

Dry but not clean?

Tackling technical cleanliness to reduce scrap in dry electrode manufacturing

Created for:

Dry Coating Forum 2025

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Dry Coating Forum

Shaping the Future of Dry Battery
Electrode Processing

November 3–4, 2025 | Fraunhofer IWS | Dresden



TECHNOLOGY
SOFTWARE
CONSULTING

Facts, figures & data to the point.

> **1800**

Employees from
70 nations



21

Subsidiaries
within the P3



29

years of experience in Europe,
Asia and America



34

Locations on
4 continents

> **70%**

Our employees are
engineers & software developers

100%

Ready for
any challenge

P3 is an international tech consulting company with an excellent footprint in automotive industry and extensive experience along the whole e-mobility value & supply chain.



18

years of international experience in e-Mobility consulting

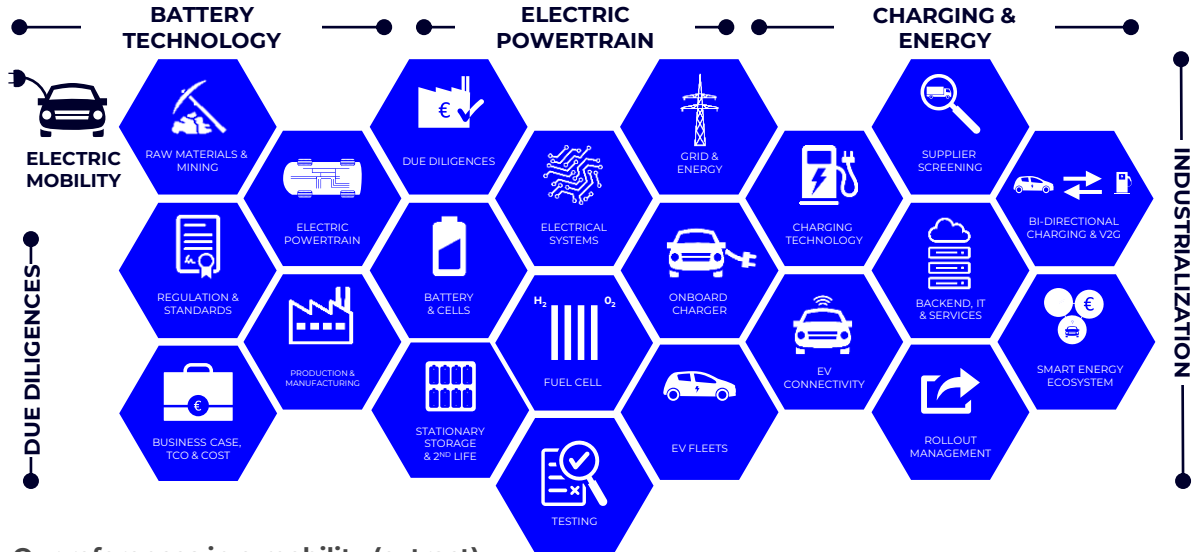
>250

employees around the globe in the tech field of e-mobility

75%

of the employees are engineers and software developers

Our experience in E-Mobility range from strategy development to reverse engineering and cost-down programs in the area of charging, electric powertrain & battery systems.



Our references in e-mobility (extract)





TecSa & Dry Coating

What is Technical Cleanliness

(TecSa) and why is it important to Dry Coating?

What are typical critical **particle size limits** within a battery cell?

What are the **contamination risks** in wet and dry electrode processes?

Why can traditional **prevention and detection methods** not be directly transferred?

Which **alternative solutions** are viable to implement for Dry Coating?



Our agenda for today

1

WHAT IS
“TECSA”?

2

PARTICLE
SIZE LIMITS

3

WET VS.
DRY
PROCESS

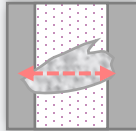
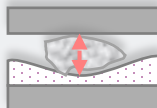
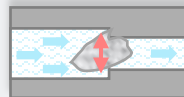
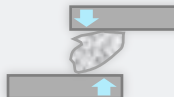
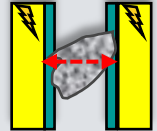
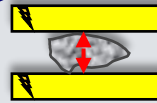
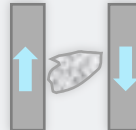
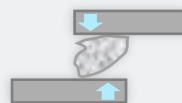
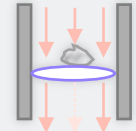
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SOLUTIONS
FOR DRY
COATING

