OCTOBER 2nd, 2018
ACROPOLIS, NICE FRANCE

Beyond Lithium-Ion Workshop

From Current Research to Industrial Application

Organized by:

Organized in the framework of:

These projects have received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements Nº 666157 and Nº 686646.

Beyond Lithium-Ion Workshop

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Welcome to the Beyond Lithium-Ion Workshop.
This event is dedicated to the exchange of knowledge from current running European collaborative projects and industrial development dedicated to post lithium for stationary or electrical mobility. It is organised in the framework of ALISE and ALION Horizon 2020 founded projects developing post-lithium batteries. The event will be moderated by Deborah Creamer, Senior Consultant and Director at Optimat.
The program is composed of the following 3 sessions:

- SESSION 1
  EU-Funded Research on Post Lithium-Ion: Ca, Mg, Li-S, Metal Air, Solid State
- SESSION 2
  Technologies manufacturing opportunities and barriers: Cell manufacturers
- SESSION 3
  Technologies integration opportunities and barriers: EV, stationary and aeronautic integrators

The workshop will take place on the first day of the Batteries Conference (more info www.batteriesevent.com).

EU RESEARCH

08h30 - 09h00 Registration

S1 EU-FUNDED RESEARCH ON POST LITHIUM-ION: Ca, Mg, Li-S, Metal Air, Solid State

09h00 - 9h10	Introduction	Optimat	Deborah Creamer
09h10 - 9h30	The challenging path towards Ca metal anode based batteries	ICMAB	Alexandre Ponrouch
09h30 - 9h50	Advances on Aluminium electrochemistry for battery application	Albufera Energy Storage	Joaquín Chacón
09h50 - 10h10	Lithium sulfur battery research progress in HELIS project	National Institute of Chemistry	Robert Dominko
10h10 - 10h30	**Q&A Session 1: EU-Funded Research on Post Lihiuum (Part I)**		
10h30 - 11h00	Coffee Break, Posters & Demonstrators		
11h00 - 11h20	Advanced Lithium Sulphur battery for xE	Leitat	Christophe Aucher
11h20 - 11h40	Lithium Air Batteries: Can this be the future for Electric Vehicles?	Politécnico di Torino	Silvia Bodoardo
11h40 - 12h00	ZAS Zinc Air Secondary innovative nanotech based batteries for efficient energy storage	SINTEF	Mari Juel
12h00 - 12h20	Advanced Lithium-metal electrodes for post lithium-ion technologies	CEA	Céline Barchasz
12h20 - 12h40	**Q&A Session 2: EU-Funded Research on Post Lihiuum (Part II)**		
12h40 - 13h40	Lunch Break, Posters & Demonstrators		

INDUSTRIAL DEVELOPMENT

S2 TECHNOLOGIES MANUFACTURING OPPORTUNITIES AND BARRIERS: Cell manufacturers

13h40 - 14h00	Organic redox-flow batteries for stationary energy storage	Jena Batteries	Tobias Janoschka
14h00 - 14h20	Evolution of Zinc-Air primary batteries into new cost-effective rechargeable energy solutions	CEGASA	Igor Cantero
14h20 - 14h40	Toward Longer Life, High Energy Li-S Batteries	OXIS Energy Ltd	Ulderico Ulissi
14h40 - 15h00	Lithium metal polymer batteries for automotive and energy storage applications	SEEO	Hany Eitouni
15h00 - 15h20	Current status of a 1 Ah class solid-state lithium metal secondary battery: Cycle and Rated capability	Samsung	Yuichi Aihara
15h20 - 15h40	**Q&A Session 3: Technologies manufacturing opportunities and barriers**		
15h40 - 16h10	Coffee Break, Posters & Demonstrators		

S3 TECHNOLOGIES INTEGRATION OPPORTUNITIES AND BARRIERS: EV, stationary and aeronautic integrators

16h10 - 16h30	Lithium Metal Polymer battery: its specificities and its applications	Blue Solutions	Marc Deschamps
16h30 - 16h50	Ultralight LiS cells for space applications: opportunities and barriers	Ariane Group	Geraldine Palissat
16h50 - 17h10	How to achieve zinc-air battery competitivity for stationary Energy storage systems	Zinium	Emmanuel Benefice
17h10 - 17h30	**Q&A Session 4: Technologies integration opportunities and barriers**		

17h30 - 18h00 Closing Remarks

PRESENTER

Deborah Creamer
Director & Senior Consultant

optimat

Deborah Creamer is a Director at Optimat, one of Europe's leading niche strategy consultancies. Deborah has 20 years' consultancy experience following a career in materials R&D where she focused on high performance metallic materials, polymers and composites. She specialised in strategic industrial analysis, focusing on high technology sectors and applications, and developing a robust evidence base to support strategic and economic development and policy making. Her main area of technical expertise is advanced materials and nanotechnology with particular emphasis on their application in advanced batteries and energy storage. She acts as an expert monitor for EC funded projects and provides expert advice to the EC in termsof policy goals and future research needs.

