7th Issue
August
2019

NEWS

Sintbat

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

Sintbat

improved lithium-ion batteries

In this Issue

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 innovate 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 Sinbat 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.

Project Progress

In this newsletter we would like to give you a brief overview of the latest findings of the Sintbat project.

Project Management (WP 1):

After the publication of the last newsletter the second periodic report could be accomplished and submitted timely. This report contains the results of the previous project period. In addition, no reportable deviations from the project objectives or the use of funds and the budget could be identified. Minor deviations from the plan, which typically occur in projects, are resolved within the project.

Research and Development:

Cell Benchmark, Advanced Electrode Development and Balancing (WP 2):

Prelithiation levels evaluation

Based on the results with the Generation 1 & 2 higher levels of prelithiation (40-66%) were studied for Gen3.The use of SLMP-powder shows several drawbacks concerning homogeneous prelithiation and processability. By use of the surface application method, an additional layer is casted on the electrode surface and thereofore only lower capacities can be achieved compared to non-threated electrodes, especially at higher mass loadings. However, it still was possible to show the positive effect of prelithiation by use of SLMP-powder on the cycling stability and the capacity retention. 82% of capacity retention was observed after 500 cycles for Gen-3A with prelithiation compared to 77% of capacity retention after only 300 cycles.

Conclusions are similar when using a lithium foil. It impacts significantly the energy density as a 50µm thick foil was added in the jelly roll. However, capacity retention is much more improved as 90% of the initial capacity was recovered after 1200 cycles. From cycling at 70% DOD, it is possible to expect 80% of capacity retention after 10.000 cycles.

Aqueous processed positive electrode

For Generation 3, 3 NMC622 grades from Umicore (standard, A & B) have been evaluated for aqueous process using carbon coated current collectors (from ARMOR). 500 mAh cells were assembled with anode provided by VMI coated in both sides. 6 cells were assembled for tests at 25 and 45°C. Blanc for Cycling at 25°C has shown the same capacity retention than other generations with the same anode, figure below. Also, discharge capacity at 3C were around 85% after 20 cycles and evolved similarly than reference generation.

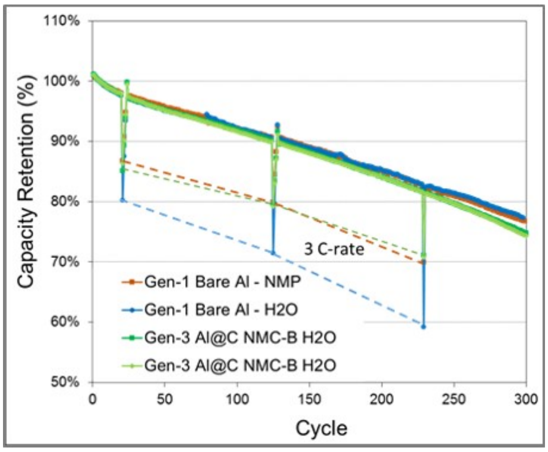


Figure: Comparison of different generations for capacity retention at C/2 and RT.

WP3, Uppsala University

The effect of electrolyte fluorination on the electrochemical performance of a silicon-based anode has been studied in a full cell configuration coupled with LiNi1/3Mn1/3Co1/3O2 (NMC111) cathode. Electrolytes with different degree of fluorination have been explored. The reference electrolyte was LP57 (1 M LiPF6 in ethylene carbonate (EC)/ethyl methyl carbonate (EMC) (3:7, v/v)).

Project Progress

Another highly fluorinated alternative, LiBOB, as well as the afore-mentioned additives, FEC and VC. Alternatively, a fluorine free electrolyte composed of LiBOB and VC additive was prepared. Discharge capacity and Coulombic efficiency for these electrolyte formulations are shown in the following figure. Compared to the cell with the reference LP57 electrolyte, the one with the fluorine free electrolyte shows improved performance in terms of discharge capacity and Coulombic efficiency due to its ability to form a solid electrolyte interphase (SEI) that stabilises the anode. Despite the good performance of the cell with the fluorine free electrolyte, the highly fluorinated electrolyte is still the best performing one. The full cell cycled with LP57+FEC+VC shows the highest capacity and cycle life, 140 mAh/g initial discharge capacity at C/2 with 78 % capacity retention after 300 cycles. X-ray photoelectron spectroscopy reveals that this electrolyte forms a highly fluorinated SEI on the anode's surface, which contributes to a better stabilisation of the anode and therefore improves the electrochemical performance of the cell.

