NAMEC workshop on nanotechnologies & advanced materials for batteries

Project portfolio review (status on February 2017)

European Commission

EMIRI Bridging the Innovation Gap

1. ALION

ALION				
GENERAL INFORMATION				
Project acronym	ALION			
Project title	HIGH SPECIFIC ENERGY ALUMINIUM-ION RECHARGEABLE DECENTRALIZED ELECTRICITY GENERATION SOURCES			
GA number	646286			
Workprogramme	NMBP			
Starting date	01/06/2015			
End date	31/05/2019			
Budget (€)	7 223 551.25			
Grant (€)	7 223 551.25			
Coordinator	LEITAT			
Partners (research)	NTNU, UNIV. SOUTHAMPTON, CEA, TU BERLIN, DECHEMA-FORSCHUNGSINSTITUT			
Partners (industry)	TORRECID, ALBUFERA, ACCIONA, SOLVIONIC, CEG ELETTRONICA INDUSTRIALE, ACCUREC, VARTA MICROBATTERY			
Contact	eknipping@leitat.org			
Project website	http://alionproject.eu/			
PROJECT CONCEPT				
Thematic area	Post-lithium-ion batteries (aluminum-ion)			
TRL range	3-5			
Main challenge	Increasing battery lifetime and energy density			
Proposed material solutions	Pyrolytic graphite or manganese-based cathode materials, aluminum metal or aluminum alloy anode materials, ionic liquid electrolytes			
Technology risk	VERY HIGH Very new technology (1st patent in 2010), still at TRL 4 in 2017			
Main targeted market	Stationary energy storage			
Market risk	VERY HIGH There are already many technologies in the market			
Expected benefits for advanced material manufacturers in Europe	Manufacturing of less critical materials (no Co) and more accessible (Al vs. Li)			
Expected benefits for battery cell manufacturers in Europe	New technology potentially cheaper, new market possibilities			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Al-ion lab cell with energy of 150 Wh/kg and cycling life of 3000 cycles.			
Main result #2	Al-ion 6V stack cell using an aqueous system			
Number of publications	1			
Number of patents	0			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	400	140	Target too ambitious
Cell (pack) energy density (Wh/L)	750 (500)	300	90	Values not defined at the beginning
Cell (pack) power density (W/kg)	700 (470)	500	50	
Cell (pack) power density (W/L)	1500 (1000)	320	32	
Cycle life to 80% DOD	1000-5000	3000	3000	
Targeted pack cost (€/kWh)	90			
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Help is needed for new technology battery cell up-scaling. Generally the cell manufacturers will not introduce the fabrication of new battery cells in their production line in the frame of the project. A solution has to be found to enable the production of cells at pilot scale.			

2. ALISE

ALISE	
GENERAL INFORMATION	
Project acronym	ALISE
Project title	Advanced Lithium Sulphur battery for xEV
GA number	666157
Workprogramme	NMBP
Starting date	01/06/2015
End date	31/05/2019
Budget (€)	6 899 233
Grant (€)	6 899 233
Coordinator	LEITAT
Partners (research)	IK4 CEIT, FRAUNHOFER IWS, TU DRESDEN, POLITO, CRANFIELD UNIVERSITY
Partners (industry)	AVICENNE, FICO-TRIAD, OXIS, SEAT, SOLVIONIC, VARTA MICROBATTERY, C-TECH INNOVATION, DARAMIC, IDNEO, WILLIAMS ADVANCED ENERGY
Contact	caucher@leitat.org
Project website	http://www.aliseproject.com/
PROJECT CONCEPT	
Thematic area	Post-lithium-ion batteries (lithium sulfur)
TRL range	3-6
Main challenge	**Double the cell gravimetric energy density** (from 250 to 500 Wh/kg). Reach **EUCAR hazard level nº4** (no flame, no explosion).**Up-scale materials and processes** for the production of enough cells (>1000 units) for modules and full battery packs construction according to test catalogues (electrical, mechanical safety test). **New algorithm model** for SoC and SoH estimation and ready for BMS adapted to LiS complex behavior. Other challenges such as volumetric energy density, power, cycle life and aging are taking in account in ALISE project.
Proposed material solutions	**Tailored cathode** to optimize S % utilization and content (both at 80% to reach theoretically >400Wh/kg). **Protected lithium anode** to allow longer cycle life. **Cell manufacturing components and processes optimization** impacting on optimized electrolyte content, higher Wh/L, higher C-rate, longer cycle life...
Technology risk	HIGH OXIS is the **single LiS cell manufacturer in Europe** able to produce such a quantity of LiS cells within these performances. Insofar **no model available for LiS and BMS** for EV application. **Limitation in Wh/L** impacting on car integration (module, pack).
Main targeted market	Electric vehicles
Market risk	MEDIUM Insofar there is no technology able to reach the present Wh/kg proposed by LiS and may be currently applied to non-automotive market in replacement of lithium ion. Safety aspect (much more than NMC or NCA) and the use of S in exchange to Co are clearly two strong advantages of the LiS technology in term of complete life cycle cost from the production, European dependency of raw materials, to the recycling. On the other hand, LiS is not at the maturity level of lithium-ion and not so versatile in terms of volumetric energy density, cycle life (aging) and power (low C-rate) which is limiting its use with respect to low electrical hybridization (PHEV) and EV.
Expected benefits for advanced material manufacturers in Europe	The work done in ALISE project is involving membrane separator (DARAMIC) and electrolyte (SOLVIONIC) manufacturers who are screening new options for strengthening the material manufacturing from Europe and beyond the lithium ion USA/Asian market. Mostly all materials and originals processes proposed in ALISE aims to allow the production from Europe (C, S, lithium, electrolyte, separator...).
Expected benefits for battery cell manufacturers in Europe	To allow the full production of a new and different technology 100% made in Europe.

PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Protected lithium anode allow to double the cycle life (from 50 to 100, 80% DoD and 80% BoL, C/5)			
Main result #2	Tailored cathode allowing 1200 mA.h/g of S and 400 Wh/kg of 10 A.h pouch cell			
Main result #3	Hundred of prototype cells (290 Wh/kg) designed and produced for first module assembly			
Number of publications	1			
Number of patents	0 (3 currently under studies)			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	500	290	Achieved for small series production. 400Wh/kg of 10Ah cell has been validated at laboratory scale
Cell (pack) energy density (Wh/L)	750 (500)	550	320	Achieved for small series production. 440Wh/L of 10Ah cell has been validated at laboratory scale
Cell (pack) power density (W/kg)	700 (470)	1000	<100	Considering C/5 for 100 cycles at 80% DoD up to 80% BoL. 1C is achievable with lower cycles life and lower DoD
Cell (pack) power density (W/L)	1500 (1000)	1100	<100	Considering C/5 for 100 at 80% DoD up to 80% BoL. 1C is achievable with lower cycles life and lower DoD
Cycle life to 80% DOD	1000-5000	2000 cycles at 50% DoD and 80% BoL	100 cycles at 80% DoD and 80% BoL	C/5, metallic lithium anode is key bottleneck
Targeted pack cost (€/kWh)	90	300		
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Specific to LiS or other post-lithium-ion technology, **research at the material level is needed**. For LiS, lithium metallic anode production and protection need to be improved. Silicon does not make sense due to Wh/L and breathing of the cell. Electrolyte and S/C tailoring are essential for volume optimization, performances and safety.			
Recommendation #2	**Assumption on material up scaling must be considered**. New materials or process need several steps of validation from laboratory, prototype and real integration. Reproducibility, timing and production volume from grams to thousands of kilos, are very difficult to be implemented in a project from powder to power. New materials involve new synthesis and new manufacturing processes which by definition are not implemented in current production lines.			
Recommendation #3	**Knowledge and knowhow for cell manufacturing is needed.** Due to the availability of the materials and components (quantities and price) it is often considered to use commercial goods, to ensure to get the same performance at the same price (see recommendation #2). Manufacturing makes the difference using original processes allowing reducing production steps, increasing the reproducibility then cell performance, and decreasing the scrap, the energy cost, and infrastructure. Research on manufacturing must be proposed not only for conventional lithium-ion manufacturing, to learn on new material and processes are also expected to strengthen the European manufacturing of the new emerging technologies.			
Recommendation #4	**Research for the optimization of new battery management algorithms specific to new electrochemistry has to be undertaken**. Physical, chemical, mechanical and electrochemical aging or the impacts of temperature, C-rate, DoD are completely different from one technology to another. Without electronic of control it is impossible to monitor, integrate, and use the cells in real applications. This type of research requires a huge quantity of reproducible samples and testing time for aging under several conditions.			