SPEAKERS

Alexandre Ponrouch
Post-Doctoral Researcher
ERC Grant
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Dr Alexandre Ponrouch received his Master Degree in Electrochemistry from Paul Sabatier University (Toulouse, France) and his PhD from the Institut National de la Recherche Scientifique (INRS-EMT, Canada) in 2010 working on electrodeposition of metals, alloys and oxides for application in fuel cells and supercapacitors. Then he moved to the Institut de Cíencia de Materials de Barcelona (ICMAB-CSIC, Spain) as a postdoctoral fellow working on electrode and electrolyte formulation for Li and Na-ion batteries. In early 2017, in the framework of an ERC starting grant, he set up a new laboratory in ICMAB dedicated to multivalent cation (Ca and Mg) based rechargeable batteries.

ICMAB
INSTITUT DE CIÈNCIA DE MATERIALS DE BARCELONA
EXCELENCIA SEVERO OCHOA

SPEAKER

Igor Cantero

R&D Director

PhD in Chemistry from the University of the Basque Country, author of 40 articles published in specialized scientific-technical journals and 5 invention patents extended internationally, as well as more than 50 papers and oral presentations at national and international meetings. In 2000 I started the New Technologies area of the R&D Department of Celaya, Emparanza y Galdos (CEGASA) and in 2012 I became head of the R&D department of the CEGASA Group. Since 2015 I'm the Chief Technology Officer of CEGASA Portable Energy. As head of the technical area of the company, I have worked in the development of different storage technologies such as primary lithium batteries, lithium-ion batteries, fuel cells, supercapacitors or advanced zinc-air, lithium-sulfur or lithium-air batteries.

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Céline Barchasz

Research Engineer

Dr. Céline BARCHASZ received her Ph.D. in materials science and electrochemistry about the "development of lithium/suphur battery technology" in 2011 from Grenoble University (France), in collaboration with LEPMI laboratory (Grenoble – France). Since 2011, she works as a Research & Development engineer in the battery materials laboratory in CEA-LITEN (Grenoble – France). She is the author of
14 papers and has filled 11 patents. She is currently involved in different projects in the field of lithium batteries, in particular for post lithium-ion batteries.

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SPEAKER

Tobias Jonoschka
Co-Founder

Tobias is co-founder of JenaBatteries GmbH, where he manages R&D actives for the company's award-winning energy storage technology. He holds a diploma in chemistry and a master of science in business administration from Friedrich Schiller University. Tobias' current focus is to develop economically feasible materials for redox-flow batteries (RFB) as well as intellectual property management. In recognition of his contributions towards the field of organic energy storage, including thirty scientific papers in internationally acclaimed journal as well as several patents, he was awarded the IQ Innovation Award in the category chemistry and polymers (2015) and the Thuringian Research Prize for top performance in applied research (2017).

JENA BATTERIES

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Robert Dominko
Research & Associate Professor

Robert Dominko is employed at the National Institute of Chemistry in Slovenia, as a research professor and at the University of Ljubljana. His research interests are in the field of materials science and electrochemistry, more precisely in electrochemical systems for energy conversion and storage, with main activities on the field of modern battery systems. He has published more than 110 per reviewed papers (H index 45). He is a deputy director of Alistore ERI and a coordinator of EU project with acronym HELIS. HELIS project is aim to develop Li-S batteries and it is addressing issues connected with the stability of the lithium anode during cycling, engineering of the complete cell and questions about LSB cell implementation into commercial products.

NATIONAL INSTITUTE OF CHEMISTRY

Abstract: page 13

Christophe Aucher
Principal Researcher

LEITAT managing technologies

Christophe Aucher holds a doctorate in Energy and Material Sciences from both the University of Québec at Montréal and the Material Institute of Nantes. His research has been principally focused on the study and improvement of lead-acid batteries, lithium ion and supercapacitors. He is leading the Energy Storage Team from the Energy & Engineering Business Unit, where post lithium ion technologies and 3D micro-printed devices are developed. The Energies Storage Team from LEITAT is currently involved in National and European initiatives for electrical mobility, stationary and wearable electronics.

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Mari Juel
Senior Research Scientist

SINTEF

Dr. Mari Juel has been the coordinator for the ZAS project (Zinc Air Secondary innovative nanotech based batteries for efficient energy storage). She took her PhD in surface science in 2007 in which she studied the formation of bimetallic surface structures. In SINTEF Mari Juel has worked with development of renewable energy solutions and has been actively involved both in activities related to crystallization for silicon for PV application and development of new battery technologies. She has long experience as a project manager and has lead central activities in both European and National R&D projects.

