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NEWS



**Silicon based materials and
new processing technologies
for improved lithium-ion**

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Introduction

According to the European Energy Storage Technology Development Roadmap towards 2030 (EASE/EERA) energy storage will be of the greatest importance for the European climate energy objectives.

The Sintbat project aims at the development of a cheap energy efficient and effectively maintenance free lithium-ion based energy storage system offering in-service time of 20 to 25 years. Sintbat will use innovative approaches to address these aims. These include, the latest generation of anode materials based on silicon as well as a prelithiation process for lifetime enhancement will be implemented in the cell manufacturing process. Insights gained from advanced in-situ and in-operando analysis methods will be used for multi scale modelling targeting on the simulation of aging mechanisms for a reliable life-time prediction and enhancement.

The implementation of high energy materials combined with a low cost and environmental benign aqueous cathode manufacturing process will lead to remarkable cell costs reduction down to 130 € per kWh.

This will enable battery based storage system for an economic reasonable price of less than 400 € per kWh (CAPEX) and will lower the OPEX down to less than 0.09 € per stored kWh for the targeted in-service time of 20 to 25 years (10,000 cycles).

The technical developments will be supported by the set-up of a relevant roadmap as well as a catalogue for good practice. To guarantee the highest possible impact for the European economy the Sintbat consortium installed an Industrial Advisory Board including various European battery material suppliers, cell manufacturer and end-users whereby the whole value added chain in this way is completed within the Sintbat project.

This strong interaction of the Sintbat consortium with relevant stakeholders in the European energy economy will assure that battery based energy storage systems are becoming an economic self-sustaining technology.



improved lithium-ion batteries

Consortium

VARTA Microbattery GmbH



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. VMB employs nearly 750 persons in Germany and approx. 2,000 worldwide. The company headquarter is located in Ellwangen in the southern part of Germany where the entire research, engineering and production of the electrochemical cells are done. 150 VARTA employees work in the Innovation Tower at our headquarters in Ellwangen.

This central Research and Development department focuses on developing new products and optimizing existing solutions. Particular attention is paid to material and structural research, converting and storing energy (light, heat, vibration, etc.), and nanotechnologies, fuel cells, and printed batteries.

Uppsala Universitet



Uppsala Universitet (UU), founded in 1477, is the oldest University in the Nordic countries. In all different ranking lists UU is 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.

The Ångström Advanced Battery Centre (ÅABC) is an integral part of the Department of Chemistry – Ångström Laboratory, Uppsala University; it is housed within the Ångström Laboratory – one of Europe's best equipped Materials Research Laboratories. The Centre involves the full-time activities of 35-40 researchers, of whom 8 are Senior Staff and research engineers; the remainders are PhD students and postdocs. It is the leading basic research environments for the development of electrochemical storage materials and advanced battery technology in the Nordic countries. It is publishing more than 20 battery research papers per year. It is a member of ALISTORE-ERI a network of excellence for battery research started more than 10 years ago within FP6. It is a member of SHC (The Swedish Hybrid Vehicle Centre) and of several existing and former FP7 programs.



improved lithium-ion batteries

Consortium

Varta Storage GmbH



The VARTA Storage GmbH (VS) is a developer and manufacturer of stationary battery storage systems. The company has substantial know-how in the field of energy storage by using long-life lithium-ion batteries and conducts in the context of innovative research and development activities. The first commercial product from VARTA Storage is the ENGION Family, a modular storage system which allows the storage of PV-Energy in order to increase the self-consumption of private households up to 70%. With the development of novel large-sized storage systems the company addresses new applications like the efficient use of renewable energies and the support of grid stability.

Commissariat à l'énergie atomique et aux énergies alternatives



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 Sintbat project. CEA-INAC is a fundamental research institute (420 people) involved in nanoscience, while CEA-LITEN is a technological research institute (1,000 people) specialized on energy R&D (fuel cell, batteries, biomass, and solar application).