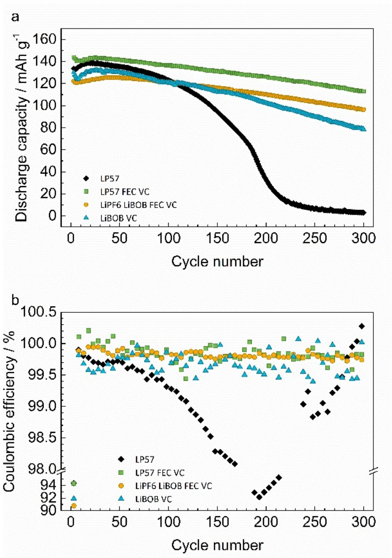


Figure. (a) Discharge capacity and (b) Coulombic efficiency of full cells (NMC111/Si alloy-graphite) with LP57 (black), LP57+FEC+VC (green), LiPF6 and LiBOB with FEC and VC (yellow) and LiBOB+VC (blue).

Based on these results, a fluorinated electrolyte is chosen as the best electrolyte formulation (deliverable D3.6), and the second generation of electrolyte is the highly fluorinated one.

Therefore, the electrolyte LP57 with FEC and VC additives is the best choice for the NMC111/Si alloy-graphite full cells studied within the Sintbat project.

WP 4 Modelling, Simulation and experimental validation:

Regarding structural and morphological testing of the components more results were obtained by 3D analysis. The 3D data gives the possibility to go slice by slice through the data set and help to extract information concerning the distribution of the different phases within the Volume Of Interest (VOI). The pristine anode material as well as the change of the material with respect to the Si-phase for different cycling stages could be shown in a first step. Results are combined with CEA-results. A Publication is in preparation.

Next steps will be the quantification of the volume fraction obtained from the SCT data with respect to pores, graphite, agglomerated Si particle phases as well as the additional phase (small Si-particles, binder, carbon black) for different cycling rates and link the results to modelling (UOW) and compare with complementary characterization methods (CEA).

Development of a 1D macro electrochemical cell model

In this modelling activity, an electrochemical model was first parametrised with measured SINTBAT Gen1A chemical data and validated against experimental measurements. A detailed sensitivity study has been conducted by varying the particle radius and the diffusion coefficient. Both parameters are sensitive on operating characteristics of the battery. A methodology to parametrise an electrochemical model for ageing (SEI) has been also presented. This model can in future be used for applications combining cycling

Project Progress

as well as storage SEI growth. The electrochemical model-based approach offers more physical insight into the SEI growth and property of the SEI than existing data driven model approaches.

Development of a time dependent capacity-power fade phenomenological model

In order to develop a time dependent capacity degradation model, advanced machine-learning techniques are applied to derive a hybrid data-driven model for accurate future capacity and remaining useful life prediction with reliable uncertainty management for Li-ion batteries.

