



ECO2LIB Project Newsletter

Dear readers,

Welcome back to the fifth newsletter of the Horizon2020-project ECO2LIB. In this issue, we want to give you an overview of the project activities in the first reporting period of the project. In addition, for new readers, we also provide a short summary of the ECO2LIB project and some more information on the project consortium.

I hope you enjoy the newsletter and the activities we are doing!



... join our LinkedIn group and stay up to date:
[ECO²LIB Project](#)



... or follow us on Twitter:
[ECO²LIB Twitter](#)

Summary of the ECO2LIB project

After the successful EU-project Sintbat, ECO2LIB aims to continue the effort by focusing on a new KPI, the cycle related costs per energy: €/kWh/cycle. This KPI very well reflects the real need of the customers in the energy storage market if a minimum volumetric energy density is added. The research and development activities will be supported by a clear recycling concept and an extended Life Cycle Assessment, to judge the environmental impact of the different options and to choose the best. To show both ECO-aspects (**ECO**logical and **ECON**omical) of our project the acronym ECO²LIB was created. The consortium decided to continue the improvement of the well-established **Lithium-Ion system** with advanced materials, methods, and corresponding recycling-concept. So, it will be possible to directly exploit the results of ECO²LIB in an IPCEI project, which is under preparation.

Summary of the project progress

We have crossed the mid of the project and with the impact of COVID-19 significantly decreasing, the project is back on a usual track. In this period, we were able to hold the first physical project meeting and also made some good progress:

Electrodes and Electrolytes: The platform has been established for the second generation of gelled electrolytes. Electrodes with the given anode recipe were successfully built. The anode and cathode loading were adjusted to the higher anode capacity. The cell design was adopted to achieve the energy density specification in the project scope. The cell manufacturing was finalized with the standard project electrolyte. Further samples of the fluorine-free electrolyte will be supplied and tested. The capacity check showed positive values and met the specified energy density.

Various strategies have been developed and tested for the aqueous process. In the end, similar capacity retention results could be reached as for the standard process.



Design of the manufactured 21700 cells.

Requirements specification: The requirements for the battery module has been fixed. The BMS was developed and optimised using the insights of the sustainability assessment. In this context, the potential to reuse certain components was investigated.

Recycling: The basic process design has been finished. The test setup has been established and the technical evaluation is ongoing. The lab-scale tests have been completed.

Characterisation: Operando XRR measurements for the developed electrolytes have been performed and look fine. However, some questions regarding the quality of the different electrolytes remain for now. Further investigation will thus be performed and also compared with XPS measurements.

Sustainability: The settings and framework for a full-competence technical LCA and cost analyses for the ECO2LIB project has been finalised. It defines the scope and the methodology to be followed to achieve the aim of the project. One of the major strengths of described life cycle assessment is that it provides results quantitatively on how sustainable (environmentally and economically) the products, processes and services will be developed under the ECO2LIB project. Due to the iterative nature of the designed LCA approach, some of the established settings such as system boundary, and functional units could be updated while progressing further in the project.

M30 General Assembly Meeting in Warsaw, Poland

After 2.5 years of online meetings, the consortium partners finally had the opportunity to meet in person again in June 2022. Thanks to the hospitality of project partner UW, a very nice and fruitful meeting could be held at the University of Warsaw.



Publications

Publications in journals

Multi-scale quantification and modeling of aged nanostructured silicon-based composite anodes

Vorauer, T., Kumar, P., Berhaut, C.L. et al., Commun Chem 3, 141 (2020)

“Advanced anode material designs utilizing dual phase alloy systems like Si/FeSi₂ nano-composites show great potential to decrease the capacity degrading and improve the cycling capability for Lithium (Li)-ion batteries. Here, we present a multi-scale characterization approach to understand the (de-)lithiation and irreversible volumetric changes of the amorphous silicon (a-Si)/crystalline iron-silicide (c-FeSi₂) nanoscale phase and its evolution due to cycling, as well as their impact on the proximate pore network.” Read more: <https://doi.org/10.1038/s42004-020-00386-x>

Surface Oxidation of Nano-Silicon as a Method for Cycle Life Enhancement of Li-ion Active Materials

Ratynski, M., Hamankiewicz, B., Buchberger, D. A. et al., *Molecules* 2020, 25(18), 4093