3. BACCARA

BACCARA				
GENERAL INFORMATION				
Project acronym	BACCARA			
Project title	Battery and superCapacitor ChARActerization and testing			
GA number	608491			
Workprogramme	ENERGY			
Starting date	01/10/2013			
End date	30/09/2016			
Budget (€)	3 796 468.4			
Grant (€)	2 721 093			
Coordinator	CEA			
Partners (research)	CNRS, TECHNION			
Partners (industry)	HUTCHINSON, VARTA MICRO INNOVATION, IOLITEC			
Contact	pascale.bayle-guillemaud@cea.fr			
Project website	http://cordis.europa.eu/project/rcn/109512_en.html			
PROJECT CONCEPT				
Thematic area	Lithium-ion batteries, Super Capacitors			
TRL range	1-3			
Main challenge	Investigating material interfaces in operating batteries (silicon anode), and in supercapacitor (graphene)			
Proposed material solutions				
Technology risk				
Main targeted market	Potentially all battery end markets			
Market risk				
Expected benefits for advanced material manufacturers in Europe	New characterization tools and methods New knowledge on fundamental electrochemical mechanisms Test of novel mixed electrolytes for lithium-ion batteries Investigating new type of materials for supercapacitors (graphene)			
Expected benefits for battery cell manufacturers in Europe	New concepts for improved performance or safety			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	New knowledge on the formation and evolution of SEI in silicon anodes for lithium-ion batteries with classical carbonate electrolytes and mixed electrolytes			
Main result #2	New knowledge on the mechanic stability of silicon particles under prolonged cycling			
Main result #3	New concepts for safer Li-ion batteries (mixtures of electrolytes)			
Main result #4	Development of operando characterization techniques (TEM, RAMAN, large scale facilities)			
Main result #5	New tools, methods and technical platform for lithium-ion batteries electrodes characterization			
Main result #6	Knowledge on Ucap (grafted) graphene electrodes stability under prolonged cycling			
Main result #7	Knowledge on electrolyte formulation and purification has been gained during the project and will result in new products available in the industrial portfolio			
Main result #8	Knowledge on the methodology of safety testing (including procedures, set-up, evaluation, conclusions) has been gained and will be used to provide R&D services on safety related issues of energy storage devices.			
Number of publications	5			
Number of patents	0			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)			
Cell (pack) energy density (Wh/L)	750 (500)			
Cell (pack) power density (W/kg)	700 (470)			
Cell (pack) power density (W/L)	1500 (1000)			

Cycle life to 80% DOD	1000-5000			
Targeted pack cost (€/kWh)	90			
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Coupling electrochemical testing to advanced in situ/operando investigations is one key enabling methodology to elucidate the degradation phenomena in electrodes for energy storage.			
Recommendation #2	Improvement solutions for safer silicon-based lithium-ion batteries were proposed and explored (electrode and electrolyte formulation, additives, …) and should be further tested.			
Recommendation #3	Baccara results provided inputs to help and guide the development of future, higher energy and eco-friendly energy storage systems with longer lifetimes and safer performances.			

4. BASMATI

BASMATI				
GENERAL INFORMATION				
Project acronym	BASMATI			
Project title	Bringing innovAtion by Scaling up nanoMATerials and Inks for printing			
GA number	646159			
Workprogramme	NMBP			
Starting date	01/01/2015			
End date	31/12/2017			
Budget (€)	6 136 703.75			
Grant (€)	5 000 359.75			
Coordinator	UMICORE			
Partners (research)	CEA, LEITAT, ARISTOTLE UNIV. OF THESSALONIKI			
Partners (industry)	MICRODROP TECHNOLOGIES, GENES'INK, GWENT GROUP, JSR MICRO, VARTA MICROBATTERY, PRAYON			
Contact	tim.vanrompaey@eu.umicore.com			
Project website	www.basmati-project.eu			
PROJECT CONCEPT				
Thematic area	Lithium-ion batteries			
TRL range	4-6			
Main challenge	Upscaling functional ink fabrication processes			
Proposed material solutions	Conductive inks based on metallic nanoparticles (Cu, Ni), electrochemical inks based on LFP and NMC			
Technology risk	HIGH This project envisages innovations and development at different levels of battery development: nanomaterials synthesis, printable ink formulation and battery design.			
Main targeted market	Portable or wearable devices			
Market risk	MEDIUM The market for printed electronics is growing. The demand for functional inks is increasing. New applications requiring printed batteries will be developed.			
Expected benefits for advanced material manufacturers in Europe	Recipes and pilot installations for the production of functional battery inks have been developed at partners in Europe.			
Expected benefits for battery cell manufacturers in Europe	Know-how is available to produce printed battery cells.			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Synthesis of nano-Cu, nano-LFP and nano-NMC suitable for printing applications			
Main result #2	Formulation of electrochemical active ink containing nano-LFP			
Main result #3	Formulation of conductive ink containing nano-Cu			
Number of publications				
Number of patents	2			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)			The project is focusing on setting up pilot lines for functional ink formulation. The demonstrator application are printed thin film batteries. In the frame of the BASMATI project, these KPIs are not relevant.
Cell (pack) energy density (Wh/L)	750 (500)			
Cell (pack) power density (W/kg)	700 (470)			
Cell (pack) power density (W/L)	1500 (1000)			
Cycle life to 80% DOD	1000-5000			
Targeted pack cost (€/kWh)	90			
Project-related KPI #1 : Develop LFP and NMC nanoparticles suitable for screen printing and digital printing technologies (e.g. inkjet printing)	Status: upscaling to pilot scale is ongoing			

Project-related KPI #2: Develop pilot lines for the production of 150 kg/batch electrochemically active ink, containing LFP or NMC nanoparticles	Status: pilot lines have been commissioned
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET	
Recommendation #1	Support projects to assess faster the market feasibility/potential of the novel advanced materials and their production processes.