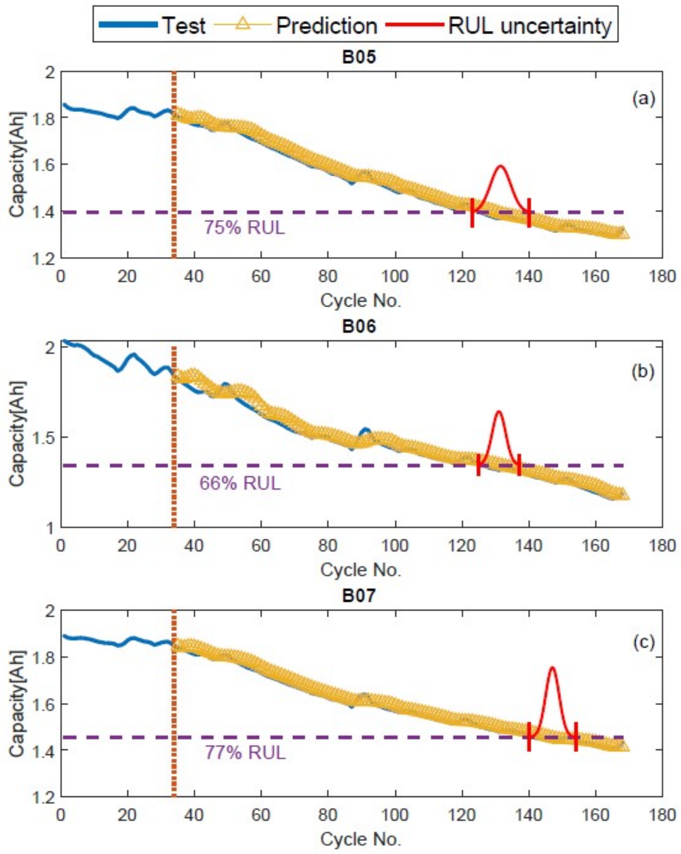


Figure: Time dependent capacity prediction results for NASA batteries.

For time dependent capacity predictions, this proposed hybrid data-driven approach is capable of offering highly accurate results with strong reliability. Without any battery mechanism knowledge, the proposed approach can be easily extended to other battery types for health diagnosis (fig. time dependent capacity prediction results for NASA battery data).

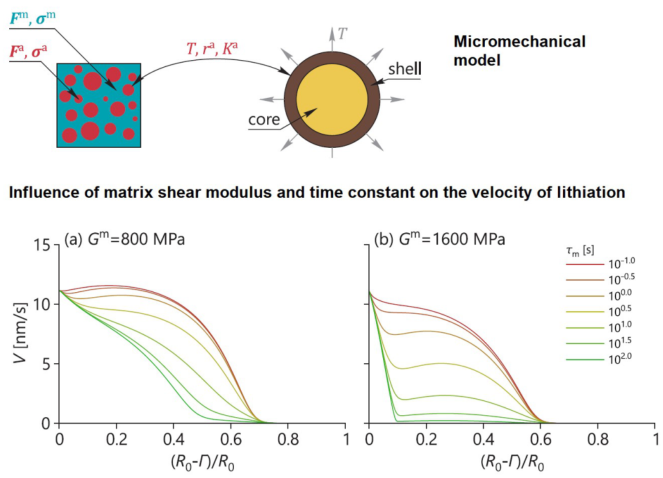
3D micromechanical model for the anode

A nonlinear 3D micromechanical model of the Si particle based Li-ion battery anode was developed, to study relationships between anode material composition (e.g. Si particle content) and its in-situ and macroscopic chemo-mechanical behaviour. The model is formulated based on the incremental Mori-Tanaka theory, and its numerical implementation follows the nonlinear finite-element (FE) framework. The model is computationally efficient (i.e. its solution procedure is much faster) compared to full-field FE models.

The model shows an important feature that the time-dependence of the effective anode material (i.e. mixture of pores, graphite and polymeric binder) surrounding Si particles can have a significant impact on lithiation kinetics during battery cycling. In particular, when the effective matrix is viscoelastic there are two competing mechanisms within the anode: (1) the retardation of the lithiation reaction due to build-up of stresses and (2) stress relaxation within the effective anode matrix. Those competing factors lead to non-monotonous kinetics of the lithiation, which is subject to decelaration and acceleration patterns during battery charging.

Project Progress

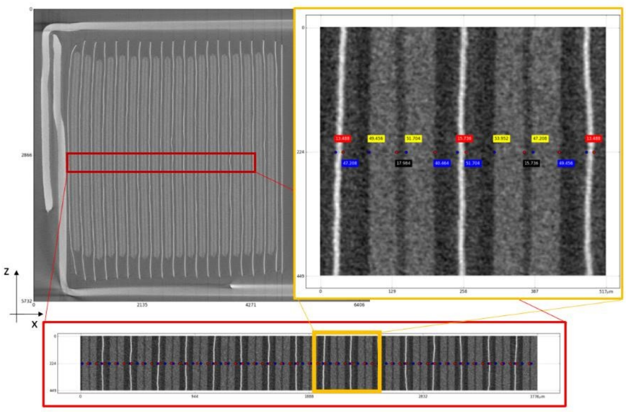
Further details on the model can be found in a paper co-authored by M. Poluektov, A.B. Freiding, and Ł. Figiel, and recently published online (with open access) Journal Modelling and Simulation in Materials Science and Engineering:
[https://iopscience.iop.org/article/10.1088/1361-651X/ab3b3a]