"Among the many studied Li-ion active materials, silicon presents the highest specific capacity, however it suffers from a great volume change during lithiation. In this work, we present two methods for the chemical modification of silicon nanoparticles. Both methods change the materials' electrochemical characteristics. The combined XPS and SEM results show that the properties of the generated silicon oxide layer depend on the modification procedure employed." Read more: <https://doi.org/10.3390/molecules25184093>

The role of coordination strength in solid polymer electrolytes: compositional dependence of transference numbers in the poly(ϵ -caprolactone)–poly(trimethylene carbonate) system

Eriksson, T., Mace, A., Mindemark, J., Brandell, D., *Phys. Chem. Chem. Phys.*, 2021,23

"Both polyesters and polycarbonates have been proposed as alternatives to polyethers as host materials for future polymer electrolytes for solid-state lithium-ion batteries. While being comparatively similar functional groups, the electron density on the coordinating carbonyl oxygen is different, thereby rendering different coordinating strength towards lithium ions. In this study, the transport properties of poly(ϵ -caprolactone) and poly(trimethylene carbonate) as well as random copolymers of systematically varied composition of the two have been investigated, in order to better elucidate the role of the coordination strength." Read more: <https://doi.org/10.1039/D1CP03929E>

Facile preparation of hierarchical 3D current collector for Li-ion anodes

Ratynski, M., Hamankiewicz, B., Czerwinski, A. *Electrochimica Acta*, 403 (2021)

"Beside great commercial success of Lithium-ion batteries, initiated by Sony in 1991, the cells manufacture details, active material selection, synthesis routes and further modifications are still under intense development. To increase the capacity of the whole cell, the researchers are focusing on new, high capacity, alloy type anode materials such as tin, germanium, aluminum and silicon. Apart from the great capacity, all of the alloy-type materials suffer from large volume changes during lithiation, e.g. silicon volume expansion can reach 300%." Read more: <https://doi.org/10.1016/j.electacta.2021.139698>

A cut finite-element method for fracture and contact problems in large-deformation solid mechanics

Poluektov, M., Figiel, Ł. *Computer Methods in Applied Mechanics and Engineering*, 388 (2022)

"Cut finite-element methods (CutFEMs) belong to the class of methods that allow boundaries/interfaces to cut through the elements, which avoids any meshing/remeshing problems. This is highly convenient from a practical point of view, especially when non-stationary interfaces are considered, e.g. phase boundaries in solids, as the interfaces can move independently of the mesh. There are many research directions related to CutFEM, one of which focuses on the equations of solid mechanics." Read more: <https://doi.org/10.1016/j.cma.2021.114234>

Articles

Ageing of nanostructured silicon-based composite anodes: Morphology changes and inhomogeneous lithiation

Brunner, R. (2020)

"Alloy systems like Si/FeSi nano-composites have great potential as stable anode materials in Li-ion batteries, but their characterization at different scales and throughout their ageing remains challenging due their complex architecture." Read more: <https://go.nature.com/3lWmRuC>

Innovatives Materialdesign für hocheffiziente Energiespeicher [German]

Brunner, R. (2020)

"Ohne effiziente Energiespeicher und einhergehende Kosteneffizienz wird es keine Energiewende geben. Wie kann Energie möglichst effizient und über eine Vielzahl von Lade- und Entladezyklen gespeichert werden?" Read more: <https://www.just-magazin.com/innovatives-materialdesign-fuer-hocheffiziente-energiespeicher/>

Improving the Design of Anode Materials in Lithium Ion Batteries

Interview with R. Brunner on the ZEISS Blog

"Researchers use advanced imaging methods to understand the structure-property relationship

Dr. Roland Brunner is a Group Leader for Material and Damage Analytics in the Microelectronics Division at the Materials Center Leoben (MCL) in Austria. The group strongly focuses on 3D nano/micro-structure image- based characterization and analysis with respect to innovative materials used in microelectronics and energy, to trigger improved functional material design for industrial applications." Read more: <https://blogs.zeiss.com/microscopy/en/fesem-anode-materials/>

Elektrolyt utan giftigt fluor ger elbilsbatterier samma prestanda

Kristensson, J. (2020)

Article on the development of fluorine-free electrolytes at Uppsala University

<https://www.nyteknik.se/batterier-premium/elektrolyt-utan-giftigt-fluor-ger-elbilsbatterier-samma-prestanda/1177032>

