to SENSIBAT, its results and the use of the results.

Discussion on cell leakage after L1-incorporation

It was explained what steps the consortium has taken to protect the L1-sensor from the electrolyte by encapsulation and what problems arise when the L1-sensor matrix was incorporated in the 5 Ah battery cell. Subsequently it was explained how the consortium has solved the problems with the leakage of the cell with the L1-sensor, i.e. placing the sensor matrix on the surface of the pouch bag. Furthermore, the suspected cause of the leakage, beaching of coating during sealing, has been discussed. The experts noted that the project partners should take into consideration to reduce the number of sensors on the sensor matrix to reduce the width of the feed-through of the sensor matrix. Although this would minimise the areal resolution of the sensor matrix, it would reduce potential leaking.

There was also a discussion on the problems that may arise due to the sensor matrix not being completely flat. The SENSIBAT project partners explained that this effect has not been seen in the post-mortem analysis of the 1 Ah cells with integrated L1 sensor and it is also not expected in the 5 Ah cells due the very small height differences. The electrochemical cycling studies did not display a change in the aging characteristics compared to baseline cells, which indicates that this problem does not significantly affect the cell characteristics.

Impact of L2-sensors

The possible impact of the use of L2-sensors on battery life has been discussed. The goal of the sensors is to increase the cycle life so that the additional sensor costs are covered. It has been suggested to use the sensors to avoid unwanted conditions, like e.g. lithium plating conditions. The L2-sensor could also offer the possibility to understand what is happening in the battery and be used in battery development in addition to use during operation. Another suggestion is that with this sensor, one can get closer to the battery limits without damage (offering e.g. larger range), but also prevent cells from going beyond the limits. By this, the sensor will not only enhance battery life, but also performance and safety. It was concluded that work needs to be done for large scale integration of these sensors, but that the concept is there.

Cost analysis sensors

It was discussed that the L1-sensor will gain a lot of information, but that it is expensive with its current structure. At the moment, this sensor is not competitive for commercial exploitation in operational battery cells. However, it should also be noted that the sensor costs used in the calculations are current lab-scale costs, producing at a larger scale would reduce the costs. It was suggested to reduce the costs by using a less complex matrix by e.g. reducing the number of pressure points. The tests with the module could give information on sensor complexity reduction. It was also suggested to consider combining the L1-sensor with external sensors, determine the critical points that the L1-sensors measures and with that reduce measurement points and price.

Scalability (going to higher capacity, e.g. 100 Ah cells) may also help to reduce cost price per energy unit.

The production yield is also a point if attention; if the L1 is integrated and has a low yield (now estimated at

60%), then there will be lot of waste with high resulting costs.

For the benefits of the L1-sensor, it was recommended to further detail the benefits of the L1-sensor with numbers to make people enthusiastic about this sensor and have a convincing story. It was also recommended to make a difference between the use of the L1-sensor in R&D and use in industrial applications in the costs calculations and determination of the benefits.

It was concluded that the L1-sensor in its current form is typically an R&D sensor that reduces development testing time, not only for battery cells, but also for battery cell usage and for module components (e.g. cooling). The sensors may also be used in R&D towards battery cell usage. In these cases, sensor costs are not relevant and the sensor may be very well applicable.

It might be that it turns out that less sensors are required in applications that optimise cell usage and operation, and the implementation of L1-sensors therefore becomes attractive.

For the L2-sensor, the sensor itself and its production are much cheaper than the L1-sensor, but also other costs, like e.g. hardware costs, should not be forgotten.

<u>Other suggestions for future research</u>
Next to the suggestions above, it was also discussed that after the project, work will need to be performed on the exact use of the sensors and the long-term influence on battery lifetime. The sensor development work should also continue to aid in the development of new and future battery types, in studying cell formats, cell materials, etc. Next to this, there should be a good look at reducing sensor complexity, influence on costs and influence on scaling up of sensor production.

4 Conclusion

The AB-workshop has been a successful event which received a lot of praise from the participants and in which a lot of knowledge has been exchanged. In addition, there were interesting discussions on the SENSIBAT results, the use of the developed sensors and ideas for future research.

5 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

#	PARTICIPANT SHORT NAME	PARTNER ORGANISATION NAME	COUNTRY
1	IKE	IKERLAN S. COOP.	Spain
2	BDM	BEDIMENSIONAL SPA	Italy
3	POL	POLITECNICO DI TORINO	Italy
4	FHG	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	Germany
5	FM	FLANDERS MAKE VZW	Belgium
6	TUE	TECHNISCHE UNIVERSITEIT EINDHOVEN	The Netherlands
7	NXP NL	NXP SEMICONDUCTORS NETHERLANDS BV	The Netherlands
8	NXP FR	NXP SEMICONDUCTORS FRANCE SAS	France
9	ABEE	AVESTA BATTERY & ENERGY ENGINEERING	Belgium
10	VAR	VARTA INNOVATION	Germany
11	AIT	AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH	Austria
12	UNR	UNIRESEARCH BV	The Netherlands

DISCLAIMER/ ACKNOWLEDGMENT

Annex 1 Participant List

sensibat — SENSIBAT Final AB-Workshop

Please check this box below for approval for posting photographs of you on the project website (e.g. group photo's etc)

Partner	Name	Signature 5 October 2023	
ABEE	Rahul Gopalakrishnan	—	—
AIT	Bernd Eschelmüller		✓
BDM	Sebastiano Bellani		✗
FHG	Martin Wenger		✗
FM	Glen Vandenbempt	—	—
FM	Joris de Hoog		✓
FM	Taranjit Singh		✓
IKE	Josu Olmos		✗
IKE	Iñigo Gandiaga		✗
NXP-FR	Philippe Perruchoud		✓
NXP-NL	Henk Jan Bergveld		✓
POL	Piera Di Prima		✓
UNR	Maaike van der Kamp		✓
UNR	Anje Middelbos		✓
VAR	Harald Kren		✓
BEPA	Bozorg Khanbaei		✓
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TNO	Feye Hoekstra		✓
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Page 1 of 1