5. ECO COM'BAT

ECO COM'BAT				
GENERAL INFORMATION				
Project acronym	ECO COM'BAT			
Project title	Ecological Composites for High-Efficient Li-Ion Batteries			
GA number				
Workprogramme	EIT RawMaterials			
Starting date	01/04/2016			
End date	31/09/2018			
Budget (€)	2 600 000			
Grant (€)	2 500 000			
Coordinator	FRAUNHOFER			
Partners (research)	CEA, CSIC, ENEA, VITO, TU DARMSTADT			
Partners (industry)	ARKEMA, UMICORE, CCI, SAFT			
Contact	Andreas.bittner@isc.fraunhofer.de			
Project website				
PROJECT CONCEPT				
Thematic area	Lithium-ion batteries			
TRL range	5-7			
Main challenge	Increasing battery cycle life and energy density, ensuring battery material sustainability			
Proposed material solutions	High-energy cathode materials with low cobalt content (UMICORE NMC 622), functional protective coatings for active materials (FRAUNHOFER ORMOCER®), carbons with specific porous structure (HERAEUS Porocarb®), carbon nanotube conductive additives (ARKEMA Graphistrength®), high-voltage electrolyte based on LiFSI salts (ARKEMA)			
Technology risk	HIGH Different materials have to be scaled up and combined in one battery cell.			
Main targeted market	Electric vehicles			
Market risk	VERY HIGH There are numerous competitors, mainly from the Asian area			
Expected benefits for advanced material manufacturers in Europe	An opportunity to secure the location of Europe with new technology and jobs			
Expected benefits for battery cell manufacturers in Europe	An opportunity to secure the location of Europe with new technology and jobs			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Upscaling of ORMOCER® synthesis and ORMOCER® coated NMC 622			
Main result #2	Upscaling of LiFSi electrolyte (lithium salt production)			
Main result #3	Test cells stable at voltage > 4.4 V			
Number of publications	0			
Number of patents	0			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)		Lab tests in progress, pilot tests scheduled	ECO COM'BAT is an upscaling project for the individual battery materials, which are to be combined into pilot cells for demonstration. Cell specifications are based on the EU targets.
Cell (pack) energy density (Wh/L)	750 (500)		see above	see above
Cell (pack) power density (W/kg)	700 (470)		see above	see above
Cell (pack) power density (W/L)	1500 (1000)		see above	see above
Cycle life to 80% DOD	1000-5000		see above	see above
Targeted pack cost (€/kWh)	90		see above	see above

6. EUROLIS

EUROLIS	
GENERAL INFORMATION	
Project acronym	EUROLIS
Project title	Advanced European lithium sulphur cells for automotive applications
GA number	314515
Workprogramme	NMBP
Starting date	01/10/2012
End date	30/09/2016
Budget (€)	3 904 174.4
Grant (€)	2 799 084
Coordinator	National Institute of Chemistry, Ljubljana
Partners (research)	CNRS, MAX PLANCK, CHALMERS UNIV. OF TECHNOLOGY, ELETTRA, CoE LCT, FRAUNHOFER
Partners (industry)	RENAULT, SOLVIONIC, SAFT, VOLVO
Contact	robert.dominko@ki.si
Project website	www.eurolis.eu
PROJECT CONCEPT	
Thematic area	Post-lithium-ion batteries (lithium-sulfur)
TRL range	2-3
Main challenge	Increasing battery lifetime and energy density
Proposed material solutions	Cathode materials based on nanostructured porous carbon host matrix, ion selective separators preventing polysulfide diffusion from cathode to anode, ionic liquid electrolytes
Technology risk	HIGH Stabilization of Li metal and electrolyte quantity determines performance and stability
Main targeted market	Electric vehicles
Market risk	MEDIUM Once this battery type is commercialized, the potential risk would be the price of metallic lithium
Expected benefits for advanced material manufacturers in Europe	New materials like ion selective membranes and porous carbon host matrices with capability of polysulfide adsorption are required along with new electrolytes (solvents and additives)
Expected benefits for battery cell manufacturers in Europe	Market leaders on the field of post-lithium-ion batteries
PROJECT RESULTS OBTAINED SO FAR	
Main result #1	Set of newly developed analytical tools for Li-S batteries which helped us to understand better electrochemical processes during battery operation
Main result #2	Ion selective separator based on thin layer of fluorinated reduced graphene oxide which effectively prevents polysulfide diffusion from positive electrode composite to the metallic lithium
Main result #3	Application of new ionic and polymer ionic liquids as electrolyte and protection/separation barrier for polysulfides diffusion/migration
Number of publications	12
Number of patents	1 (Chemically modified reduced graphene oxide as a separator material in sulfur-containing batteries EP 3080852 A1)

PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	500	150	All tests were performed in the 18650 cells with non-optimized quantity of electrolyte
Cell (pack) energy density (Wh/L)	750 (500)			Volumetric energy density is based on the cell dimensions
Cell (pack) power density (W/kg)	700 (470)			In this step we were not focused on power denisty
Cell (pack) power density (W/L)	1500 (1000)			Power density was not optimized at this

				level of research
Cycle life to 80% DOD	1000-5000	Requested by automotive industry	300	This was achieved in the combination with ceramic separator
Targeted pack cost (€/kWh)	90			It was not planned
Project specific KPI #1: Low cost carbon host matrix used in the cathode composite		1-2 EUR/kg	Achieved on the laboratory scale	Hydrothermal carbonization of biomass based precursors. Carbons with designed porosity and pore volume.
Project specific KPI #2: Electrolyte for Li-S batteries		Mixture of ionic liquids and ethers	Applied within one cell generation	Problematic cell fabrication due to high viscosity
Project specific KPI #3: Li-S cells in the 18650 cell configuration		12 cells per generation	Achieved for all three generations	Constant improvement of energy density and cycle life based on improved components.
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	More clustering between similar projects and open access research			
Recommendation #2	Flexible adjustments of project objectives in the case of planned work which is not leading to applicable results			

7. FIVEVB

FIVEVB	
GENERAL INFORMATION	
Project acronym	FIVEVB
Project title	Five Volt Lithium Ion Batteries with Silicon Anodes produced for Next Generation Electric Vehicles
GA number	653531
Workprogramme	TRANSPORT
Starting date	01/05/2015
End date	30/04/2018
Budget (€)	5 927 428.75
Grant (€)	5 673 272.5
Coordinator	AVL List GmbH
Partners (research)	Vrije Universiteit Brussel (VUB, Belgium), Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW, Germany), JRC -Joint Research Centre - European Commission
Partners (industry)	3M Deutschland GmbH, Arkema France SA, Robert Bosch GmbH (Germany), Umicore SA (Belgium), Bayerische Motoren Werke Aktiengesellschaft (BMW, Germany), Kompetenzzentrum – Das Virtuelle Fahrzeug, Forschungsgesellschaft mbH (VIF, Austria)
Contact	thomas.traussnig@avl.com; corina.taeubert@avl.com
Project website	http://www.fivevb.eu/
PROJECT CONCEPT	
Thematic area	Lithium-ion batteries
TRL range	5-6
Main challenge(s)	Achieve lifetime goals of the materials especially when operating at the targeted high-voltage conditions; ensure the manufacturability of the materials in large series production; provide materials in a reasonable quantity, with the required quality, and in due time for fulfilling the project aims; increase the energy density of an advanced Li-ion cell / technology at lower costs.
Proposed material solutions	For fulfilling the project targets, FiveVB introduces a highly innovative combination of materials to be developed and optimized: a high capacity anode (Si-based, from 3M), a cathode material able to operate at high voltages (from Umicore), and a high-voltage stable electrolyte that is additionally safe and environmentally friendly (from Arkema). The proof-of-concept will be an automotive scale industrial PHEV1 cell produced in Europe using materials and technologies provided by European companies.
Technology risk	MEDIUM / HIGH Since the project deals with a highly innovative combination of materials (anode, cathode and electrolyte) that has not been proposed so far, as well as manufacturing procedures (e.g. anode pre-lithiation), the technology risks can be assessed as medium to high.
Main targeted market	Electric vehicles
Market risk	MEDIUM Provided that the project targets will be successfully completed, and the materials will reach a sufficient maturity, no obstacles against a market entry can be assessed.
Expected benefits for advanced material manufacturers in Europe	Overcome the risks related to critical raw materials supply (e.g. cobalt and natural graphite) and thus consolidating the position of the European manufacturers on the market; early adoption of advanced Li-ion cell chemistry with higher energy density and lower cost as competition advantage.
Expected benefits for battery cell manufacturers in Europe	Increasing the know-how on Li cell production processes, and thus initiating the launch of a new production in Europe; market perspective for possible cell manufacturers with new Li-ion cell chemistry, tailored for automotive purposes already at an early technology stage.
PROJECT RESULTS OBTAINED SO FAR	
Main result #1	Cell requirements and specifications were derived from system level; the cell testing

