NEWSLETTER

ECO²LIB

ECO2LIB Project Newsletter

Dear readers,

Welcome back to the fourth 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!

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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 (ECOlogical and ECOnomical) 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

Much to the disappointment of the project partners, no physical meeting could take place during the first 24 months of the project. Nevertheless, very good project progress was achieved:

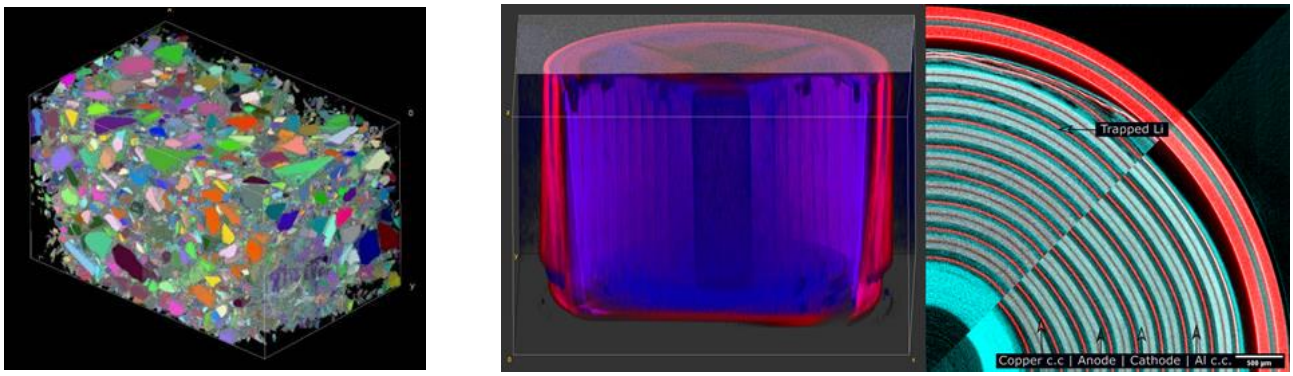
Electrodes and Electrolytes: In the first project months, the structure of the 3D current collector was fully optimized, leading to great improvement in the electrode cycling stability. Now, the focus was on enhancing the mechanical stability of the second-generation 3D current collector for industrial production processes. In parallel, the work on developing the second-generation electrolyte was continued and is still ongoing. So far, unfortunately, cells with fluorine-free liquid electrolytes do not perform at the standard while gel polymer electrolyte is still under development to boost the ionic conductivity.

On the cathode side, a green aqueous manufacturing process was developed and investigated. It was possible to stabilize the aqueous NMC622 slurry, so that after electrode coating and testing, no aluminium corrosion was observable on the positive current collector. The electrochemical evaluation showed that the specific capacity was not impacted by the aqueous production process.

Requirements specification: The benchmarking and specification of the use cases was completed, and two dedicated use cases have been selected for the ECO2LIB project. Building on this, cell tests of the first ECO2LIB cells are now foreseen and the ideal battery modules will be designed.

Recycling: In the past six months, the possible recycling process for the ECO2LIB battery was further investigated. For the underwater shredding process step, Accurec has modified a normal shredder with Silane Terminated Polymer so that the whole system is watertight. Then, conventional end of life lithium-ion batteries were collected, discharged, and ready for the shredding tests.

Characterisation: The developed electrodes, electrolytes and battery cells have been characterized in their pristine and aged states, using a multi-technique approach to correlate (electro)chemical, structural and morphological information at multiple length scales. The composite nature of the anodes, which contain a large amount of silicon, induces SEI formation and porous network variations along with cycling, both strongly dependent on the nature of electrolytes and binders, and affecting electrochemical performances.



Left: 3D volume of a non-calandered pristine electrode with high Si content. Right: Combined neutron and x-rays imaging of coin cells.

Sustainability: First screening analyses of benchmarks, e.g., with regard to recycling processes, have been completed and have revealed the meaningfulness of simplified LCA in order to identify saving potentials and derive recommendations for the development and upscaling of sustainable ECO2LIB recycling strategies. Building on this, the definition and settings for the overall sustainability assessment will be completed in the next six months.

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/D1CP03929F

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

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)

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

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