5

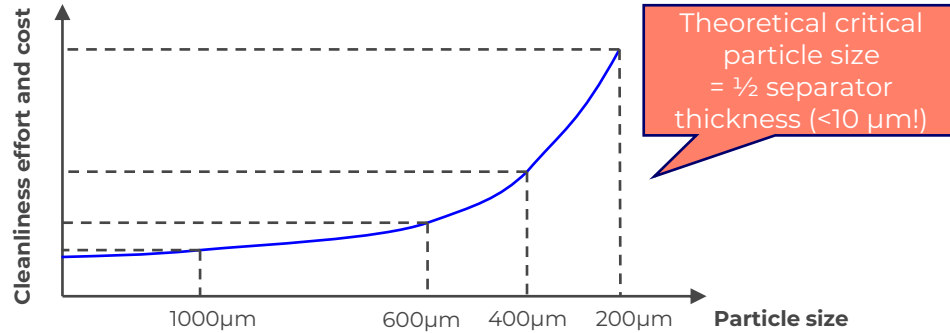
SUMMARY
& OUTLOOK

Main TecSa-related failure modes within battery cells are mechanical damage of separator and insulation tapes or dendritic plating of dissolved metal particles.

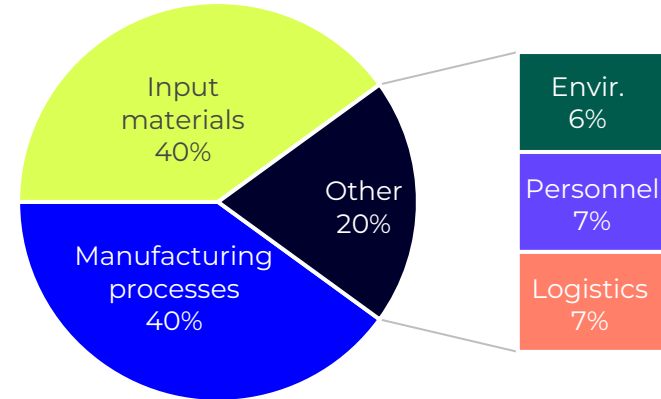
1. Contribution to media-tight systems (leak tightness)		1.1 Particles or fibers exceed the seal		1.2 Particles reduces the sealing contact pressure of the seal		
2. Contribution to fluid-carrying systems (blockage)		2.1 Particles or fibers reduce the flow velocity of the medium.		2.2 Particles block a valve and keep the circuit open	Mechanical damage of separator / insulation tapes or dissolution & dendritic plating	
3. Contribution to electrical systems (Isolation coordination)		3.1 A particle reduces the air and creepage distances of two conductors.		3.2 A particle damages the electrical insulation between two conductors.		
					3.3 A particle increases the distance between two conductors to be connected.	
4. Contribution to mechanical systems		4.1 A particle prevents the precise positioning of a component in the installation space.		4.2 Particles cause wear in a dynamic system.		4.3 Particles block a dynamic system.
5. Contribution to optical systems		5.1 A particle obstructs the beam path in the optics of a sensor.		5.2 Particles on a clean surface cause visual impairment.		

Absolute cleanliness or purity does not exist. Therefore, limit values must be set at a level that is practically feasible and economically reasonable.

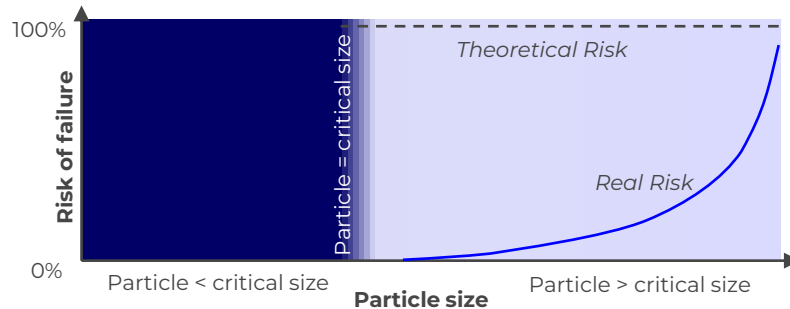
Technical Cleanliness in Design



Technical Cleanliness in Production



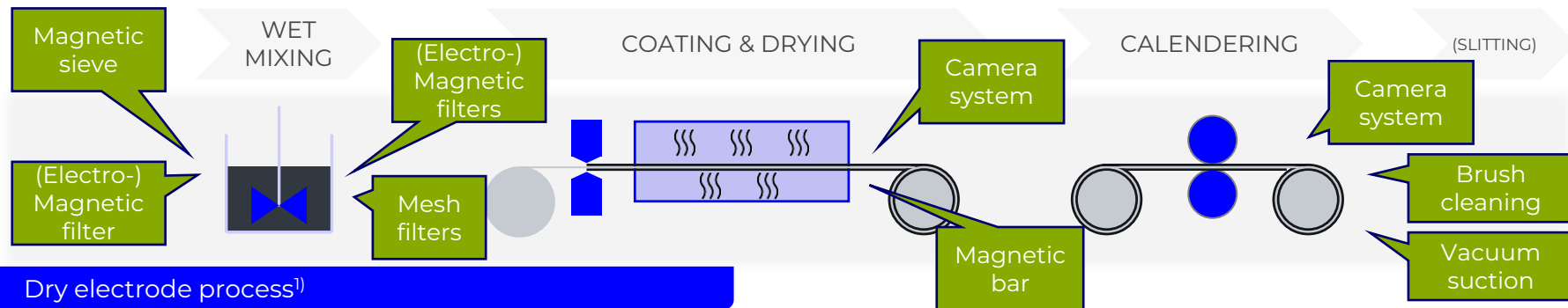
Origin of particle contamination in production