	procedure was defined.			
Main result #2	Two generation of cells were developed so far: Gen 0 - baseline cells, state-of-the-art anode and cathode materials; Gen1 (with Si-based anode and a cathode and electrolyte operating at higher voltages).			
Main result #3	10% increase in the energy density in comparison to state-of-the-art already reached.			
Number of publications	1 article: Kriston et al., Electrochimica Acta 201 (2016) 380; 3 oral presentation; 1 poster			
Number of patents				
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	+ 20 – 30% at cell level vs. state-of-the-art PHEV1 cell		State-of-the-art PHEV1 cell – May 2015: 134 Wh/kg
Cell (pack) energy density (Wh/L)	750 (500)			
Cell (pack) power density (W/kg)	700 (470)			
Cell (pack) power density (W/L)	1500 (1000)			
Cycle life to 80% DOD	1000-5000			
Targeted pack cost (€/kWh)	90			FiveVB aims at decreasing the costs of Li-ion cells (-20% on cost at cell level), while increasing their energy density. There are no targets at system level. However, a system cost analysis will be carried out within the framework of the project.
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Develop generic technologies for the next generation battery cells – easy to scale up and flexible in case of market changes. This could mitigate the relatively high financial risks associated to the industrialization of Li-based technologies.			
Recommendation #2	Identify energy and resource efficient cell manufacturing technologies and assets tailored to the existing European industrial infrastructure.			
Recommendation #3	Generate solutions for cell manufacturing that are modular and scalable for different applications.			

8. HELIS

HELIS				
GENERAL INFORMATION				
Project acronym	HELIS			
Project title	High energy lithium sulphur cells and batteries			
GA number	666221			
Workprogramme	NMBP			
Starting date	01/06/2015			
End date	31/05/2019			
Budget (€)	7 974 352			
Grant (€)	7 974 352			
Coordinator	National Institute of Chemistry, Ljubljana			
Partners (research)	MÜNSTER UNIV., MAX PLANCK, CHALMERS UNIV. OF TECHNOLOGY, TEL AVIV UNIV., CNRS, FRAUNHOFER, IREC, INERIS			
Partners (industry)	SOLVIONIC, PICOSUN, ACCUREC, SAFT, PSA			
Contact	robert.dominko@ki.si			
Project website	http://www.helis-project.eu/			
PROJECT CONCEPT				
Thematic area	Post-lithium-ion batteries (lithium-sulfur)			
TRL range	3-4			
Main challenge	Increasing battery lifetime, energy density, and safety			
Proposed material solutions	Cathode materials based on nanostructured porous carbon host matrix, lithium metal anode surface functionalization, ion selective separators preventing polysulphide diffusion from cathode to anode, new electrolytes			
Technology risk	HIGH Stabilization of Li metal and electrolyte quantity determines performance and stability			
Main targeted market	Electric vehicles			
Market risk	MEDIUM Once this battery type is commercialized, the potential risk would be price of metallic lithium			
Expected benefits for advanced material manufacturers in Europe	Protection of lithium metal, production of electrodes and separators, recycling procedure, new solvents for Li-S batteries			
Expected benefits for battery cell manufacturers in Europe	Market leaders on the field of post Li-ion batteries			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	With help of modelling we modified the positive electrode formulation and excellent electrochemical properties can be achieved with high loading electrodes processed on the prototype coating equipment			
Main result #2	Atomic layer deposition coating and polymer coatings show promising direction which in the combination of presence of low concentration of polysulphides can prolong cycle life of lithium			
Main result #3	New types of glymes are under implementation to the electrolyte configuration for Li-S batteries			
Number of publications	0			
Number of patents	1			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	500	150	All tests were performed in the D-size cell configuration with electrolyte from EUROLIS project
Cell (pack) energy density (Wh/L)	750 (500)			Volumetric energy density is based on the cell dimensions
Cell (pack) power density (W/kg)	700 (470)	1000		Cells with high power are planned for second half of the project
Cell (pack) power density (W/L)	1500 (1000)			NA

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Cycle life to 80% DOD	1000-5000	1000 cycles or 5 years	<100	Cycle life with non protected lithium depends on amount of electrolyte
Targeted pack cost (€/kWh)	90			Preliminary study of 6 cells in the pack is planned by end of the project
Project specific KPI #1: High energy density cathodes		5 mA/cm^2	4.5 mAh/cm^2	Use of modeling results improved electrochemical behavior of positive electrodes
Project specific KPI #2: Lithium protection		1000 cycles with twofold excess	>250 cycles	Polymer and composite protection layers show the possible long term use of metallic lithium
Project specific KPI #3: Li-S cells in the D-size configuration		50 cells	1st gen. of D-size cells	Cells are currently used for safety and ageing tests.
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	More clustering between similar projects and open access research			
Recommendation #2	Flexible adjustments of project objectives in the case of planned work which is not leading to applicable results			

9. HI-C

HI-C				
GENERAL INFORMATION				
Project acronym	HI-C			
Project title	Novel in situ and in operando techniques for characterization of interfaces in electrochemical storage systems			
GA number	608575			
Workprogramme	ENERGY			
Starting date	01/09/2013			
End date	28/02/2017			
Budget (€)	6 141 839.8			
Grant (€)	4 646 299			
Coordinator	DTU			
Partners (research)	UNIV. OF TOURS, CEA, KIT, UPPSALA UNIV.,			
Partners (industry)	HALDOR TOPSOE, UNISCAN INSTRUMENTS, VARTA MICROBATTERY			
Contact	pnor@dtu.dk			
Project website	http://www.hi-c.eu/			
PROJECT CONCEPT				
Thematic area	Lithium-ion batteries			
TRL range	1-3			
Main challenge	Investigating material interfaces in operating batteries			
Proposed material solutions				
Technology risk				
Main targeted market	Potentially all battery end markets			
Market risk				
Expected benefits for advanced material manufacturers in Europe	New characterization tools and methods New knowledge on fundamental electrochemical mechanisms			
Expected benefits for battery cell manufacturers in Europe	New concepts for improved performance or safety			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Materials optimization by interface manipulation ($LiFeBO_3$, Li_2VO_2F)			
Main result #2	New tools and methods for in situ studies of interfaces (in situ SECM cell, being commercialized by Uniscan / Biologic; in situ TERS; operando monitoring of lithium batteries and supercapacitors; in situ synchrotron X-ray diffraction; in situ and high pressure XPS)			
Main result #3	Interfaces and SEI (development of new additives for SEI formation, theoretical calculations of transport across interfaces and conductive coatings)			
Number of publications	32			
Number of patents	3			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)			
Cell (pack) energy density (Wh/L)	750 (500)			
Cell (pack) power density (W/kg)	700 (470)			
Cell (pack) power density (W/L)	1500 (1000)			
Cycle life to 80% DOD	1000-5000			
Targeted pack cost (€/kWh)	90			
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Support R&I across the whole TRL range			