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Silvia Bodoardo
Associate Professor

Silvia Bodoardo is professor at Politecnico di Torino. Her research activity in the Electrochestry Group is mainly focused on the study of materials for Li-ion and post Li-ion batteries, i.e. Li-S, Li-air. She participated in 6 EU funded projects (coordinator of STABLE project) and several national and regional ones. Silvia organized several conferences and workshops on materials with electrochemical application and was Chair woman at the launch of the Horizon Prize on Innovative Batteries. She is author of more than 80 papers on peer reviewed journals.

POLITECNICO
DI TORINO

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Joaquín Chacón Guadalix
Chief Executive Officer

Joaquín Chacón graduated in Chemistry from the Autonomous University of Madrid (AUM), then fulfilled an MBA at IEDE and finalised his studies with a PhD in electrochemistry at the AUM. He was managing director of Electro Mercantil Industrial from 2000-2003 and then managing director of Saft Batteries until 2012. Since 2013, he is chief executive officer of Albufera Energy Storage, company specialized in aluminium electrochemistry for energy storage applications. Beneath that, he is active is various associations such as the Spanish association of batteries and energy storage (AEPIBAL). He is also vice-president of SECARTYS, the Spanish association for the internationalization of businesses, and is active other organizations.

albufera Energy Storage

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Emmanuel Bénéfice
Chief Executive Officer

Emmanuel Bénéfice brings a strong 25-year experience in the energy sector. He has first worked as an engineer in the USA and in France, and as a project manager. He joined the leading energy company EDF, where he led the project for the opening of the electricity and gas residential market in France. He has been Customer Service and Sales VP and also Chief Marketing Officer for EDF Entreprises. He has been a member of the board of several innovative startups and SME in the energy sector. He firmly supports the vision of a carbon-free world, through the development of renewable energies and electricity storage. Emmanuel is graduated from the Ecole Polytechnique in Paris. He also holds a master degree from Telecom ParisTech University.

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Géraldine Palissat
Expert in Energy Storage and Distribution

Géraldine Palissat received her Master Degree in Electrochemistry from Paul Sabatier University (Toulouse, France) in 2004 working on carbon materials for application in supercapacitors. She worked 7 years in materials R&D where she focused on high performance inorganic materials for application in supercapacitors, batteries and fuel cells. She is graduated from Ecole d'Ingénieur CNAM (Paris, France) in 2011; she has an engineer diploma in composite materials. She joined Ariane Group in 2012, and acts as an expert in energy storage and distribution for aerospace and aeronautics. Her main area of technical expertise is advanced batteries technologies (advanced lithium-ion, lithium-sulphur …), high energy density supercapacitors and their hybridization.

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SPEAKER

Hany Eitouni

Chief Technology Officer

Dr. Eitouni has more than 15 years' experience with polymer materials with specialized expertise in ionic transport through polymers. In 2007 Dr. Eitouni co-founded Seeo, a battery startup company focused on the development and commercialization of polymer solid state battery technology. The technology, which was originally developed at Lawrence Berkeley National Laboratory, has won numerous awards such as the R&D100 Award and the Going Green 100 Award. Additionally, Dr. Eitouni has been recognized as an innovator in the energy field. In 2010, he was selected by MIT's Technology Review as one of the country's top 35 innovators under age 35 and was granted the prestigious TR35 Award. At Seeo, Dr. Eitouni has successfully led the effort to design, synthesize, and optimize Seeo's proprietary electrolyte polymers with improved properties. He is an inventor on more than 50 granted patents. He received a PhD from University of California, Berkeley and a BS from University of Texas, Austin, both in chemical engineering.

SEEO

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Ulderico Ulissi

Research Scientist

Ulderico Ulissi is the technical lead for the ALISE project at OXIS Energy. After his MSc in industrial chemistry at "Sapienza", University of Rome, he moved to the Karlsruhe Institute of Technology (KIT) where he completed his PhD in chemistry, in 2017. His main expertise is on solid state and high energy lithium-ion batteries, with a focus on negative electrode materials. He his author of 11 peer-reviewed papers and 2 patents.

OXIS ENERGY

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SPEAKERS

Marc Deschamps
Electrochemical & Tests Manager

Dr. Deschamps has more than 25 years' experience in lithium battery field. He received his PhD of electrochemistry at Grenoble University in 1995 studying "Contribution to the study of the carbon-lithium electrode with polymer electrolyte". After his PhD, he spent around 3 years in Japan for Mitsubishi Chemical Corporation working on the development of new liquid electrolytes for Li-ion batteries. He joined Bolloré in 1999 and is the leader of the electrochemical group since. He develops and enhances the Lithium Metal Polymer Battery (LMP) for Bolloré, Batscap and BlueSolutions (Bolloré's subsidiary companies). In 2011 the LMP became the first all solid secondary battery with Lithium Metal entering the mobility market (blue Car and blue Bus). He has strong knowledge on raw materials, battery design and on battery optimizations for applications. He also participates actively for the tuning of all solid process. He is author of more than 30 patents.