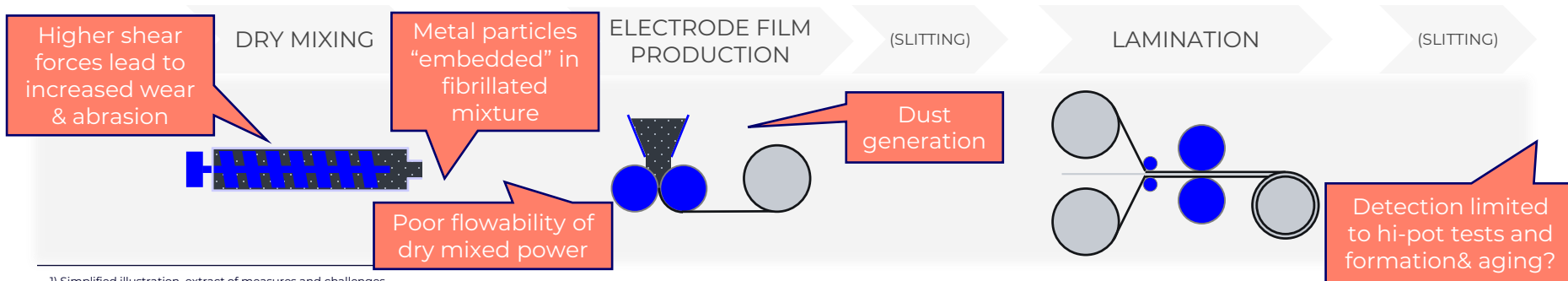
Practical limits typically >100-200 μm

Established wet coating systems have elaborate filtering and quality inspection systems to prevent and detect undesired particle contamination.

Wet electrode process¹⁾



Dry electrode process¹⁾



¹⁾ Simplified illustration, extract of measures and challenges

Since conventional slurry filtration systems are not suitable for poorly flowing powders used in dry coating, new solutions must be found.

Process optimization to avoid contamination

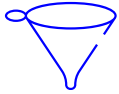


- Wear reduction (e.g., coated mixing screws)
- Shear force optimization
- Process additives



Contamination prevention is key to avoid production scrap and reduce risk of short circuits in final battery cell!

Contamination removal



- Permanent magnetic rotary filters for fibrillated mixture (to ensure flowability and remove metal contaminants)
- Vacuum suction (to remove dust in calendering / edge cutting)



Selective removal of unavoidable particle contamination.

Quality inspection



- Inline metrology to detect foreign particles (e.g., vision systems)
- Offline measurement for samples (e.g., ICP)



Detection of undesired particles as early as possible in the process to reduce scrap costs in later stages.

1) Not focus of today's presentation, has been covered within last year's P3 presentation on Dry Coating Forum 2023



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Relevant key takeaways.

- Technical cleanliness has a **significant impact on product quality and is a core driver of scrap rates**.
- Absence of liquid phases in **dry electrode processing impedes effective filtering and inline detection** of metallic particles.
- **Process optimization and dedicated filtering systems are required** to avoid and remove undesired particle contamination
- By **proactively managing cleanliness**, manufacturers can reduce avoidable scrap, **improve yield rates**, and support the reliable integration of dry coating into high-volume battery production lines.

We are within reach.



Dr.-Ing. Joscha Schell

Team Lead

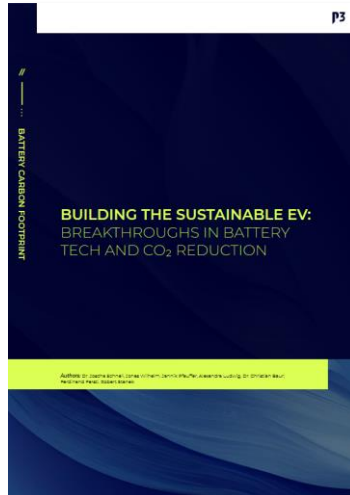
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P3 is at the forefront of consulting in energy storage technologies along the entire value chain, from raw material procurement to evaluating different cell technologies to developing efficient storage concepts.



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