10. IPES

IPES				
GENERAL INFORMATION				
Project acronym	IPES			
Project title	Innovative Polymers for Energy Storage			
GA number	306250			
Workprogramme	ERC			
Starting date	01/12/2012			
End date	30/11/2018			
Budget (€)	1 430 239			
Grant (€)	1 430 239			
Coordinator	UNIV. OF THE BASQUE COUNTRY			
Partners (research)				
Partners (industry)				
Contact	david.mecerreyes@ehu.es			
Project website	http://www.polymat.eu/en/groups/innovative-polymers-group			
PROJECT CONCEPT				
Thematic area	Polymers for several battery technologies, Li-Ion, Li-S, Na, Rechargeable Zn, Polymer Redox-flow			
TRL range	1-3			
Main challenge	Developing new (bio-sourced) polymers for battery applications: binder and conductive additives, polymer electrolytes, active materials (redox polymers)			
Proposed material solutions	PEDOT/lignin hybrids, new polyimides, sulfur polymers, polyionic liquids, single-ion block copolymers, new polycarbonates, iongels, quinone-polymers			
Technology risk	VERY HIGH			
Main targeted market	Potentially all battery end markets			
Market risk	LOW It is an existing market			
Expected benefits for advanced material manufacturers in Europe	Available materials and know-how			
Expected benefits for battery cell manufacturers in Europe	Available materials and know-how			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Single-ion conducting polymer electrolytes for Li-ion batteries			
Main result #2	Sulfur-copolymer cathodes for Li-S batteries			
Main result #3	Lignin/PEDOT hybrids for batteries and supercapacitors			
Number of publications	20			
Number of patents	1			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)			
Cell (pack) energy density (Wh/L)	750 (500)			
Cell (pack) power density (W/kg)	700 (470)			
Cell (pack) power density (W/L)	1500 (1000)			
Cycle life to 80% DOD	1000-5000			
Targeted pack cost (€/kWh)	90			
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	More involvement of polymer chemistry groups (academy and industry)			
Recommendation #2	Give opportunities to all TRL levels and materials technologies			
Recommendation #3	Push projects within Marie Slowdowska Curie Activities (Training)			

11. LIRICHFCC

LIRICHFCC				
GENERAL INFORMATION				
Project acronym	LIRICHFCC			
Project title	A new class of powerful materials for electrochemical energy storage: Lithium-rich oxyfluorides with cubic dense packing			
GA number	711792			
Workprogramme	FET			
Starting date	01/10/2016			
End date	30/01/2019			
Budget (€)	4 114 753.75			
Grant (€)	4 114 753.5			
Coordinator	HELMHOLTZ-INSTITUTE ULM / KIT			
Partners (research)	CEA, DTU, National Institute of Chemistry, UPPSALA UNIV.			
Partners (industry)				
Contact	maximilian.fichtner@kit.edu			
Project website	http://cordis.europa.eu/project/rcn/203539_en.html			
PROJECT CONCEPT				
Thematic area	Lithium-ion batteries			
TRL range	1-3			
Main challenge	Increasing battery energy density			
Proposed material solutions	High-energy cathode based on lithium-rich FCC materials (Li_2MO_2F)			
Technology risk	HIGH			
Main targeted market	Electric vehicles, portable devices			
Market risk	MEDIUM			
Expected benefits for advanced material manufacturers in Europe	New cathode materials			
Expected benefits for battery cell manufacturers in Europe	High energy density batteries			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Synthesis and delivery of materials to partners (first project milestone)			
Number of publications	0			
Number of patents	0			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	750		
Cell (pack) energy density (Wh/L)	750 (500)	1400		
Cell (pack) power density (W/kg)	700 (470)			
Cell (pack) power density (W/L)	1500 (1000)			
Cycle life to 80% DOD	1000-5000			
Targeted pack cost (€/kWh)	90			
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Develop improved next generation materials (NMC 622, 811, etc.) and establish a related cell fabrication even if this means considerable investment and time for establishing the process. Otherwise high supply risks and costs for European carmakers.			
Recommendation #2	Be aware of the resource situation, especially on the cathode side. According to a big German OEM, the global resources/reserves of Co (given 622 or 811 NMC would be used) allow building of 85 Mio battery cars only → a global electromobility based on the current technology is not possible.			
Recommendation #3	Search and develop alternatives: (1) Co-free cathodes for lithium-ion batteries, (2) post-Li-ion and post-Li technologies.			

12. MARS-EV

MARS-EV	
GENERAL INFORMATION	
Project acronym	MARS-EV
Project title	Materials for Ageing Resistant Li-ion High Energy Storage for the Electric Vehicle
GA number	609201
Workprogramme	NMBP
Starting date	01/10/2013
End date	30/09/2017
Budget (€)	9 097 135.84
Grant (€)	6 575 034
Coordinator	CIDETEC
Partners (research)	POLITO, TEL AVIV UNIV., ENEA, CTP, IMPERIAL COLLEGE, FRAUNHOFER, OXFORD BROOKS UNIV., KIT
Partners (industry)	JOHNSON MATTHEY, SGL CARBON, SOLVIONIC, LITHOPS, RECUPYL, JOHNSON MATTHEY BATTERY SYSTEMS
Contact	iurdampilleta@cidetec.es
Project website	http://www.mars-ev.eu/homepage
PROJECT CONCEPT	
Thematic area	Lithium-ion batteries
TRL range	2-5
Main challenge	Increasing battery lifetime and energy density
Proposed material solutions	High-voltage cathode materials, high-capacity anode materials, water-based formulation, stable liquid or solid electrolytes, cellulose-based packaging
Technology risk	MEDIUM / HIGH The project is aiming to develop high-energy innovative components (high-voltage cathodes, silicon-based high capacity anodes, water-based electrode formulations, polymer-ionic liquid electrolytes, cellulose-based light eco-packaging), with 2 selection milestones to upscale new materials at proof-of-concept level (1kg-scale for active materials, small pouch cell prototypes). The combination and harmonization of all innovative components (cathode, anode, electrolyte and pouch packaging) into a final cell prototype can be assessed as High risk and fallback positions with conventional components are considered.
Main targeted market	Electric vehicles
Market risk	MEDIUM For materials achieving project targets in terms of energy density, safety and acceptable life-cycles, demonstrating sustainable upscaling from lab to industrial scale in terms of cost vs increased performance compared to state of the art may hinder market entry. There are also many competitors, mainly from Asia.
Expected benefits for advanced material manufacturers in Europe	Commercial exploitation of advanced battery materials (high-V phosphate cathode, JOHNSON MATTHEY; Graphites, SGL; Ionic Liquid-based electrolytes, SOLVIONIC; battery materials recovery and reuse, RECUPYL). Technology transfer on advanced materials (polymer electrolytes, Li-rich NMC, nano-silicon composite anodes; paper-based packaging).
Expected benefits for battery cell manufacturers in Europe	Manufacturing knowledge (process know-how, innovative materials implementation; LITHOPS). Environmentally friendly electrode and cell competitive manufacturing processes to secure cell production in Europe (water-based electrode coating, safe electrolytes, paper-based eco-packaging).
PROJECT RESULTS OBTAINED SO FAR	
Main result #1	**High voltage cathodes**: nanodimensional 4.8V $LiCoPO_4$ (850 Wh/kg) by Flame Spray Pyrolysis (patent filled); coated Li-rich NMC with increased capacity and cycle-life.
Main result #2	**High-capacity anodes**: nano-silicon composites with MWCNT – electrolyte compatibility for stable SEI (600mAh/g, 300 cycles); synthesis of high capacity ZnFe2O4 by FSP (lab-scale); optimized Graphite for aqueous slurry processing (pilot line coating).

