FRAUNHOFER INSTITUTE FOR MANUFACTURING ENGINEERING AND AUTOMATION IPA

in cooperation with the institutes EEP and IFF of the University of Stuttgart



Future is our product Sustainable. Personalized. Smart.



DIGITALIZATION IN BATTERY CELL MANUFACTURING

Duygu Kaus

Max Weeber, Soumya Singh, Johannes Wanner, Kai Peter Birke

16. Symposium Energieinnovation 2020, 12-14.02.2020, Graz



IPA







- **1** Fraunhofer Institutes and Fraunhofer IPA
- 2 Center for Battery Cell Manufacturing
- **3** What do we offer?
- **4** Battery Cell Manufacturing in Europe
- **5** Digital Twin and its implemantation
- **6** Use Cases
- **7** Ongoing Projects: Digibatt Pro 4.0-BW, DeMoBatt
- 8 Contact us



Fraunhofer Institutes and Fraunhofer IPA Center for Battery Cell Manufacturing What do we offer? Battery Cell Manufacturing in Europe Digital Twin and its implemantation Use Cases

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Fraunhofer-Gesellschaft, the largest organization for applied research in Europe

- Application-oriented research for immediate benefit to the economy and to the benefit of society
- 72 institutes and research units
- 26,600 staff
- €2.6 billion annual research budget totaling. Of this sum, more than

€2.2 billion is generated through contract research

- Roughly two thirds of this sum is generated through contract research on behalf of industry and publicly funded research projects
- Roughly one third is contributed by the German federal and Countries governments in the form of base funding



Fraunhofer IPA

with an interdisciplinary organization, more than 1,000 Employees

Directors: Prof. DrIng. Fritz Klocke and Prof. DrIng. Thomas Bauernhansl Deputy Director: Dr. rer. nat. Michael Hilt							
Location Stuttgart	Resource- efficient Production	Networked Production	Intelligent Automation and Clean Manufacturing	Medical Engineering and Biotechnology	Surface Engineering and Materials Technology	Manufacturing and Process Engineering	
Automotive	Sustainable	Factory Planning	Robot and		Coating Systems	Additive Manufacturing	
Machinery and Equipment Industry	Production and Quality	and Production Management	Assistive Systems	Biomechatronic Systems	and Painting Technology		
Electronics and Microsystems	Management	Corporate Strategy	Ultraclean Technology		Electroplating		
Energy		and Development	Micromanufacturing	Laboratory	Licenoplating	Lightweight Construction Technology	
Medical Engineering and Biotechnology	Efficiency Systems	digITools for Manufacturing	Image and	Automation and Biomanufacturing Engineering	Functional Materials		
Process Industry		Manalactaring	Signal Processing				
Additional Locations							
EPIC – Center of Excellence in Production, Informatics and Control, Budapest	er of Fraunhofer Austria Fraunhofer Project Center oduction, Research GmbH, Wien for Electroactive Polymers I Control, Production and at AIST, st Logistics Management Kansai		Fraunhofer Project Group for Automation in Medicine and Biotechnology (PAMB), Mannheim	Fraunhofer Project Group or Automation in Medicine and Biotechnology (PAMB), Mannheim		Reutlinger Zentrum Industrie 4.0, Reutlingen	
Administration and Business Development							



Laboratory Infrastructure at Fraunhofer IPA



mixing

wet coating

dry coating



assembly - laser welding, electrolyte filling



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Center for Battery Cell Manufacturing Adding manufacturing competencies to the research networks

Stuttgart

Universität

Stuttgart

Karlsruhe

Freiburg

🜌 Fraunhofer

Fraunhofer

Ellwangen

DLR

2 SW





🜌 Fraunhofer

Center for Battery Cell Manufacturing Researching the entire value chain





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Battery Cell Manufacturing in Europe Motivation

Poland – Breslau

Germany – Erfurt

Hungary – Budapest

. . .

Sweden – Skellefteå

GWh/year 15

14

GWh/year 2.5 GWh/year

> 32 GWh/year

planed

Battery Cell Factory Sites

Global production capacities by 2030 ca. 1.200 GWh/year

(estimate)

Political goal for production capacities in Europe by 2030 ca. 360 GWh/year

(Goal: 30 % of worldwide production capacities to be located in Europe)

rightarrow ca. 10 new Gigafactories (à 30 GWh/year) in Europa

Company	Country	Cell Type		
LG Chem	South Korea	Pouch	6 GWh	
Samsung SDI	South Korea	Prismatic	3GWh	
CATL	China	Prismatic	In planning	
Farasis	USA	Pouch	In planning	
Leclanché	Switzerland	Pouch	1 Gwh	
Saft	France	Cylindrical	2 GWh	
Varta Germany		Cylindrical, Pouch	< 1GWh	

Source: Production capacities taken from Manager Magazin (2018)



Current situation in battery manufacturing Manufacturing process quality – ratio between good and reject parts



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What is "Digital Twin?"

intelligent digital prototype of a real product, system or process





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Multi-Hierarchy Digital Twin







Process Digital Twin





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Digital Twin Technology – State estimation for battery cells Determination of battery states Testing Modelling **Decision Support** SoH 100 % **Physical Model** 90 % 80 % 70 % years 0 **Design of Experiments** **Regression Model** Machine Learning (ML) Model Cell Module

*Source: Myall, D.; Ivanov, D.; Larason, W.; Nixon, M.; Moller, H. (2018) Accelerated Reported Battery Capacity Loss in 30 kWh Variants of the Nissan Leaf.



Digital Twin Technology – State estimation for battery cells Determination of battery conditions





Reuse, Remanufacturing, Recycling Battery Disassembly





Reuse, Remanufacturing, Recycling Battery Disassembly





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Ongoing Projects: DigiBattPro 4.0 - BW



Requirements & Concept			Solut	Solution & Implementation			Test & Demonstration		
2019		2020				2021			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
TP 1 Markt Analysis and Technology Assessment VARTA Test & Demonstration TP 2 Scientific evaluation of digitalization concepts IPA Digitalization TP 3 Verification and integration of the digitalization concepts in VARTA CoinPower									
& Electro TP 4 Rese ZSW Electrode	odes arch on elect es	trode materia TP 5 5	als and comp Scaling of hi demonstrati	oonents for h gh-performa on in LIC 217	nigh-perform ance electrod 700	ance cells les and			



Digital Quality Management & Traceability Data Acquisition Technology



Digital Quality Management & Traceability Data Acquisition Technology – Example Electrode Manufacturing

Labeling



- Technology: Laser printer
- Results: Data matrix code
- Challenges: Printing at high machine speeds

Measurement 1



- Technology: Visual Camera
- Parameter: Detection of pinholes
- Challenges: High Resolution needed to detect agglomerations

Measurement 2



- Technology: 3D Laser line sensor
- Parameter: Coating thickness Height anomalies - Edge position and gradient
- Challenges: High data acquisition frequency – Synchronization of data – Requires high color sensitivity



Source: Carsten Glanz – Fraunhofer IPA

Ongoing Projects: DeMoBatt: Automated Battery Disassembly



Quelle: Fraunhofer IPA



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