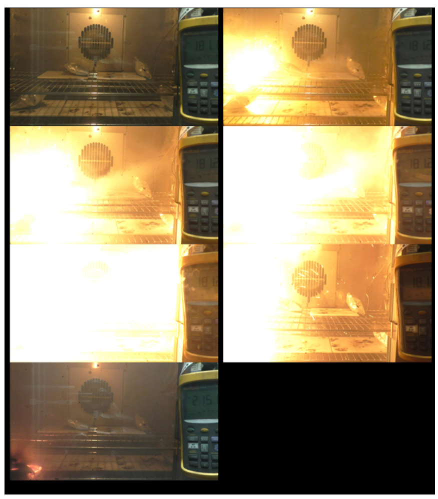
WP 5: Implementation, cell development, analysis and safety tests

The Transfer of advanced materials into industrial scale was continued. Problems arising from volume expansion of the anode, for example, were made provision for by changes in production processes for coating and calendaring. Cells shop show a capacity distribution within a limit of 2mAh, which is a good range for cells from sample shop and a high reproducability. The impact of discharge conditions on the capacity were tested.

The Structural and electrochemical characterization of the test cells were continued as well. X-ray computed tomography (XCT) was used for 3D-analysis, refined in resolution and the evaluation automated regarding thickness. The results obtained from the 3D analysis were compared with the electrochemical characterization. The combination of both could provide significant input to the production in order to adapt the process towards an improved cell design (figure: Slice image obtained from the XCT measurements in the z-x plane on different length scales to determine the thickness of the cathode, anode + separator, copper and aluminium).



Testing safety on lithium ion cells is described in different standards and regulations. The most common in battery world are: UN38.3 (transport regulations) and IEC battery standards. Further standards are provided by non-profit-organizations like IEEE or companies like UL (Underwriting Laboratories). For the Sintbat project, cells have been put into this oven test at fresh and cycled state. Pictures right show the thermal runaway triggered at a temperature around 180 °C.



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Independent of the number of cycles, all tested cells went into thermal runaway in this test. Interestingly, the onset temperature of 180 °C is matching with the melting point of lithium. Under discussion is the influence of surface plated lithium on safety behaviour. Further tests were discussed in the Sintbat consortium and will be conducted on cell level.

WP 6 Prototyping and Demonstration

The main work flowed last into the task „Modules specification and assembly“. One of the decision parameters is, of course, the cost. Ten small modules were originally planned in the project. Since larger modules cause lower costs, they are preferred. With the new Sintbat batteries, twice as high energy contents can be generated per module compared to the currently used ones.

Regarding the larger module, three possible options were first identified, which fit into the current product portfolio of VARTA Storage ranging from 3.8-7.5kWh.

After defining the possible module topologies based on 26650 cells, it was discussed in the consortium that alternative cell types like 21700 and 18650 should be investigated as well. Thus, different module topologies for three different round cell types were compared. In order to obtain the capacity of a potential 18650 and 21700 Sintbat cell, the volume of all three types were calculated and based on this the volume factors compared to the 26650 cells were identified. By considering these factors as well the envisaged 26650 capacity, the capacities for the 18650 and 21700 were derived.

Taking into account the maximum upper limit of 60V, the number of cells connected in series and in parallel was determined. Moreover, this module voltage allows an integration into existing storage systems of VARTA Storage. Based on the requirement, the design of the battery module was worked out by Varta Storage. The size of the module is based on a width of 19 inch which is standard for many battery racks and also used for VARTA product lines.

WP 7 Life Cycle and Health Risk Assessment

As resource conservation and recycling are major key criteria for an ecologically sustainable lithium-ion-battery supply, we are currently strongly focussing this issue together with industrial support.

Due to material criticality and resulting cost intensity, recycling issues are also of particular interest regarding economic sustainability. In times of rising resource and energy prices as well as increased environmental regulations, cost models are needed which can safely and reliably calculate the associated costs. Especially for a fair comparison of products with different capital, operation and maintenance costs, the LCC method (Life Cycle Costing) offers a well-founded and holistic approach.