Main result #3	**Safe electrolytes**: electrolyte formulations with selected additives increasing cycle-life of Li-rich NMC cells (85% retention over 485 cycles); solid polymer electrolytes with no flammability and performance at 20°C (UV-cured = 0.5 mS·cm-1 (RT), PEO-IL > 1 mS·cm-1 (20°C)).			
Number of publications	16			
Number of patents	1			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	250	120 190 (Gen2), TBC	Baseline LFP 15Ah pouch cell 1Ah prototype LiCoPO4/Graphite (4.7V)
Cell (pack) energy density (Wh/L)	750 (500)			
Cell (pack) power density (W/kg)	700 (470)		900	LFP 15Ah (50%SOC; 10s)
Cell (pack) power density (W/L)	1500 (1000)			
Cycle life to 80% DOD	1000-5000	3000	>3600	LFP pouch cell with aqueous electrode manufacturing (70%DoD, 2C Ch., 30ºC)
Targeted pack cost (€/kWh)	90			
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Strong involvement of European companies, especially materials and battery manufacturers, and ensuring IP protection in collaborative projects may increase the upscaling from lab to market. Fruitful to have academic, RTO and industry with complementary expertise and collaboration links.			
Recommendation #2	Support projects and R&I partners to assess the upscaling and market feasibility/potential of the novel advanced materials and their energy and resource efficient materials and cell production processes.			
Recommendation #3	Provide opportunities at lower TRL levels for high-risk battery concepts that may provide competitive advantage in a longer-term horizon			

13. MAT4BAT

MAT4BAT				
GENERAL INFORMATION				
Project acronym	MAT4BAT			
Project title	Advanced materials for batteries			
GA number	608931			
Workprogramme	NMBP			
Starting date	01/09/2013			
End date	28/02/2017			
Budget (€)	11 443 522.09			
Grant (€)	8 191 959			
Coordinator	CEA			
Partners (research)	ZSW, CIC ENERGIGUNE, VITO, CIDETEC, NEWCASTLE UNIV., EIGSI, INSA LYON, KIT, IMC			
Partners (industry)	SOLVAY, IMERYS, RENAULT, SOLVIONIC, DIRECTA PLUS, WAVESTONE			
Contact	dane.sotta@cea.fr			
Project website	http://mat4bat.eu/			
PROJECT CONCEPT				
Thematic area	Lithium-ion batteries			
TRL range	2-6			
Main challenge	Increasing battery lifetime and energy density			
Proposed material solutions	High-capacity cathode materials, water-based formulation, stable liquid or solid electrolytes			
Technology risk	MEDIUM Starting from state-of-the-art EV Li-ion cells the project is aiming to develop new cell generations with innovative components (Li-rich cathode materials, water-based formulation, polymer-based electrolytes)			
Main targeted market	Electric vehicles			
Market risk	MEDIUM Material developments are expected to reach the market soon but high risk on performances increments (lifetime, safety, …) compared to SoA cells			
Expected benefits for advanced material manufacturers in Europe	Technology transfer and/or commercial exploitation of advanced materials (PVdF latexes, carbon materials, electrolytes, Li-rich material)			
Expected benefits for battery cell manufacturers in Europe	Knowledge increment (process know-how, innovative materials implementation) Options for competitive process in Europe (water-based electrode manufacturing, advanced process for electrolytes)			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Development of high energy density Li-rich cathode material: composition optimization, production scaling-up, integration in Li-ion battery cells			
Main result #2	Pilot-scale manufacturing of EV-size soft pouch cells using innovative materials (Li-rich materials, binders, conductor additives) and process (water-based electrode production)			
Main result #3	Methodology development to better understand battery ageing mechanisms: new tools like GD-OES spectroscopy, wide battery testing plan to analyse impact of parameters on lithium deposition, modeling of ageing evolution			
Number of publications	20			
Number of patents	1			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	250	190	Increase with the use of Li-rich material as a cathode
Cell (pack) energy density (Wh/L)	750 (500)	Not specified		
Cell (pack) power density (W/kg)	700 (470)	Not specified		
Cell (pack) power density (W/L)	1500 (1000)	Not specified		
Cycle life to 80% DOD	1000-5000	4000	4000	Best results with NMC-based technology, standard charging

				conditions (1C charging rate, 25°C)
Targeted pack cost (€/kWh)	90	Not specified	Not specified	
Project-related KPI #1: Cycle life with fast charging		3000	1500	Best results with NMC-based technology, fast charging conditions (3C charging rate, 45°C)
Project-related KPI #2: Safety		Similar to SoA EV cells	Similar to SoA EV cells	
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Strong involvement of European companies, especially battery manufacturers, is mandatory to clearly set technology roadmaps			
Recommendation #2	Implementation of materials with high enough maturity (TRL>4) in NMBP projects to control technology risks			
Recommendation #3	Interest of modeling and simulation tools to rapidly bridge the gap between scales (components, process)			

14. NAIADES

NAIADES				
GENERAL INFORMATION				
Project acronym	NAIADES			
Project title	Na-Ion bAttery Demonstration for Electric Storage			
GA number	646433			
Workprogramme	ENERGY			
Starting date	01/01/2015			
End date	31/12/2018			
Budget (€)	6 492 262.5			
Grant (€)	6 492 262			
Coordinator	CEA			
Partners (research)	VITO, VDE, CNRS, CSIC, CHALMERS UNIV. OF TECHNOLOGY			
Partners (industry)	MAST, ESTABANELL ENERGIA, SOLVAY, SAFT			
Contact	loic.simonin@cea.fr			
Project website	http://www.naiades.eu/			
PROJECT CONCEPT				
Thematic area	Post-lithium-ion batteries (sodium-ion)			
TRL range	2-5			
Main challenge	Increasing battery lifetime and energy density			
Proposed material solutions	$Na_3V_2(PO_4)_2F_3$ or $Na_{2/3}Fe_{1/2}Mn_{1/2}O_2$ cathode materials, hard carbon anode materials, $NaPF_6$ or NaTFSI electrolytes			
Technology risk	HIGH			
Main targeted market	Stationary energy storage			
Market risk	MEDIUM Lithium market evolution is quite unclear → lithium replacement: a critical need ?			
Expected benefits for advanced material manufacturers in Europe	No critical raw materials (Co, Li)			
Expected benefits for battery cell manufacturers in Europe	Easy process switch from Li-ion to Na-ion			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Cathode material ($Na_{2/3}Fe_{1/2}Mn_{1/2}O_2$, $Na_3V_2(PO_4)_2F_3$) synthesis and scale up (10 × 1kg-batches produced with reproducible performances; 10 kg/batch ongoing, delivery of 50 kg expected very soon)			
Main result #2	Anode material (hard carbon) development, electrolyte formulation			
Main result #3	First cells produced (1 A.h)			
Number of publications				
Number of patents				
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)			
Cell (pack) energy density (Wh/L)	750 (500)			
Cell (pack) power density (W/kg)	700 (470)			
Cell (pack) power density (W/L)	1500 (1000)			
Cycle life to 80% DOD	1000-5000			
Targeted pack cost (€/kWh)	90			
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Investigate vanadium-free cathode materials			
Recommendation #2	Maintain high cycle life & energy density even with V-free materials…with no compromise on abundant elements, cheap electrolytes, and cheap process			