Conferences, seminars, lectures

Date	Presentation title	Event	Speaker
26.05.2020	Operando synchrotron experiments and porous-electrode modeling: a combined approach. Case study: sequential lithiation mechanisms in Silicon-graphite blended anodes.	Battery 2030+ workshop	S. Lyonnard (CEA)
03.09.2020	Elimination of Fluorination: The Influence of Fluorine-Free Electrolytes on the Performance of Si-based Li-ion Batteries	ISE meeting	G. Hernández (Uppsala)
15.10.2020	Monitoring Li-ion batteries by advanced operando neutron techniques	ILL-ESS user meeting satellite workshop	S. Lyonnard (CEA)
11.2020	Elimination of Fluorination: The Influence of Fluorine-Free Electrolytes on the Performance of Si-based Li-ion Batteries	2020 Virtual MRS Spring/Fall Meeting & Exhibit	G. Hernández (Uppsala)
03.12.2020	Ecologically and Economically viable Production and Recycling of Lithium Ion Batteries	H2020 Low TRL Smart Grids and Storage Projects clustering event	B. Achzet (VARTA Storage)
17.12.2021	Ecologically and Economically viable Production and Recycling of Lithium Ion Batteries	H2020 Battery Projects Online Workshop	N. Bucher (VARTA Microbattery)
28.06.2022	Uncovering the impact of coordination chemistry on cation transport in polymer electrolytes	EPF 2022	J. Mindemark (Uppsala)
28.06.2022	Polymer electrolytes based on Methacrylate End-Capped Poly(trimethylene) carbonate oligomers for lithium batteries	EPF 2022	V. Vijayakumar (Uppsala)

The project consortium

VARTA Microbattery GmbH (Germany)

VARTA Microbattery (VMB) is an internationally leading and globally active manufacturer of retail and OEM batteries and has been operating for more than 125 years. [Read more](#)

CEA (France)

CEA is a French government-funded technological research organization. With more than 15,000 researchers and co-workers, its activities cover four main areas: Energy, Defence & security, Health & information technologies, and Fundamental research. Two institutes from CEA, both located on the CEA Grenoble centre, are involved in the ECO²LIB project. [Read more](#)

Warwick Manufacturing Group (UK)

WMG is a world leading research and education group, transforming organisations and driving innovation through a unique combination of collaborative research and development, and pioneering education programmes. [Read more](#)

VARTA Innovation GmbH (Austria)

VARTA Innovation GmbH (VI), with registered office in Graz, was founded in 2009 as a joint venture between VARTA Microbattery and Graz University of Technology. Within VARTA Innovation both, the industrial fabrication know-how from VARTA Microbattery and the basic research know-how from Graz University of Technology for various electrochemical energy storage systems are merged. [Read more](#)

EurA AG (Germany)

EurA AG has been established in Ellwangen (Baden-Württemberg, Germany) in 1999. The company currently employs more than 140 persons on 9 locations in Germany, Portugal, and Belgium. As an innovation service provider, EurA advises more than 1,500 mainly medium-sized companies in Germany, covering all industrial sectors. [Read more](#)

Uppsala University (Sweden)

Uppsala University, founded in 1477, is the oldest University in the Nordic countries, and generally ranked among the top 100 universities in the world. Today, it trains more than 43,000 students, and employs 6,000 people. There are about 2,500 active graduate students; 44% of these are women. Each year, the University awards some 270 doctoral degrees. [Read more](#)

Materials Center Leoben Forschung GmbH (Austria)

The Materials Center Leoben Forschung GmbH (MCL) is the leading Austrian institution in the field of applied materials science with around 150 employees. [Read more](#)

VARTA Storage GmbH (Germany)

VARTA Storage GmbH (VS) is a developer and manufacturer of stationary battery storage systems based in Nördlingen, Germany. The company has substantial know-how in the field of energy storage by using long-life lithium-ion batteries and conducts in this context innovative research and development activities. [Read more](#)

University of Warsaw (Poland)

University of Warsaw (UW) was founded in 1816. The University brings together scholars from a variety of disciplines. It is the place of a diversity of scientific research. Nearly 60,000 people study at the University of Warsaw every year. [Read more](#)

ACCUREC Recycling GmbH (Germany)

Accurec is a German SME company, founded in 1995 with its primary target to constitute the consumer battery recycling market in Germany. [Read more](#)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 875514.

Published by:
EurA AG
Max-Eyth-Str. 2
73479 Ellwangen (Jagst)
Germany
www.eco2lib.eu