Thus, in parallel to our LCA activities, LCC analyses are currently being carried out to identify cost drivers, savings, future environmental costs (in respect of climate change, acidification, eutrophication, land use or other measurable impacts) as well as to estimate the future consumer acceptance and achievable market shares.

Project Progress

WP 8 Dissemination, Exploitation and Business plan

One focus of the work was the identification of good practices or lessons learned in other words. Each Work package leader is in charge to collect their good practices. As a team, 10 scientific-technical categories were identified and the respective project results assigned and summarized.

Ultimately, a catalogue will be derived which could be shared with the EU, industry and the scientific community. The aim is to disseminate good practices, for example in workshops, open days, public seminars or using similar instruments.

The Sintbat project was selected as a success story of European research funding in the field of materials research under the FP7-NMP and Horizon 2020-NMP programmes and will be published soon in a BMBF (Department of Materials Innovations, Batteries) brochure.

General Assembly Meeting

Date: 12th-14th March 2019 Location: Munich, Germany

For the seventh General assembly meeting of Sintbat, all project partners gathered near Munich from the 12th-14th of March. This time the meeting place was chosen because of its good accessibility. Despite the fact that the nearby Munich and the Bavarian surroundings were certainly inviting to a supporting programme, the sole focus was on coping with the full work schedule.
The meeting had two main components. On the one hand the presentation of the results in the respective work packages and a detailed discussion about it, on the other hand the work on a follow-up project.

The start at lunchtime gave most participants the opportunity to travel directly to the event and so, after a little refreshment, the meeting commenced, as usual, with a welcome and the outline of the agenda. The workload for this afternoon session consisted of the work packages two to five, which were vividly discussed after the presentations. In Cell Benchmark, Advanced Electrode Development and Balancing, Aging Mechanism and Tailoring of Electrolytes, Modelling, Simulation and Experimental Validation as well as in Implementation, Cell Development, Analysis and Safety Tests significant development successes could be achieved.

The morning session next day was dedicated to the work package 6, Prototyping and Demonstration, naturally gaining full velocity in the second part of the project. Life Cycle and Health Risk Assessment was next and showed


(c) Shutterstock, Sergey Nivens

the possibilities that lie in a thorough analysis and derivations based on it. The work packages Dissemination, Exploitation and Business Plan as well as the Project Management formed the conclusion of the presentations. Over the course of the project, a trustful cooperation has developed, which provides an excellent basis for further project success in the last third of the project term.

The consortium is jointly aiming for a follow-up project and sees good opportunities, as the roadmap for the development of European energy storage technology by 2030 (EASE/EERA) attaches the greatest importance to energy storage for the European climate targets. Consequently, the remaining time was devoted to concept development and the work content to be introduced, in which the exchange with the Industrial Advisory Board could be integrated.

The participants left the event with the feeling that they had done an effective job and that they would continue their work at the next meeting in Grenoble, where CEA will be the host.

Newsflash

New solid electrolyte has properties such as liquid electrolyte

Batteries with solid electrolytes in which lithium ions move between the electrodes are a central object of research in solid-state battery research. The advantages of such systems over current lithium-ion batteries with liquid electrolytes are their higher energy density and safety due to their non-flammable components. What has been missing so far, however, are suitable materials with an ionic conductivity similar to that of liquid electrolytes. The researchers from TU Graz, TU Munich and the belgian Université Catholique de Louvain now claim to have found these materials.

The new ionic conductor with the molecular formula LiTi2(PS4)3 is a lithium titanium thiophosphate, hence the abbreviation LTPS. According to the researchers, LTPS shows an unusual crystal structure that does not offer any energetically strongly favored dwelling places for the ions.
The researchers found clear indications of two jump processes. In the structure of LTPS, the lithium ions can jump back and forth on ring-shaped paths and from one ring to the next. The last step, the inter-ring process, enables long-range ion transport.

Even at extremely low temperatures, the intra-ring jumping processes of the lithium ions could not yet be completely eliminated. Even at 20 Kelvin (minus 253 degrees Celsius), the lithium-ions are still mobile and not locked in a potential well in the very flat energy landscape of LTPS.

For more information follow the link.

Eco Combat project develops sustainable high-voltage batteries

In the Eco Combat project, ten partners have developed a battery cell that manages with 20 percent less cobalt and around 66 percent less fluorine.