BlueSolutions Bolloré

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Yuichi Aihara
Principal Reseacher/ Director

After graduating from Tokai University in 1991, Yuichi Aihara joined Yuasa Battery Corp. (today known as GS Yuasa) and was involved in the polymer based solid-state batteries over 10 years. He also completed his PhD in Engineering awarded by Mie University in 2001. In Samsung R&D Institute Japan, he worked on the development of intermediate temperature PEM-FCs for 7 years, and now he leads the all-solid-state battery project at SRJ since 2010.

SAMSUNG

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ABSTRACTS

Alexandre Ponrouch - ICMAB

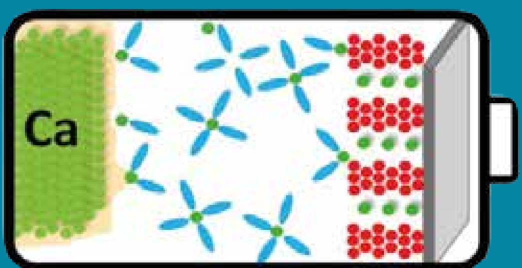
The challenging path towards Ca metal anode based batteries

Various metals have been used as battery anodes in electrochemical cells ever since the birth of batteries with Volta's pile and also in the first commercialized primary (Zn/MnO2, Leclanché 1866) and secondary (Pb/acid, Planté 1859) batteries. The first Li-MoS2 cells, employing Li metal anodes, with specific energies two to three times higher than both Ni/Cd and Pb/acid cells were withdrawn from the market after safety issues related to dendrites growth were observed. In contrast to Li and Na metal anodes, however, electrodeposition of Mg and Ca does not seem to be plagued with dendrite formation.[1,2] Pioneering work by Aurbach et al. in the early 1990's showed a surface-film controlled electrochemical behavior of Ca and Mg metal anodes in conventional organic solvent based electrolytes.[3,4] The lack of metal plating was attributed to the poor divalent cation migration through the passivation layer. Conversely, the recent demonstration of Ca and Mg plating and stripping in the presence of a passivation layer or an artificial interphase [1,5,6] has paved the way for evaluation of new electrolyte formulations with high resilience towards oxidation. However, several challenges remain to be tackled for the development of Ca based batteries.[7] Among these reliable electrochemical test protocols are needed. Also, as stronger cation-solvent and cation–anion interactions are present in divalent cation based electrolytes as compared to Li and Na systems, mass transport limitations are implied.[8] Here the reliability of electrochemical set-ups is discussed and a systematic investigation on the impact of the electrolyte formulation on the cation transport is presented.

References:

[1] M. Matsui, J. Power Sources, 196 (2011) 7048.
[2]. A. Ponrouch, C. Frontera, F. Bardé, M.R. Palacín, Nat. Mater., 15 (2016) 169.
[3] D. Aurbach, R. Skaletsky, Y. Gofer, J. Electrochem. Soc.138 (1991) 3536.
[4] Z. Lu, A. Schechter, M. Moshkovich, D. Aurbach, J. Electroanal. Chem. 466 (1999) 203.
[5] D. Wang, X. Gao, Y. Chen, L. Jin, C. Kuss, P. G. Bruce, Nat. Mater. 17 (2018) 16.
[6] S.-B. Son, T. Gao, S. P. Harvey, K. X. Steirer, A. Stokes, A. Norman, C. Wang, A. Cresce, K. Xu, C. Ban, Nat. Chem. 10 (2018) 532.
[7] A. Ponrouch, M.R. Palacín, Current Opinion in Electrochemistry 2018, doi.org/10.1016/j.coelec.2018.02.001.
[8] D.S. Tchitchekova, D. Monti, P. Johansson, F. Bardé, A. Randon-Vitanova, M. R. Palacín, A. Ponrouch, J. Electrochem. Soc., 164 (2017) A1384.