CEA-INAC develops expertise in advanced characterization on the Nanocharacterisation platform, a large facility devoted to up-to-date electron microscopy, spectroscopy and NMR on the Minatec campus of Grenoble. INAC also manages X-rays beam line at ESRF facility and ILL neutron reactor. For many years, CEA-INAC has developed strong knowledge in LIB investigation and in particular for Si based electrodes. The Nanocharacterisation facility not only provides access to high tech equipment with experienced staff, but also develops new characterisation methods to add to its portfolio.

The Laboratory for Innovation in New Energy Technologies and Nanomaterials (CEA-LITEN) has a unit dedicated to energy for transport application (Department of Electricity, Hydrogen and Transport, DEHT) which has more than 15 years experiences in new materials for Li-ion batteries. Today, this entity is equipped with a dry room of 300 m² dedicated to Li-ion batteries prototyping from the electrode material up to the cell and more than 600 m² dedicated to Li-ion module and pack system development. CEA-LITEN intellectual properties portfolio on Li-ion batteries is more than 100 on the topics of material synthesis, battery architecture, and BMS.



improved lithium-ion batteries

Consortium

WMG, University of Warwick



The University of Warwick is one of the UK's great success stories. In less than fifty years since being founded the University has become one of the UK's best universities, consistently at the top of UK league tables and rapidly climbing the international league tables of world class universities. Warwick is globally connected, forward-looking and entrepreneurial. At its heart Warwick is about creating new ways of thinking and achieving: making us stand out from our competitors and the more 'traditional universities' and creating an inspiring place to study and undertake research.

As one of the largest academic departments at the University, WMG is able to make a real impact on industry through collaborative R&D and top class education. UK government reviews have cited WMG as an international role model for university and business collaboration. What makes it unique is a multidisciplinary approach to innovation; pushing the boundaries for science and technology and enabling the transfer of knowledge into new areas. Working at the forefront of emerging technologies, and across diverse projects and industry sectors, WMG tackles real world challenges in an environment that inspires confidence and creativity.

MCL Leoben



The Materials Center Leoben Forschung GmbH (MCL) is the leading Austrian institution in the field of applied materials science with around 150 employees. In particular, it is operating the Comet K2 Center on Integrated Research in Materials, Processing and Product Engineering (MPPE) which is the largest competence center in the field of research on application of materials in Austria. The research focuses on Integrated research in materials, processing and product engineering and covers the entire supply chain from material synthesis via materials processing and manufacturing and is also including the behavior of components in service till their deployment. About 50 scientific institutions and about 90 companies are collaborating in this network on material based innovations in the fields of (a) new materials and novel material solutions for future applications like energy storage and harvesting, (b) new and optimized processes and process chains, (c) new design concepts, (d) innovative material driven products, and (d) reliability of products in service.

The MCL has modern Lab equipment suitable for cutting edge failure characterization and material characterization.



improved lithium-ion batteries

Consortium

VARTA Micro Innovation GmbH



VARTA Micro Innovation GmbH (VMI), with registered office in Graz (AUT), is a joint venture between the battery manufacturer VARTA Microbattery (Ellwangen, DE) and Graz University of Technology (AUT). The business purpose of VARTA Micro Innovation GmbH is R&D in the area of electrochemical energy storage systems. Within VARTA Micro 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 together. This unique configuration enables VARTA Micro Innovation to perform a fast transfer of newly developed technologies into production state. The R&D activities of VMI are divided in three main research areas:

- Lithium Power - Improvement of specific energy (Wh*kg⁻¹) and energy density (Wh*l⁻¹)
- Heat Power – Enlargement of the temperature operation range
- Rapid Power – Improvement of the rate capability

VARTA Micro Innovation is highly experienced in research, reverse engineering and ordered analysis in the area of lifetime prediction and reliability of Li-Ion Batteries for different application fields (e.g. EV, storage etc.). VARTA Micro Innovation has also many years of experience in working with high capacity negative electrode materials for lithium ion batteries. This work includes on the one hand basic research of high capacity electrode materials as well as electrode fabrication and construction of batteries with these materials on prototype level.