The aim of the project was to combine environmentally friendly and high-performance materials for the next generation of high-voltage lithium-ion batteries and to improve their production. The main task of the Eco Combat project was to replace conventional, often expensive, rare or even critical materials such as cobalt in the electrodes and fluorine in the electrolyte.

Pilot production of novel battery electrodes (©P.Avavian / CEA)

In the framework of the project, ormocercoated, low-cobalt NMC 622 and a special high-voltage electrolyte based on the conductive salt lithium-bis(fluorosulfonyl)imide (LiFSI), which can be operated stably even at high voltages, were adapted to the high battery requirements and optimised.

Newsflash

This has led to a reduction of the cobalt content by about 20 percent and a reduction of the fluorine content in the electrolyte by two thirds. The researchers report that energy and power density could be significantly increased by using structuring additives such as Porocarb and Graphistrength. The sustainable materials were processed in common pouch cells, which showed up to 50 percent higher cycle stability (at 4.3 V) the industrial reference samples in the comparative test.

For more information follow the link.

Batteries made of plastic - Priority programme bundles battery research in Germany

The DFG (German Research Foundation) has announced the establishment of the "Polymer-based Batteries" priority programme, which will receive over 12 million euros in funding over the next six years. The Priority Programme will bring together locally dispersed activities in Germany and promote research into new organic and polymer materials for energy storage.

The research programme will focus on polymer batteries, which should open up new applications that cannot be addressed with the "old" battery concepts used to date. The innovative plastic-based battery systems have numerous advantages over the established classic lithium-ion batteries. Thanks to the use of organic and polymer materials, advantages can be achieved with regard to the energy required for production, recycling and application, for example as flexible and printable batteries. Especially batteries with polymers as active electrode material offer the possibility to replace the often used heavy metals in many applications and are therefore more sustainable.

In addition, polymer-based batteries can have unique properties, such as charging within minutes or even seconds, processability of the electrodes at comparatively low temperatures, which improves the carbon balance, and the printability of the batteries.

Five areas are being investigated by the partners involved in the priority programme "Polymerbased batteries": modelling for the identification of promising materials, a basic understanding of the (redox) processes taking place and possible side reactions, the design and synthesis of redoxactive polymers, the development of new electrolytes, the detailed characterization for the elucidation of the processes taking place in composites.

For more information follow the link.

Thin film battery with printed polymer-based electrode. (©Jan-Peter Kasper/FSU)

Newsflash

European initiative Battery 2030+: developing batteries of the future, including Artificial Intelligence

The ten-year European research initiative Battery 2030+ brings together leading scientists and companies from across Europe to make decisive advances in battery science and technology. The Battery 2030+ preparatory project started in March and lays the groundwork for this initiative on battery technologies of the future.

The aim of Battery 2030+ is to develop more powerful batteries and cutting-edge technology for European industry. Batteries are among the key technologies when it comes to storing energy sustainably from renewable sources and thus reducing carbon dioxide emissions. This requires new generations of extremely powerful, reliable, safe, sustainable and cost-effective batteries. The consortium of Battery 2030+ and the Karlsruhe Institute of Technology (KIT) comprises five universities and eight research centres across Europe, including the Celest research platform, the University of Ulm and the ZSW.

Including artificial intelligence:
The initiative be involved in all key topics, especially accelerated materials development. Battery 2030+ is particularly about fundamentally changing the way research and development has been conducted so far, for example by including artificial intelligence (AI). Based on AI-based data analysis of many individual samples produced by robots, the latter could learn how certain materials behave and answer the question of how a material must be designed in order to obtain certain properties.

Special focus on sustainability:
The Battery 2030+ research initiative will establish a platform that can discover new battery materials more quickly through machine learning and artificial intelligence. Of particular interest are the interfaces in the batteries, where reactions take place that affect the service life of the battery. The aim is to design intelligent functions for the entire system right down to the battery cell level and pay particular attention to the issue of sustainability.

For more information follow the link.

Batteries repair themselves

The service life of lithium-ion batteries depends on the number of charging cycles. No electric vehicle manufacturer currently guarantees a charging capacity of more than 80 percent for more than eight years. This is due to small cracks that form as the electrodes expand and shrink during charging. Atsuo Yamada and his colleagues at the University of Tokyo have now discovered a process that allows the electrodes to repair themselves (DOI: 10.1038/s41467-019-09409-1).