Figure:
Scheme of a Ca metal anode-based battery with the main problems/requirements outlined [7]



Metal anode
Need for SEI allowing for Ca^{2+} migration

Cathode
Ca^{2+} solid state diffusion
Need for reliable testing protocols

Electrolyte
Cation mobility (high transfer number)
Solvation shell (low desolvation energy)

Céline Barchasz - CEA

Advanced Lithium-metal electrodes for post lithium-ion technologies

Need of better energy storage systems is definitely a challenge for 21th century, and a lot of efforts have been devoted to post lithium-ion batteries. As a promising alternative to Li-ion, the use of lithium metal negative electrode is expected to bring major breakthroughs in terms of performances and key actors [1]. Indeed, the lithium anode will be key while developing high energy density post-Li-ion systems such as high energy cathode materials, solid-state systems, lithium/sulfur (Li/S) and lithium/oxygen batteries. In particular, Li/S system has been under intense studies for the last two decades, with a particular interest since 2010. Use of elemental sulfur as an active material allows for high theoretical specific capacity, while sulfur has also the benefit of being abundant, cheap and non-toxic as compare to cobalt-containing oxides [2]. It is now well admitted that cyclability of current Li/S cells is limited by the progressive electrolyte depletion and lithium metal consumption [3]. In turn, sudden death of Li/S cells is usually observed and correlated to the poor cyclability of the lithium metal anode in liquid-based organic electrolytes. At the same time, the challenge of mastering the lithium metal anode has already been solved by BlueSolutions with their solid-state Lithium Metal Polymer (LMP®) technology. Then, this presentation will review the remaining challenges of the lithium metal anode and possible strategies to address them, through current activities at CEA-LITEN including running collaborative projects.

[1] E. J. Berg et al., J. Electrochem. Soc., 162 (2015) A2468-A2475
[2] D. Eroglu et al., J. Electrochem. Soc., 162 (2015) A982-A990
[3] X.B. Cheng et al., Energy Storage Materials, 6 (2017) 18–25

Hany Eitouni - SEEO

Lithium metal polymer batteries for automotive and energy storage applications

Improving the energy density of Li-ion batteries is a key means to improving range in automotive applications, enabling a smaller footprint for distributed energy storage, and reducing battery costs; implementing advanced active materials is one of the main paths to improving energy density. Several new materials have been proposed for next generation batteries such as lithium metal anodes, Si anodes, high voltage cathodes, and high capacity cathodes. The rechargeable batteries for automotive and energy storage applications additionally require extended life and safety as compared to small batteries used in mobile applications. Meeting those requirements, however, while achieving high energy density presents additional challenges. Seeo has developed its unique solid-state DryLyteTM technology based on a non-flammable solid polymer, which serves as both separator and electrolyte. Seeo's DryLyte technology enables a new generation of high energy batteries that are safer, higher capacity, lighter weight with lithium metal anodes, and are more reliable than conventional Li-ion batteries. Additional hurdles for next generation batteries are manufacturability and cost. They are critical to realizing new technologies. Seeo has also demonstrated manufacturability by building 10Ah Li-LFP cells using Seeo's DryLyte polymer technology. Cells and modules are validated using automotive standard testing protocols and aging tests. We will present Seeo's DryLyte battery performance results. Seeo's DryLyte technology has also been applied to high voltage cathodes. In conventional Li-ion batteries, the liquid electrolyte needs to have a wide voltage stability range to be useable at both cathode and anode potentials, while our multiple solid electrolytes can be physically separated at the cathode and anode. Seeo is also developing 350-400 Wh/kg cells with our next generation polymer, DryLyte-LT. This new polymer electrolyte is capable of improved room temperature performance compared to conventional polymer electrolytes, which typically operate above 60°C. Additionally, the solid-state DryLyte-LT polymer can be processed into cells using conventional Li-ion manufacturing processes which do not rely on vapor deposition or extreme dry conditions like some ceramic-based cell processes do. We will present R&D data for these higher energy density cells approaching this target.
Co-authors: Hiroyuki Yumoto and Thorsten Ochs

ABSTRACTS

Robert Dominko - National Institute of Chemistry

Lithium sulfur battery research progress in HELIS project

Lithium sulfur batteries (LSB) are viable candidate for commercialization among all post Li-ion battery technologies due to their high theoretical energy density and cost effectiveness. Despites many efforts, there are remaining issues that need to be solved and this will provide final direction of LSB technological development. The remaining issues are mainly connected with optimization of electrolyte composition and quantity and with a stability of lithium anode during cycling. Besides that, questions related to cell ageing, safety aspects, recycling are still not well understood. Instability of lithium metal in the most of conventional electrolytes and formation of dendrites due to formation of high surface area lithium upon the deposition cause several difficulties. Safety problems connected with dendrites and low columbic efficiency with a constant increase of inner resistance due to electrolyte degradation represent main technological challenges. From this point of view, stabilization of lithium metal will have an impact on safety issues and long term stability. Stabilized interface layer is important from view of engineering of cathode composite and separator porosity since this is important parameter for electrolyte accommodation and volume expansion adjustment. Finally, the mechanism of LSB ageing can determine the practical applicability of LSB in different applications.