15. OMICON

OMICON				
GENERAL INFORMATION				
Project acronym	OMICON			
Project title	Organic Mixed Ion and Electron Conductors for High-Energy Batteries			
GA number	636069			
Workprogramme	ERC			
Starting date	01/04/2015			
End date	31/03/2020			
Budget (€)	1 494 253.75			
Grant (€)	1 494 253.75			
Coordinator	TU GRAZ			
Contact	freunberger@tugraz.at			
Project website	http://cordis.europa.eu/project/rcn/193371_en.html			
PROJECT CONCEPT				
Thematic area	Lithium-ion batteries			
TRL range	1-3			
Main challenge	Exploiting the potential of beyond intercalation chemistries with high volume changes and low conductivity such as Si, Li-S, Li-O2, Na-O2, Na-S			
Proposed material solutions	Flexible organic mixed conductors			
Technology risk	HIGH Materials research at the fundamental level			
Main targeted market	Potentially all battery end markets			
Market risk	Not predictable			
Expected benefits for advanced material manufacturers in Europe	Shift batteries from current intercalation chemistries with scarce elements and energy intensive manufacturing and recycling to easily available main group chemistries			
Expected benefits for battery cell manufacturers in Europe	Enabling higher energy cells that go substantially beyond current energy storage and power			
PROJECT RESULTS OBTAINED SO FAR				
Main result #1	Singlet oxygen generation was identified as the single most important cause for the ageing and parasitic chemistry of Li-O2 and Na-O2 batteries. With this recognition, we suggested and demonstrated new approaches to minimize the parasitic chemistry in Li–air batteries.			
Main result #2	The first organic liquid mixed ion and electron conductor is demonstrated. Further soft polymeric mixed conductors are demonstrated. Both able to address high energy storage materials.			
Main result #3	The first liquid redox material with solid like redox density to enable high energy supercapacitors is demonstrated (Collaboration Montpellier).			
Number of publications	5 articles: Nature Materials 16, 446 (2017), Nature Energy 1, 16074 (2016), Nature Energy 2, 17036 (2017), Nature Energy 2, in press (2017), Chemical Science, submitted. 23 talks.			
Number of patents				
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	Si > 900, Li-S > 800, Li-O2 > 700	Proof of principle	Values in mAh/g total electrode
Cell (pack) energy density (Wh/L)	750 (500)	Si > 1000, Li-S > 1000, Li-O2 > 1000	Proof of principle	Values in mAh/cm3 total electrode
Cell (pack) power density (W/kg)	700 (470)			
Cell (pack) power density (W/L)	1500 (1000)			
Cycle life to 80% DOD	1000-5000			
Targeted pack cost (€/kWh)	90			

16. POROUS4APP

POROUS4APP				
GENERAL INFORMATION				
Project acronym	POROUS4APP			
Project title	PILOT PLANT PRODUCTION OF CONTROLLED DOPED NANOPOROUS CARBONACEOUS MATERIALS FOR ENERGY AND CATALYSIS APPLICATIONS			
GA number	686163			
Workprogramme	NMBP			
Starting date	01/03/2016			
End date	29/02/2020			
Budget (€)	7 944 717.4			
Grant (€)	6 535 878			
Coordinator	LEITAT			
Partners (research)	CNRS, UNIV. OF YORK, EMPA, ICIQ, BDC			
Partners (industry)	JOHNSON MATTHEY, VARTA MICRO INNOVATION, META GROUP, BLUEPRIME, IBERCAT			
Contact	damantia@leitat.org			
Project website	www.porous-4app.eu			
PROJECT CONCEPT				
Thematic area	Lithium-ion batteries			
TRL range	4-7			
Main challenge	Manufacturing and control of nanoporous materials			
Proposed material solutions	Starbon® technology (bio-based porous materials derived from modified polysaccharides)			
Technology risk	MEDIUM Scalability to 500Kg/month scale might be an issue.			
Main targeted market	Electric vehicles			
Market risk	HIGH Scalability cost might be an issue.			
Expected benefits for advanced material manufacturers in Europe	Increased rate capability of today commercialized materials			
Expected benefits for battery cell manufacturers in Europe	High power density combined with high cycle life			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	150		Increase is not targeted within P4A
Cell (pack) energy density (Wh/L)	750 (500)	450		Increase is not targeted within P4A
Cell (pack) power density (W/kg)	700 (470)	2000		Pouch cell
Cell (pack) power density (W/L)	1500 (1000)	6000		Pouch cell
Cycle life to 80% DOD	1000-5000	2500		
Targeted pack cost (€/kWh)	90			
Project-related KPI #1 (please specify)				
Project-related KPI #2 (please specify)				
Project-related KPI #3 (please specify)				
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	For pilot projects, funding should be more flexible for the pilot construction, e.g., funding of part of the equipment or loan at low rate.			

17. SINTBAT

SINTBAT	
GENERAL INFORMATION	
Project acronym	SINTBAT
Project title	Silicon based materials and new processing technologies for improved lithium-ion batteries
GA number	685716
Workprogramme	NMBP
Starting date	01/03/2016
End date	29/02/2020
Budget (€)	9 755 886.25
Grant (€)	8 334 786.25
Coordinator	VARTA MICROBATTERY
Partners (research)	CEA, UNIV. OF WARWICK, UPPSALA UNIV., MCL, UNIV. WARSZAWSKI
Partners (industry)	VARTA MICRO INNOVATION, EURA-CONSULT, VARTA STORAGE,
Contact	martin.krebs@varta-microbattery.com
Project website	http://www.sintbat.eu/home.html
PROJECT CONCEPT	
Thematic area	Lithium-ion batteries
TRL range	
Main challenge	Increasing battery lifetime and energy density
Proposed material solutions	Silicon-based high-capacity anode materials, water-based formulation
Technology risk	MEDIUM
Main targeted market	Stationary energy storage
Market risk	MEDIUM
Expected benefits for advanced material manufacturers in Europe	Longer cycle life of the lithium-ion battery cells due to investigation of the degradation mechanisms
Expected benefits for battery cell manufacturers in Europe	Better chance to compete with the far east. High-performance lithium-ion battery cell production in Europe.

PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	836		Full cells not yet made
Cell (pack) energy density (Wh/L)	750 (500)	2442		Full cells not yet made
Cell (pack) power density (W/kg)	700 (470)			Not subjected
Cell (pack) power density (W/L)	1500 (1000)			Not subjected
Cycle life to 80% DOD	1000-5000	10000		Full cells not yet made
Targeted pack cost (€/kWh)	90			Not subjected
Project-related KPI #1: CAPEX (€/kWh)		< 400		Not yet calculated
Project-related KPI #2: OPEX (€/kWh)		< 0,09		Not yet calculated
Project-related KPI #3: Cost reduction		31%		

18. SIRIUS

SIRIUS				
GENERAL INFORMATION				
Project acronym	SIRIUS			
Project title	SIlicon nanopaRticles based composItes UpScaling			
GA number				
Workprogramme	EIT RawMaterials			
Starting date	01/04/2017			
End date	31/09/2019			
Budget (€)	1 600 000			
Grant (€)	1 600 000			
Coordinator	NANOMAKERS			
Partners (research)	CEA, UPPSALA UNIV.			
Partners (industry)	SGL GROUP, VARTA MICRO INNOVATION			
Contact	jfperrin@nanomakers.fr			
Project website				
PROJECT CONCEPT				
Thematic area	Lithium-ion batteries			
TRL range	5-7			
Main challenge	Increasing battery energy density			
Proposed material solutions	Si-C nanocomposite high capacity anode materials			
Technology risk	MEDIUM The risk is the stability in time of the performances which remains too low to be marketed today. The second risk is the compatibility with the other components of the battery which requires optimization.			
Main targeted market	Electric vehicles			
Market risk	LOW All the world-wide actors acknowledge that silicon will be used in future high capacities Li-ion batteries. The main risk is a misuse of the product which has then to be as ready-to -use as possible.			
Expected benefits for advanced material manufacturers in Europe	This new anode materials will position European actors on the most advanced materials for Li-ion batteries and also strengthen the current European players (graphite suppliers) in this market by complying the market growth.			
Expected benefits for battery cell manufacturers in Europe	They will benefit from an easier access to the latest innovations and possibilities of interactions with various suppliers to obtain the best product.			
PROJECT PROGRESS VERSUS KPIs				
KPI	**EU 2020 target**	**Project target**	**Project status**	**Comments**
Cell (pack) energy density (Wh/kg)	350 (235)	Similar		
Cell (pack) energy density (Wh/L)	750 (500)			
Cell (pack) power density (W/kg)	700 (470)			
Cell (pack) power density (W/L)	1500 (1000)			
Cycle life to 80% DOD	1000-5000			
Targeted pack cost (€/kWh)	90			
RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET				
Recommendation #1	Involve more industrial partners as project leaders			

19. SPICY

<table>
<tr><th colspan="5">SPICY</th></tr>
<tr><td colspan="5">GENERAL INFORMATION</td></tr>
<tr><td>Project acronym</td><td colspan="4">SPICY</td></tr>
<tr><td>Project title</td><td colspan="4">Silicon and polyanionic chemistries and architectures of Li-ion cell for high energy battery</td></tr>
<tr><td>GA number</td><td colspan="4">653373</td></tr>
<tr><td>Workprogramme</td><td colspan="4">TRANSPORT</td></tr>
<tr><td>Starting date</td><td colspan="4">01/05/2015</td></tr>
<tr><td>End date</td><td colspan="4">30/04/2018</td></tr>
<tr><td>Budget (€)</td><td colspan="4">7 250 428.75</td></tr>
<tr><td>Grant (€)</td><td colspan="4">6 896 053.5</td></tr>
<tr><td>Coordinator</td><td colspan="4">CEA</td></tr>
<tr><td>Partners (research)</td><td colspan="4">KIT, TU MUNICH, EMPA, CIDETEC, IPC, HAHN SCHICKARD, VITO, FZJ</td></tr>
<tr><td>Partners (industry)</td><td colspan="4">TEKNA, WAVESTONE, PRAYON, RECUPYL,</td></tr>
<tr><td>Contact</td><td colspan="4">willy.porcher@cea.fr</td></tr>
<tr><td>Project website</td><td colspan="4">http://www.spicy-project.eu/</td></tr>
<tr><td colspan="5">PROJECT CONCEPT</td></tr>
<tr><td>Thematic area</td><td colspan="4">Lithium-ion batteries</td></tr>
<tr><td>TRL range</td><td colspan="4">2-6</td></tr>
<tr><td>Main challenge</td><td colspan="4">Improving battery energy density, decreasing battery cost</td></tr>
<tr><td>Proposed material solutions</td><td colspan="4">High-voltage cathode materials, silicon-based high-capacity anode materials, water-based formulation, stable liquid electrolytes, polymer-based packaging</td></tr>
<tr><td>Technology risk</td><td colspan="4">MEDIUM to HIGH
Developments of the LFMP material at the cathode side to improve mean voltage but by keeping power capabilities and safety properties of the LFP chemistry. A combined electrolyte has to be developed. At the anode side, silicon technology has to be compliant with EV requirements with developments beginning on reactor optimization in a first part.</td></tr>
<tr><td>Main targeted market</td><td colspan="4">Electric vehicles</td></tr>
<tr><td>Market risk</td><td colspan="4">HIGH
It is not very clear at the moment if there is well a market between LFP and NMC for the PHEV application.</td></tr>
<tr><td>Expected benefits for advanced material manufacturers in Europe</td><td colspan="4">LFMP material for PRAYON</td></tr>
<tr><td>Expected benefits for battery cell manufacturers in Europe</td><td colspan="4">Results on different chemistries in 17 Ah cells. Also results with the same components but different cell architectures</td></tr>
<tr><td colspan="5">PROJECT RESULTS OBTAINED SO FAR</td></tr>
<tr><td>Main result #1</td><td colspan="4">4 cells evaluated in electrical and abusive tests with same capacity, electrodes/electrolyte and conditioning steps but different cell architectures</td></tr>
<tr><td>Main result #2</td><td colspan="4">Optimization Mn/Fe ratio for power and energy in LFMP material</td></tr>
<tr><td>Main result #3</td><td colspan="4">With sulfolane solvent for high voltage electrolyte, the choice of Li salt and binder allows stable SEI formation and steady graphite operation without additives</td></tr>
<tr><td>Number of publications</td><td colspan="4">2</td></tr>
<tr><td>Number of patents</td><td colspan="4">1</td></tr>
<tr><td colspan="5">PROJECT PROGRESS VERSUS KPIs</td></tr>
<tr><td>KPI</td><td>EU 2020 target</td><td>Project target</td><td>Project status</td><td>Comments</td></tr>
<tr><td>Cell (pack) energy density (Wh/kg)</td><td>350 (235)</td><td>195</td><td>130</td><td>1st Generation optimized / 3</td></tr>
<tr><td>Cell (pack) energy density (Wh/L)</td><td>750 (500)</td><td>500</td><td>290</td><td>1st Generation optimized / 3</td></tr>
<tr><td>Cell (pack) power density (W/kg)</td><td>700 (470)</td><td>740</td><td>700</td><td>1st Generation optimized / 3</td></tr>
<tr><td>Cell (pack) power density (W/L)</td><td>1500 (1000)</td><td>1600</td><td>1500</td><td>1st Generation optimized / 3</td></tr>
<tr><td>Cycle life to 80% DOD</td><td>1000-5000</td><td>1000</td><td>500</td><td>Ref Generation</td></tr>
<tr><td>Targeted pack cost (€/kWh)</td><td>90</td><td>350-400</td><td></td><td>Too early</td></tr>
<tr><td>Project-related KPI #1: % of recycled in weight (%)</td><td></td><td>50</td><td></td><td>Too early</td></tr>
</table>

RECOMMENDATIONS FOR FUTURE R&I ORIENTATIONS OR POLICY, TO TAKE THE PROJECT RESULTS FROM LAB TO MARKET	
Recommendation #1	PHEV (autonomy on battery of around 50 km) will cover most of the customer needs and comply with emission regulations, while putting much less constraints on the battery specifications and material resources → there should be some specific efforts for developing batteries for PHEV applications
Recommendation #2	Relevant to validate material improvements in Li-ion cell and to be in link with OEM
Recommendation #3	Fruitful to have academic, RTO and industrials with strong expertise in the field