GUIDANCE FOR DATA IN PUBLICATIONS

A checklist for Li-batteries process- and equipment parameters in publications

EXECUTIVE SUMMARY

The overall objective of LiPLANET is to support the European innovation and production ecosystem by forming a network of lithium battery cell pilot lines that integrates industrial stakeholders and establishes unique selling propositions towards EU industry in support of its market access within the cell manufacturing ecosystem. Moreover, reinforcing the position of the European Union (EU) in the lithium battery cell manufacturing market will be further achieved by exploiting synergies between pilot line operators, identifying knowledge and equipment gaps, creating common training and standardization initiatives, and ultimately jointly developing strategies for scaling up the impact of the network.

To reinforce the European battery production and to boost innovation, transparent and comparable research is necessary. In addition to cooperation between the European pilot lines and other research facilities in developing common standards, basic information about the circumstances under which published results were generated is the most important aspect to reach this goal. This publication aims to contribute to improve this transparency.

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LiPLANET e.V.
Volkmaroder Straße 5, 38104 Braunschweig | Amtsgericht Braunschweig VR 202117
represented by:
1st chair: Prof. Arno Kwade, Institute for Particle Technology, Technische Universität Braunschweig
2nd chair: Simon Perraud, CEA-Liten

Responsible authors

Robin Moschner Institute for Particle Technology, Technische Universität Braunschweig

Contributors & Reviewers

LiPLANET Expert group “Scientific Exchange”
Prof. Dr.-Ing. Arno Kwade

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1 INTRODUCTION

1.1 LiPLANET in brief

The overall objective of the LiPLANET project is to create a European innovation and production ecosystem and reinforce the position of the European Union (EU) in the lithium battery cell manufacturing market. LiPLANET plans to build a more competitive lithium battery cell manufacturing ecosystem and increase the production of lithium battery cells towards industrial scale, by bringing together the most relevant European lithium battery cell pilot lines and the main stakeholders of the battery sector. The project LiPLANET lays the foundation for a network of battery cell pilot lines in Europe. This network allows to exploit synergies between pilot line operators, identify knowledge and equipment gaps, organize joint trainings as well as, favor collaboration with industry and academia, and facilitate the access to market.

For this purpose, different activities are followed throughout the project:

- mapping of the European lithium battery cell pilot lines and implementation of a network,
- creation of a standardized legal framework and a data exchange platform for the cooperation between industry, academia and pilot lines,
- development of a roadmap for joint strategies of the network towards industrial scale battery cell production in Europe.

1.2 Scope and objective of this deliverable

Process- and equipment parameters/characteristics used for generating research results are often as important as the results themselves, because they enable other members of the scientific community to assess and evaluate these results in greater depth or even recreate them. The following deliverable is intended as a checklist for researchers regarding relevant information about the circumstances of the production of LIB electrodes and cells, which should be outlined in publications.

2 GUIDANCE FOR DATA IN PUBLICATIONS

2.1 Relevant data

Material pre-processing (dry)	
Device	Process parameters
▪ Device name ▪ Device type ▪ Device size (scale)	▪ Duration (batch) or mean residence time (cont.) ▪ Intensity like (tangential) velocity or rpm and tool sizes ▪ Cooling ▪ Mass / mass flow rate of process material ▪ Composition of process material (PSA, tap density)

Processing (wet or dry)	
Device	Process parameters
▪ Dry or wet ▪ Device name ▪ Device type ▪ Device size (scale)	▪ Duration (batch) or mean residence time (cont.) ▪ Intensity like (tangential) velocity or rpm and tool sizes ▪ Cooling and/or degassing ▪ Mass /mass flow rate of process material ▪ Composition of process material (e.g. tap density, PSA, viscosity) ▪ Atmosphere (e.g. vacuum, nitrogen, air)

Coating (wet or dry)	
Device	Process parameters
▪ Self-metered, pre-metered, device type (e.g. slot-die chamber design) ▪ Device name ▪ Device size (scale)	▪ Relevant device parameters (e.g. Coating position (8 o'clock, 12 o'clock…), pressure drop, slurry feeding, device setup) ▪ Areal loading (whole coating and/or active material) and fresh (wet) coating thickness ▪ Coating velocity/web speed ▪ Coating width ▪ Coating pattern (intermittent, stripes etc.) ▪ Atmosphere