EurA Consult AG



EurA Consult AG has been established in 1999. As an innovation service provider, EurA advises more than 800 mainly medium-sized companies in Germany, covering all industrial sectors. EurA Consults mainly focuses on consulting and assisting companies in national and European R&D projects. This comprises the entire innovation process, including the generation of promising ideas, the search for suitable partners, the establishment of the project consortium, the technical and administrative coordination of the project as well as the project controlling.

Consortium

Uniwersytet Warszawski



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. The candidates are offered a very broad range of courses in the fields of humanities, social sciences and natural sciences, as well as many interdisciplinary courses combining knowledge and skills of many disciplines. The University offers undergraduate and doctoral studies, organizes summer schools, postgraduate studies and vocational courses, initiates interdisciplinary programmes and introduces new teaching techniques.

The Faculty of Chemistry, University of Warsaw, is a large research and teaching centre. There are fully developed programs in analytical chemistry, biochemistry, inorganic, nuclear, organic, and physical chemistry as well as in chemical physics. The faculty has been regarded as one of the top chemistry departments in the country for decades, and it attracts outstanding faculty and students. Many faculty members have distinguished themselves both nationally and internationally.



Kick-off Meeting

Date: 27th April 2016

Location: Brussels, Belgium



After the Grant Agreement for the project „Sintbat: Silicon based materials and new processing technologies for improved lithium-ion batteries” was officially signed at the end of December 2015, it was agreed on holding the kick-off meeting in Brussels, Belgium, right at the heart of the European Commission.

On the eve of this event that had been organized by the project coordinator VARTA Microbattery GmbH and EurA Consult AG a welcome dinner offered the perfect opportunity to get acquainted, maintain already existing relationships and join in vivid discussions.

The kick-off meeting started with representatives from all nine project partners, the EU officer in charge, Martin Gieb and an extensive agenda. To open the event, a general introduction and a project overview was given by the project coordinator Dr. Martin Krebs

from VARTA Microbattery providing all participants with important facts & figures as well as crucial information regarding major requirements of the future products in their respective markets and applications.

Subsequently all project partners not only portrayed themselves but pictured specific know-how, expertise in their line of work and recent achievements. The information given led to interesting in-depth discussions and improved alignment. Within this item of the agenda goals, tasks and planned approaches of each work package were presented by the work package leader and discussed in detail. All questions were met and concrete actions and timelines decided.

With the successful conclusion of the kick-off meeting, the project partners are looking forward to a fruitful collaboration in delivering the challenging outcomes of project Sintbat.

Project Progress

The project started officially on March 1st 2016. The first steps focus on the installation of proper management and communication structures, the work on Electrode Development, the Ageing Mechanisms and Modelling. Several tasks have been achieved in the starting phase of the project:

Project Management:

- The consortium agreement was signed shortly after the official project start at the beginning of April 2016
- The kick-off meeting was held on April 27th 2016 in Brussels (see page 8).
- A project handbook was established which reflects the most important details of the project management structure, including key summaries and tables from the Technical Annex, partners contact points, format of templates for documents, and naming conventions for files and documents. This document will be updated whenever necessary during the project life-cycle, to provide explicit rules for situations not clearly specified.
- Moreover templates for deliverables, reporting and presentations were created and made available for all project partners.

Research and Development:

In the scientific field, the partners started with:

- cell benchmarking of commercially available silicon based lithium ion cells,
- the development of advanced silicon based negative electrodes and the
- evaluation of a green process for manufacturing of cathodes.

Simultaneously, the investigation of the ageing mechanisms began using samples provided by project partners.

In order to predict the electrochemical cell behavior and lifetime the development of 1D macro and 3D microscale models was initiated. The systematic assessment of the entire life cycle taking into account all environmental, safety and social aspects of the Sintbat project started with the elaboration of definitions, settings and system boundaries to guarantee a coherent analysis throughout the project.

Dissemination Activities:

As far as the dissemination of project results is concerned, first activities could already be conducted successfully:

- The project website has been launched in and is available via www.sintbat.eu.
- It is planned to present the Sintbat project on the 2nd Graz Battery Days in advance of the 6-month project meeting in September 2016 (see page 11).

