PROJECT PUBLISHABLE SUMMARY

Grant agreement no.: ELIBAMA
Project acronym: ELIBAMA
Project title: European Li-Ion Battery Advanced Manufacturing for Electric Vehicles
Funding Scheme: Collaborative Project (CP) - Large-scale integrating project (IP)


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1. **SUMMARY DESCRIPTION OF THE PROJECT CONTEXT AND OBJECTIVES:**

ELIBAMA is a 3 year FP7 project dealing with Li-Ion batteries for Electric vehicles manufacturing processes.

In a context of strong competition, especially from Asia, ELIBAMA aims at enhancing and accelerating the creation of a strong European automotive battery industry structured around industrial companies already committed to mass production of Li-ion cells and batteries for EVs.

Started in November 2011, with a budget of 15 M€, the ELIBAMA project will exploit advanced eco-design methods of manufacturing battery cells in order to guarantee drastic gains in cost reduction and environment-friendliness across the value chain of the battery production.

The 17 partners from 5 European countries are focused on the development of eco-friendly processes for electrode production (Work package 1), electrolyte manufacturing, fast and homogenous electrolyte filling processes, cell design and assembly (Work package 2).

The project will also develop new technologies that will allow improving downstream quality and reducing the rate of defective products at the end of the manufacturing chain. Such technologies include introducing clean room manufacturing processes, online high resolution monitoring and inspection solutions and non-destructive testing processes for Li-ion cells (Work package 3).

At the end of the process chain, the recycling and refurbishing of end-of-life Li-ion batteries will be improved in different ways: logistic, diagnostic and dismantling, reuse and maximization of the recycling potential (Work package 6).

All these technical improvements will be closely monitored and validated from the environmental point of view by providing an integrated environmental assessment of the different technologies developed in the course of the ELIBAMA project battery technology (Work package 5).

2. **DESCRIPTION OF WORK PERFORMED AND MAIN RESULTS**

The work is reported against each Work Package, as follows:

**WP1 Electrode manufacturing process development**

The objective of WP1 is to develop different innovative coating processes of electrodes.

- The dry blend electrodeposition process has been set up at lab scale and relevant process parameters improved. In parallel, the first electrochemical characterizations of the obtained electrodes have been performed with encouraging results. The pilot phase (that will be managed in WP4) has been prepared in parallel with different trials performed on mass production equipment.

- Regarding the aqueous based anode process, the first part of the work has been focused on a benchmark of different Titanate based active materials leading to the selection of the most promising one in M6. After, the development at lab scale has been performed and is now finished. The appropriate binder and process parameters have been selected enabling to fully remove the organic solvent NMP. The electrochemical performance of the electrodes has been checked: no difference with the reference has been highlighted. The aqueous based coating process is now ready to be up scaled.
Regarding the NMP free cathode coating, the risk of corrosion has been fixed by adding an additive to the slurry. The optimization of the coating at lab scale is now in progress. In parallel, the calendering performance has been improved: the first results are encouraging.

**WP2 Battery cell manufacturing process development**

The Work package 2 is dedicated to the cell manufacturing processes improvements:

- The innovative LiTFSI based electrolytes’ performances have been benchmarked with the standard LiPF$_6$. In parallel, a new reactor to produce less expensive solvent has been set up and is now being improved. The recycling principle of this electrolyte is validated and will be tested in real conditions in the next months.

- The activities on cells filling are progressing as well: the test plan performed clearly shows improvement path on electrode wettability. A lab tool for the investigation of the electrolyte filling and wetting process is now available.

- The macro structured collector foils process has been set-up and already up-scaled in order to produce bigger more representative foils with two different structure sizes; the development of a micro-structuring process has also started. In parallel, the first filling tests and the first electrochemical measurements showed promising results. The development of the inspection solution for structured collectors has been pursued in parallel.

- The concept for a significantly improved stacking and joining process has been designed with the decoupling of the Z-folder from the cutting stations, a new integrated part carrier and a line shaped joining of the electrodes. The single elements tests have been performed.

**WP3 Battery cell manufacturing process control**

- In the process cleanliness field, a full risk analysis (FMEA type) has been performed: an audit on the electrodes and cells’ production lines enabled to identify the most critical contaminated areas for each step. Based on these results, the implementation of solutions aiming at minimizing the particles in solvents in the mixing stage and in the dry room have started. A similar audit approach also started on the CEA’s equipment.

- The end of production line Non Destructive Test of cells development is progressing well. Extensive testing and characterization process to determine the behavioral difference between healthy and faulty cells are still on-going. In parallel, the NDT algorithms are developed and tested. The overall results till now are cautiously promising.