Acknowledgement:
This work is supported by the HELiS project which receives funding from the European Union‘s Horizon 2020 research and innovation program under Grant Agreement No 666221

Igor Cantero - CEGASA

Evolution of Zinc-Air primary batteries into new cost-effective rechargeable energy solutions

There are several technologies that compete for post-li-ion technology such as lithium-sulphur, sodium-ion, Zinc air, Ni-Fe or Mg. In general, the technological approach starts from laboratory cell research, passing through prototypes up to an industrial product. Usually, this last stage is the most complex because the industrialization issues are completely different to research challenges. Then the modifications required for these final adjustments often result in a significant loss of the improvements achieved at the laboratory level.

In CEGASA we are presenting the problem from the radically inverse point of view:

For more than 30 years we have been manufacturing several million batteries/year of industrial Zn-air batteries with excellent energy densities (377 Wh/Kg; 676 Wh/L) at very low costs (around 25 €/KWh). However, they are primary batteries with significant power limitations, which limits their use for certain market niches. This is the reason it is not a well-known technology.

Now, the ZAR (Zinc Air Rechargeable) project aims to achieve a post-lithium-ion battery starting from the already industrialized product, modifying it to meet the new requirements, some of which we already exceed widely (energy density, cost) which allows us to focus on the others: cyclability, power, durability. For this challenge, the CEGASA’s engineers will work in close collaboration with high qualified research centers as CIC Energigune and Tecnalia.

ABSTRACTS

Tobias Janoschka - JenaBatteries

Organic redox-flow batteries for stationary energy storage

In times of an ever-growing energy demand, the development of sustainable storage technologies requests more and more attention. Redox-flow batteries (RFB) have become a promising solution in the field of stationary energy storage because they can cope with the problems that arise due to the increasing deployment of volatile renewable energy sources and their integration in the power grids. Especially RFBs based on organic materials have proven to be promising alternatives to traditional battery metals, which are problematic regarding their production, disposal and operational safety. Developing such kind of safe and scalable organic RFB systems, the startup JenaBatteries GmbH is well positioned as an innovative company in the field of large-scale energy storage solutions. The company plans to serve the market with systems starting at a capacity of 40 kWh through an expanding network of qualified licensed partners. Its award-winning organic flow-battery does not use heavy metals or dangerous acids. Thereby, it contributes to a sustainable and efficient usage of renewable energy.

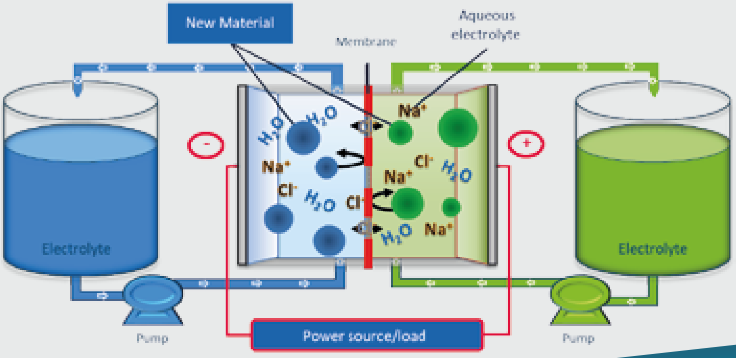


Figure:
Schematic representation of an organic redox-flow battery illustrating two storage vessels for aqueous solutions of organic, redox-active materials and a cell for energy conversion.

Joaquín Chacón Guadalix- Albufera Energy Storage

Advances on Aluminium electrochemistry for battery application

Among the challenges of the future, the cost of the energy storage systems is key to achieve the targets implemented for electric vehicle deployment and renewable energy sources integration. Looking at different aspects of the cost distribution in batteries, metals employed in the production of the electrodes are important to define direct and indirect cost drivers. Aluminium is the second element, after Lithium, with high specific energy and is abundant and cheap in the market. Furthermore, it does not create safety technology barriers which increase the cost of the protection systems associated to batteries. Albufera Energy Storage is researching since 5 years ago in different Aluminium battery based configurations including, Al-air, Al-ion and Al-S. This presentation shows a short summary of the main results obtained until today."