Aims:



Cost reduction

Low CAPEX and OPEX due to the combination of high energy materials with a low cost and environmental benign aqueous cathode manufacturing process.



Lifetime prediction & enhancement

Application of advanced in-situ and in-operando analysis methods for multi scale modelling targeting on the simulation of aging mechanisms.



Maintenance free

Improved lithium-ion based energy storage system offering in-service time of 20 to 25 years (10,000 cycles).

Newsflash

Tesla has opened the first sectors of its Gigafactory

The American automotive company Tesla has opened its own battery Gigafactory on July 2016, 29th. This plant is appropriately located in Sparks, Nevada. However, only a production area of 176,500 m² out of the capacity of over 1.2 million m² has been completed. The aim

with this production facility is to reach an annual production of 500,000 batteries for electric cars in 2018 and to minimize costs through mass production down to 100 €/kWh. In addition, a few different kinds of robots will support up to 10,000 employees at the plant.



Tesla Gigafactory construction progress (sources: elektrek.co, tesla.com)

HZB: Capacity of lithium-ion batteries can be increased by six times

According to scientists of the Helmholtz-Zentrum Berlin (HZB), the capacity of lithium-ion batteries could increase by six times when the anode is made of silicon and not of graphite. A HZB team from the Institute for Soft Matter and Functional Materials could observe in detail for the first time how lithium ions migrate into silicon. Accordingly to this observation, extremely thin silicon layers would be sufficient to realize the theoretical capacity of the battery. Researchers from the Institut Laue-Langevin had previously shown with neutrons measurements that during charging, the lithium-ions do not deeply penetrate into the silicon, but get embedded in the immediate boundary layer. Thereby a 20 nm-thin layer arises that contains an extremely high amount of lithium. This layer would be sufficient to allow a maximum loading with

lithium. According to their own statement, the HZB researchers could for the first time directly observe a half-cell of lithium and silicon during loading and unloading. They found two different zones. Near the interface with the electrolyte, an approximately 20 nm-thin layer with extremely high lithium content had formed - 25 lithium to ten silicon atoms. Attached to this layer, a second layer, poorer in lithium added with only one lithium to ten silicon atoms. Both layers together are less than 100 nm-thick after the second charge cycle, researchers said. After unloading, about one lithium-ion per silicon space remained in the silicon layer adjacent to the electrolyte back in the electrode, so that now a maximum capacity of 2.3 Ah/g is theoretically possible. The scientists published their work in the journal ACSnano of the American Chemical Society.

Event Watch

2nd Graz Battery Days

Date: 27th - 28th September 2016 **Location:** Kunsthhaus Graz, Austria



Save the Date
**2nd Graz Battery Days on
 Next Generation
 Materials and Systems –
 Truth and Consequences
 27th to 28th of Sept. 2016**

Kunsthhaus Graz, room "Space04"

Contact: GBD@vartamicroinnovation.com
 Organized by VARTA Micro Innovation GmbH
 in cooperation with Dresden Battery Days

Foto: Universalmuseum Joanneum, Eduardo Martinez

This two-day meeting will be dedicated to the exchange of knowledge between international electrochemical energy storage experts on the specific topic of **Next Generation Materials and Systems - Truth and Consequences**.

The organizing committee has invited high-level speakers to cover the topics of:

- Next generation materials for lithium-ion batteries
- Post lithium ion and alternative ion systems
- Solid state batteries

In addition to the oral presentations a poster session will organized on the 27th of September.

A scientific committee consisting of renowned researcher from leading countries in Europe,

Japan and USA provide guidance and supervision throughout the event.

For further information please visit <http://www.vartamicroinnovation.com/index.php/de/main/graz-battery-days>



The next EnergyDecentral exhibition will take place in Hanover, Germany, from 15th - 18th November 2016, and will mark 10 years of renewable energy being presented at the event. EnergyDecentral as the international trade fair for decentralized energy supply offers experts and investors a comprehensive overview of products and services. Visit www.energy-decentral.com

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