**WP4 Battery cell production demonstration**

The WP4 is dedicated to the demonstration of the processes developed in the WP1 and 2. Therefore, the activities started later than the other Work packages’ ones.
- The launch of the demonstrator of the dry blend coating process has been prepared (layout, preliminary design, …). The first trials on an existing line have been performed and have to be continued next months.

- Regarding the NMP free manufacturing, the processes are being up scaled and the first industrial batches will be made in the next months.

- The aqueous based anode process already starts to be up-scaled with the first coatings at an intermediate process level. The design of the cell that will be used as the standard for WP4 activities has also been defined.

- The production of “endless” structured foils is also being prepared (even if current equipment already enables to produce a significant amount of structured foils, sufficient to demonstrate the products improvements). The selection of the equipment supplier is expected soon.

**WP5 Eco-design and Life Cycle Assessment**

The main objective of this work package is to provide an integrated environmental assessment of different technologies developed in the course of the project.

- The first part of the period has been dedicated to the definition of the goal and scope of the LCA, the system boundaries and the methodology for data collection.
- The collection of the data from the different partners has then been performed, first at the electrode level and after, at the cell level.
- Different models were created for the different cells and scenarios, representing the baseline scenarios and scenarios reflecting the ELIBAMA developments.
- The first conclusions and recommendations were summarized and shared with the partners.

**WP6 Recycling, refurbishing and recirculation**

The Work package 6 deals with the different batteries’ end of life problematics:

- The end of life batteries’ logistic workshop has first analyzed the different logistic options for the batteries’ take back. A full logistic risk analysis (FMEA type) has then been performed: 10 process steps, 220 functions were identified in the process and 1014 failures were listed for the entire process and a quotation was done to highlight the most important failures to be considered.
- The work performed on different types of EV batteries enabled to develop several methods to discharge used or crashed batteries in safe working conditions.
- A 20% reduction of the discharge and dismantling time of end of life batteries has been achieved.
- After a full market study, 2 options of potential reuse of end of life batteries have been selected (UPS & buffer for renewable energies): the ageing of fresh cells has started and will be pursued with specified second life ageing cycles.
- In order to improve the recycling efficiency, a literature survey has first being launched. It led to a lab scale program that is now initiated. First results were obtained on Titanate electrode recycling, electrolyte recovery and Co and Ni recovery and separation from NCA materials.
- Finally, in parallel to the recycling data collection for LCA and cost evaluations, the guidance for the “batteries design for a high efficient recycling” has been initiated.
WP7 Dissemination and Exploitation

In term of dissemination:

- The ELIBAMA project’s website has been launched end of 2011. It gathers all the useful information on the project, the consortium and the progress of the technical activities (public deliverables, newsletter, …). In less than 1,5 year, more than 20 000 views have been registered on the site.
- During the first period, ELIBAMA’ partners took all the opportunities to present the content and the progress of the project activities. Among the most representative ones, we can highlight :
  - The 2013 EUCAR reception and conference;
  - The ICT4FEV/CAPIRE / EGCI Battery Workshop in 2012 and 2013;
  - ....
- Cross FP7 projects exchanges have also been organized with the eLCAr or Greelion projects for example

As far as Exploitation is concern, the first draft of the PUDF has been prepared with all the partners: it will be followed by an Exploitation Strategy Seminar that will take place in October 2013.

WP8 Management

The Work package 8 deals this all the project management topics:

- During this first period, the standard management activities have been set (monthly executive Committee meeting, resources follow up…).
- The Consortium Agreement of the project has been signed by all the partners.
- A first amendment of the project Description of Work has been validated in M11. A second one is being prepared.
- The project’s partners studied the patents landscape. This document has also updated in M18 (with 286 patents analysed).
- 23 performance indicators have been defined to follow the cost reduction and environmental improvement progress during the course of the project. The assessment has been performed in M18: the results, that still need to be refined, are globally in line with the ambitious expectations.
- 3 interim reports have been submitted to the European Commission during the first 18 months (every 6 months) and 3 Steering Committee Meetings organized.

3. CONCLUSIONS - EXPECTED FINAL RESULTS AND POTENTIAL IMPACTS

The first period of the ELIBAMA project has been mainly dedicated to the development of the beyond the state of the art manufacturing processes at lab scale. In parallel, the pilot phase has been prepared and will be performed during the 18 remaining months of the project.

The overall progress of the technical work is in line with the expectations and the first assessment of the results is very promising.

ELIBAMA opens the way to significantly improved manufacturing processes for the Electric Vehicles batteries’ electrodes and cells, more eco-friendly and less expensive.

The results of the project will provide to the involved partners durable competitive advantages that are expected to be exploit in the future generations of batteries. Thanks to ELIBAMA, the whole EV battery industry in Europe will be strengthened.