Mari Juel - SINTEF

ZAS - Zinc Air Secondary innovative nanotech based batteries for efficient energy storage

Zinc–air batteries (ZABs) are promising candidates for next-generation energy storage. Their basic operation principle is to electrochemically reduce oxygen gas from air and oxidize the zinc at the anode as sketched in Figure 1. By using the oxygen in the air as one of it reactants both the volume and the weight of the battery can be significantly reduced compared to Li-ion systems. The main component of the battery is zinc, which is an abundant and non-hazardous material and is produced in Europe. ZABs have also a superior operational safety characteristic. However, so far, the electrical rechargeability and calendar life of these batteries have been limited.
In order to increase the rechargeability, the degradation mechanisms of the electrodes and electrolyte during operation have to be understood and subsequently avoided. This includes avoiding inhomogeneous deposition of zinc, which can result in short-circuiting, passivation of active materials and balancing the liquid-air properties of the gas diffusion electrode in which the oxygen from the air is introduced into the battery.
The main objectives for the ZAS project have been to improve the performance (higher energy density, Wh/kg and Wh/L) and lifetime (number of complete charge/discharge cycles) of zinc-air batteries as well as reducing their cost (€/kWh). It has also been important to show the scalability of the technology from lab scale up to demonstration level. A market evaluation has been conducted assessing, as far as possible, the economics and market conditions with respect to introduction of zinc-air batteries into the stationary energy storage market in particular for large scale energy storage systems.

Acknowledgements:
This work is part of the ongoing EU funded H2020 project ZAS* (GA# 646186).

Géraldine Palissat - Ariane Group

Ultralight LiS cells for space applications: opportunities and barriers

Energy storage devices in many space applications are facing unique challenges. Most of such applications (Next Generation Launchers, reusable launch vehicles, human exploration missions…) depend on high performance, highly specialized batteries. Today, improved electrical power subsystems shall be developed to cope with the general trends observed in space applications with powerful payloads and increase of mission duration. All launcher batteries have one critical factor that engineers strive to optimize: specific energy. Lithium-sulphur batteries (TRL = 3-4) are an interesting candidate due to their high energy density (up to 400 Wh / kg) compared to current Li-ion batteries. However, a main challenge to meet our needs is to reach a very high number of cycles. Ariane Group is collaborating with OXIS Energy to develop Lithium Sulfur Batteries for space applications. Indeed, preliminary experiments enabled to show the interest of this technology for space applications. Early results and plans will be presented.

ABSTRACTS

Marc Deschamps - BlueSolutions

Lithium Metal Polymer battery: its specificities and its applications

Building on its industrial expertise, over twenty years of research and development, and two billion euros of investment, the Bolloré Group developed Lithium Metal Polymer (LMP) batteries. Started in the early nineties, R&D program at outlet on a first plant in 2001. The Bolloré Group launched manufacturing with the construction of this plant at its Pen-Carn site, located in Ergué-Gabéric, near Quimper. In 2009, with the viability of the technology proven, two production lines were deployed this site.

Metallic lithium is used as negative electrode. Lithium iron phosphate is the active material of the positive electrode. Between these two electrodes a polymeric film based on polyether served as separator and electrolyte. All these very thin films are dry which lead to a “solid state” batteries, conferring numerous advantages, notably in safety terms. Another common point of all these films is that they are created using extrusion techniques. Compared to coating, extrusion is a process that uses no organic solvent which confers advantages in term of price and/or at ecological level.

Mobility: The Bolloré Group develops, manufactures and markets a series of electric vehicles using LMP batteries: a range of electric cars and electric bus.

Stationary: the LMP batteries are used in different stationary application. ranging from several kWh to multiple MWh of stored energy and aimed at different end customers.

Silvia Bodoardo - Politecnico di Torino

Lithium Air Batteries: Can this be the future for Electric Vehicles?

Global warming and reduction of fossil-fuel supplies demand the pursuit of renewable energy sources and sustainable storage technologies. The rechargeable Li-air battery, coupling the light Li metal with the inexhaustible source of O2 of the surrounding air, represents an exciting opportunity. However, for many practical applications such as EV, air is the only viable option to supply the battery. In this context, moisture and gases other than O2 may cause side reactions and corrosion of the Li anode. We report a facile strategy to fabricate a highly effective O2 selective membrane based on highly hydrophobic fluorinated polymer and cyclodextrins. Several other major issues are responsible for the limited actual capacity and cycle ability. In principal, the high recharge potentials needed to decompose the insulating Li2O2 and the parasitic products formed from the electrolyte decomposition during cell discharge result in important energy losses. Palladium nanoparticles, due to the strength of O2 binding on the Pd surface, have very high intrinsic ORR activities in non-aqueous electrolytes. The use of carbon nanofibers (CNFs) as a support assures high surface area and high pores volume compared to other carbon-based materials. Pd doped mesoporous CNFs produced by electrospinning were used at the cathode of the Li-air pouch cell. Galvanostatic cycling tests in a potential/time controlled mode showed an outstanding cycling life superior to 1500h with more than 150 cycles.