Drying	
Device	Process parameters
▪ Drying type (e.g. Convection, conduction, radiation) ▪ Device name ▪ Device size (scale) ▪ Device geometry (e.g. gap between nozzles or emitters, gap to substrate) ▪ Length of Dryer	▪ Drying intensity (e.g. temperature profile, volume flow rate and direction, radiation intensity) ▪ Web speed ▪ Drying duration ▪ Atmosphere

Calendering/Compression	
Device	Process parameters
▪ Device name ▪ Device type (e.g. calender, press) ▪ Device size (scale) ▪ Device setup (e.g. roll diameter, roll width, max. line load, bearing arrangement, operating principle, hydraulic unit)	▪ Web tension ▪ Roll temperature ▪ Calendering pressure / line load ▪ Roll speed ▪ Calendering gap (width) ▪ Coating thickness (homogeneity) ▪ Porosity

Electrode post-drying	
Device	Process parameters
▪ Device name ▪ Device type (e.g. vacuum oven, continuous oven) ▪ Sample geometry (e.g. mother coil, daughter coil, single sheet)	▪ Duration ▪ Temperature (profile) ▪ Pressure (profile) ▪ Atmosphere (e.g. nitrogen, air) ▪ Humidity (in the drying chamber)

Electrode slitting	
Device	Process parameters
▪ Device name ▪ Device type (e.g. knife, laser) ▪ Device size (scale)	▪ Knife geometry / laser parameters ▪ Web speed ▪ Web tension ▪ Web width (slitted, unslitted) ▪ Electrode cutting size ▪ Substrate and coating thicknesses and types

Cell assembly
▪ Cell format and size ▪ Separator type ▪ Electrode types and dimensions ▪ Assembly type (e.g. Z-folding, Stacking) ▪ Bonding (e.g. Type, device name)

Electrolyte filling
▪ Electrolyte type (composition) ▪ Pressure ▪ Temperature ▪ Atmosphere (e.g. argon, nitrogen, air) ▪ Amount of electrolyte

Cell Soaking, Formation and Aging	
Device	Process parameters
▪ Device name ▪ Formation device type (e.g. Maccor, Basytec, EL-Cell) ▪ Climat-chamber type	▪ Soaking time ▪ Temperature ▪ Wetting status ▪ Formation procedure ▪ Voltage range ▪ Aging procedure ▪ Pressure

Degassing & Sealing	
Device	Process parameters
▪ Device name ▪ Device type	▪ Vacuum profile ▪ Amount of exhausted gas ▪ Sealing parameters ▪ Timing of Degassing (in / after formation) ▪ Pressure inside the cell ▪ Gas composition

Cycling	
Device	Process parameters
▪ Device name ▪ Cycling device type (e.g. Maccor, Basytec, EL-Cell) ▪ Climate chamber type	▪ Temperature ▪ Pressure ▪ Cycling procedure ▪ Voltage range ▪ C-rates and current densities ▪ Amount of active material mass

End-Of-Line Tests	
Device	Process parameters
▪ Device name ▪ Device type	▪ Scope and results of the EoL ▪ Electrical control ▪ Control of dimensions ▪ Optical control

2.2 Positive Examples

Baunach, M.; Jaiser, S.; Schmelzle, S.; Nirschl, H.; Scharfer, P.; Schabel, W. (2016): **Delamination behavior of lithium-ion battery anodes: Influence of drying temperature during electrode processing.** In: *Drying Technology* 34 (4), S. 462–473. DOI: 10.1080/07373937.2015.1060497.

Zheng, Honghe; Yang, Ruizhi; Liu, Gao; Song, Xiangyun; Battaglia, Vincent S. (2012): **Cooperation between Active Material, Polymeric Binder and Conductive Carbon Additive in Lithium Ion Battery Cathode.** In: *J. Phys. Chem. C* 116 (7), S. 4875–4882. DOI: 10.1021/jp208428w.

Bauer, Werner; Nötzel, Dorit; Wenzel, Valentin; Nirschl, Hermann (2015): **Influence of dry mixing and distribution of conductive additives in cathodes for lithium ion batteries.** In: *Journal of Power Sources* 288, S. 359–367. DOI: 10.1016/j.jpowsour.2015.04.081.

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www.liplanet.eu
info@liplanet.eu