Previous material layers in the electrodes are only held together by the relatively weak Van der Waals forces. The Japanese researchers have now developed an electrode material based on sodium ruthenium oxide in which the layers are bound together by the much stronger Coulomb force. As a result, the layer structures were not only more stable during the charging cycles, minor damage even repaired itself.
However, the electrodes are not suitable for lithium ions, but only for the slightly heavier sodium ions. They are not yet ready for series

Newsflash

production. Theoretically, they offer at least similar capacities as today's lithium-ion systems with a drastically extended shelf life.

For more information follow the link.

Event: Battery Storage Masterclass
18th-20th November 2019, Genk, Belgium

Innovation in battery storage solutions is disrupting the industry today and will continue to radically transform the energy landscape in the coming years and decades. Staying ahead of the field and preserving competitive edge means deep understanding of emerging technologies. And the ability to spot the opportunities – as well as the challenges – that face you and your business.
The Battery Storage Masterclass in Genk is led by InnoEnergy and delivered in partnership with some of Europe's top authorities in sustainable energy and battery storage. The Masterclass provides you with the next-generation knowledge and insights of the next generation, the innovation mindset and the vision to:

- Assess emerging solutions and understand their potential across the entire battery storage value chain
- Spot the right storage solution for your organisation
- Leverage new investment opportunities
- Design and execute competitive B2C or B2B business models
- Foresee future markets, evaluate emerging threats, brace for change and exploit new market openings
- Lead innovation at your organisation

Newsflash

Energy Symposium 2019

The 6th Energy Symposium of the Energy Innovation Europe (EIE) network takes place on 08th and 09th of October 2019 in Graz (Austria).

This vears event focusses on
Integrated Energy Systems in Urban Areas

The international symposium starts the day bevor with an interesting evening programme with:
• Guided Visit Science Tower Graz Presentation of Smart City Graz by Stadtbaudirektion Graz
• Get-together & Dinner at Landhauskeller Graz where you can

Pitch your idea! Opportunity to introduce yourself and your project idea for efficient networking

In addition to expert presentations you can actively participate workshops in parallel sessions:
• Regional Energy Supply Concepts of the Future
• Smart District Development in the Context of Current Urban Development Requirements
• Hydrogen: Technologies for Decentralized Energy Storage and Supply
• Active Facades and Windows and Phase-Change Heaters for Efficient Solar Energy and Ambient Heat Harvesting

Conference programme, registration and further information:

www.energy-symposium.eu

We are pleased to offer a discount to all readers of the Sintbat newsletter.

Get your personal promotion code here:

Contact:
Mr. Andre Nadolny
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Event Watch

AsiaSolar PV Expo
AsiaSolar Photovoltaic Innovative Technology Exhibition & Cooperation Forum
12.10. - 13.10.2019 Hangzhou, China

Energy Symposium
08.10. - 09.10.2019 Graz, Österreich

North America Smart Energy Week
23.09. - 26.09.2019 Salt Lake City, USA

EU PVSEC - European Photovoltaic Solar Energy Conference and Exhibition
09.09. - 13.09.2019 Marseille, France

Power Efficiency.Energy-Saving.Innovative Technologies and Equipment
01.10. - 04.10.2019 St. Petersburg, Russian Federation

Solar & Storage Live (formerly Solar Power UK)
17.09. - 19.09.2019 Birmingham, Great Britain

Energy Storage North America (ESNA) - Conference and Expo
05.11. - 07.11.2019 San Diego, USA

Intersolar India
The leading energy storage exhibition to secure India's energy supply
27.11. - 29.11.2019 Bangalore, India

ENERGY STORAGE EUROPE - Fair and Conference
10.03. - 12.03.2020 Düsseldorf, Germany

eMOBILITY WORLD - Sustainable Mobility Exhibition
The leading trade exhibition dedicated to energy efficient solutions for the
18.03. - 22.03.2020 Friedrichshafen, Germany

Energy / HANNOVER MESSE
Leading international trade fair for integrated energy systems and mobility
20.04. - 24.04.2020 Hannover, Germany

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 Ångstrom 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.

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.

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.

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 AG

EurA 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 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

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.

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