ABSTRACTS

Christophe Aucher - Leitat

Advanced Lithium Sulphur battery for xE

ALISE is a pan European collaboration focused on the development and commercial scale-up of new materials and on the understanding of the electro-chemical processes involved in the lithium sulphur technology. It aims to create impact by developing innovative battery technology capable of fulfilling the expected market and characteristics from European Automotive Industry needs, European Materials Roadmap, Social factors from vehicle consumers and future competitiveness trends and positioning of European Companies. The project is focused to achieve 500 Wh/Kg stable LiS cell. The project involves dedicated durability, testing and LCA activities that will ensure the safety and adequate cyclability of the battery being developed and availability at competitive cost. Initial materials research will be scaled up during the project so that pilot scale quantities of the new materials will be introduced into the novel cell designs thus giving the following advancements over the current state of the art. The project approach will bring real breakthrough regarding new components, cell integration and associated architecture. New materials will be developed and optimized regarding anode, cathode, electrolyte and separator. Complete panels of specific tools and associated modeling will be developed from the unit cell to the battery pack. Activities are focused on the elaboration of new materials and processes at TRL4. Demonstration of the lithium sulphur technology was initially planned up to battery pack levels with vehicle level validation, by replacing the current lithium technology within the same volumetric and electrical limitation. The validation of the prototype is aiming to demonstrate to double the current driving range, corresponding to 100 km for PHEV. The potential behavior of the technology will be also assessed at the module level for BEV. ALISE is more than a linear bottom-up approach from materials to cell. ALISE shows strong resources to achieve a stable unit cell, with a supplementary top-down approach from the final application to the optimization of the unit cell.

Yuichi Aihara - SAMSUNG

Current status of a 1 Ah class solid-state lithium metal secondary battery: Cycle and Rated capability.

Nowadays, especially in automotive field, application of metal lithium has been attracted attention due to expectation of its high energy density above current LIBs. However, as we know, there are many issues to apply the lithium metal to the practical large scale batteries, e.g., cycle ability and safety issue based on dendrite formation, poorer exact energy density originated in excess thick lithium, and so on. In this presentation, we would like to show a great possibility on solid-state system, based on Li-LMO cells with some demonstration results given in our prototype batteries. Since the charge/discharge efficiency is always >99.9%, we can expect longer cycle than that in general liquid system. Also, 0.5C cycle was performed with a high loading level above 5 mAhcm-2 for the cathode. Those particular characteristics are essentially originated in solid-state nature. It is certain that the all-solid-state lithium metal secondary battery is a great candidate for the next generation battery.

Ulderico Ulissi - Oxis Energy

Toward Longer Life, High Energy Li-S Batteries

To improve the energy density of lithium-ion batteries alternative chemistries are required[1]. Among possible choices, those that involve the sulfur conversion reaction at the positive electrode are considered one of the most promising for the next generation of lithium batteries[2]. The conversion reaction of sulfur to form lithium sulfide is characterized by a high theoretical specific capacity of 1672mAh g-1, translating in a theoretical energy density of c.a. 2500 Wh kg-1, a value 2.5 times higher than that of commercial state-of-the-art Li-ion cells, using transition metal oxide based cathodes[3]. Lithium-Sulfur batteries based on this conversion reaction may therefore represent the power source of choice for the future. Unfortunately, its practical application is still hindered by a few issues that effectively limit both the practical energy density and the cycle life of lithium-sulfur batteries[4]. In conventional organic electrolytes the conversion reaction is, in fact, characterized by the formation of soluble polysulfides, resulting in the shuttling mechanism, a major issue causing low coulombic efficiency and high self-discharge rates[4]. This reaction is also associated with large volume changes. This can lead to cell failure, due to the alteration of the cathode and anode structure and the favored formation of lithium dendrites[5]. Strategies to enhance cycle life, while maximizing practical energy density, require careful engineering of each cell component. This includes the positive electrode (e.g., selection of conversion reaction catalyst, use of polysulfide adsorbents, binder selection); the negative electrode (e.g., lithium encapsulation, protection); the separator (e.g. functional barriers and polymeric membranes); the electrolyte (e.g. use of alternative solvents and salts, additives, solvent-in-salt). This presentation will focus on the recent technical advances at Oxis Energy Ltd, pioneer in the research and development of high-energy, longer cycle life lithium-sulfur batteries.

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Emmanuel Bénéfice - ZINIUM

How to achieve zinc-air battery competitivity for stationary Energy storage systems

Zinium is a French company created in 2016. It is developing prototypes and field demonstrators of ESS made of zinc-air secondary batteries, for households as long as for C&I BTM markets. Zinium is currently working on a future industrialization of its products. Based on the specific implementation of zinc-air technology imagined by the EDF Lab, the cells and modules by Zinium are designed to achieve goals of cost effectiveness and longtime duration. Zinium systems include a hybrid approach.

Beyond Lithium-Ion Workshop
From Current Research to Industrial Application
October 2nd, 2018, Acropolis, Nice, France

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These projects have received funding from the European Union´s Horizon 2020 research and innovation program under grant agreements Nº 666157 and Nº 686646.