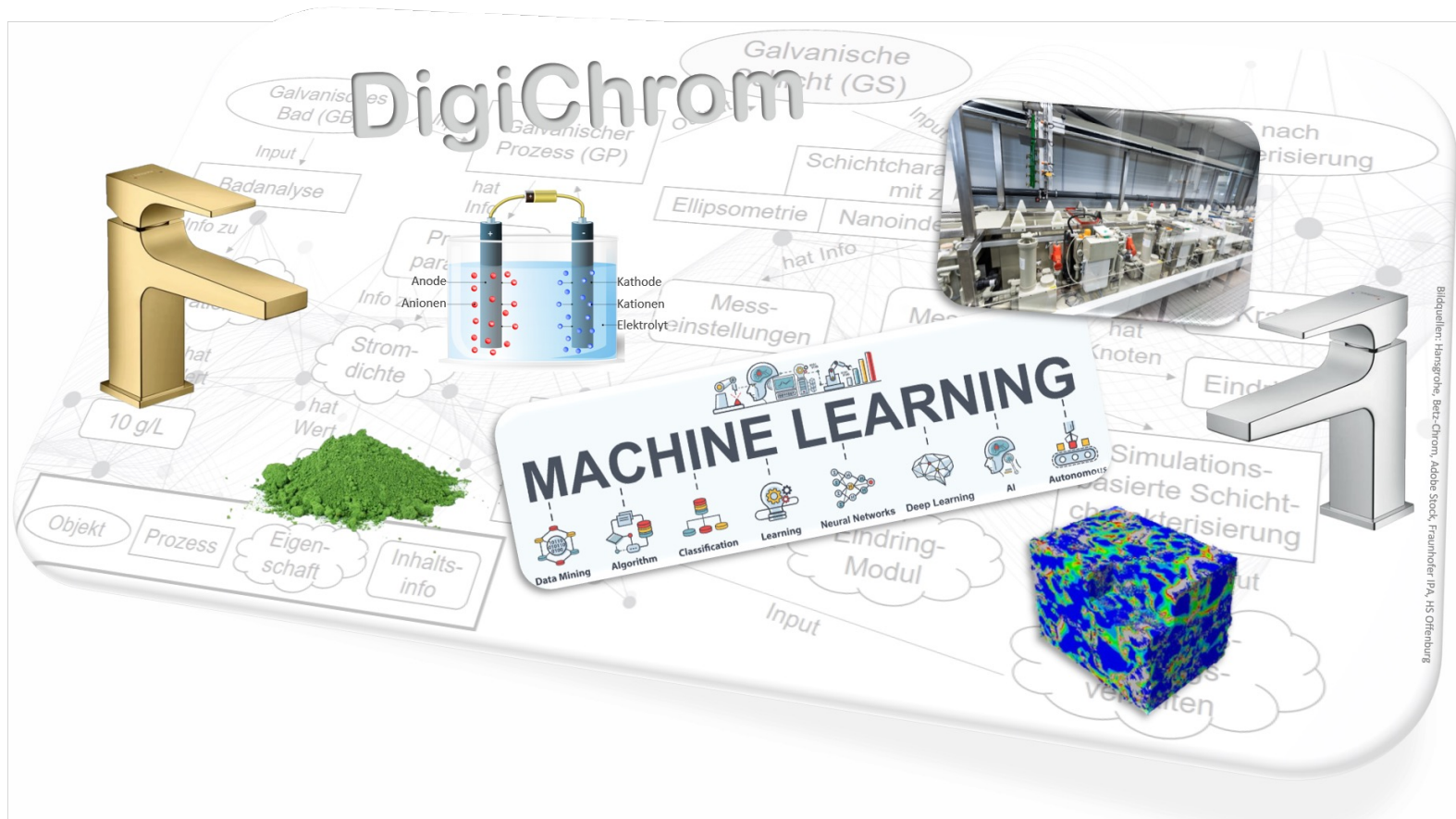
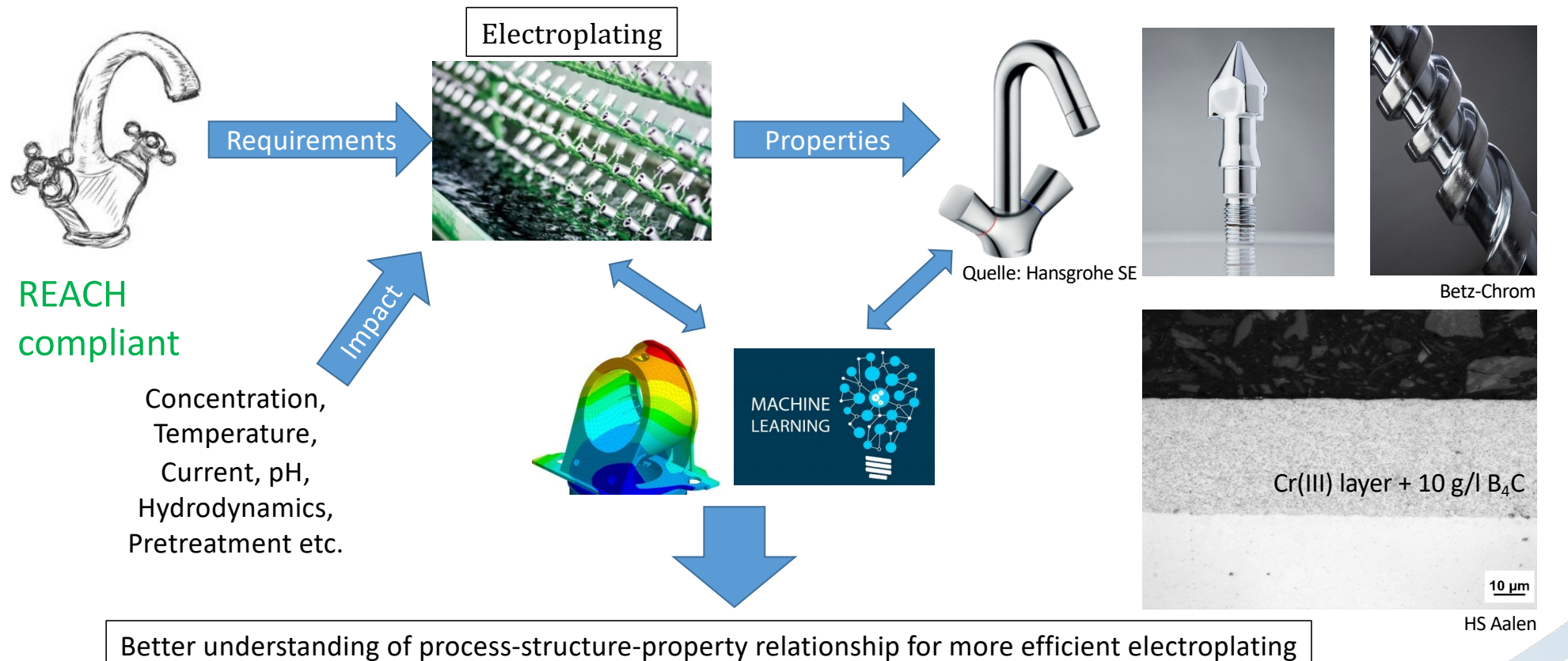


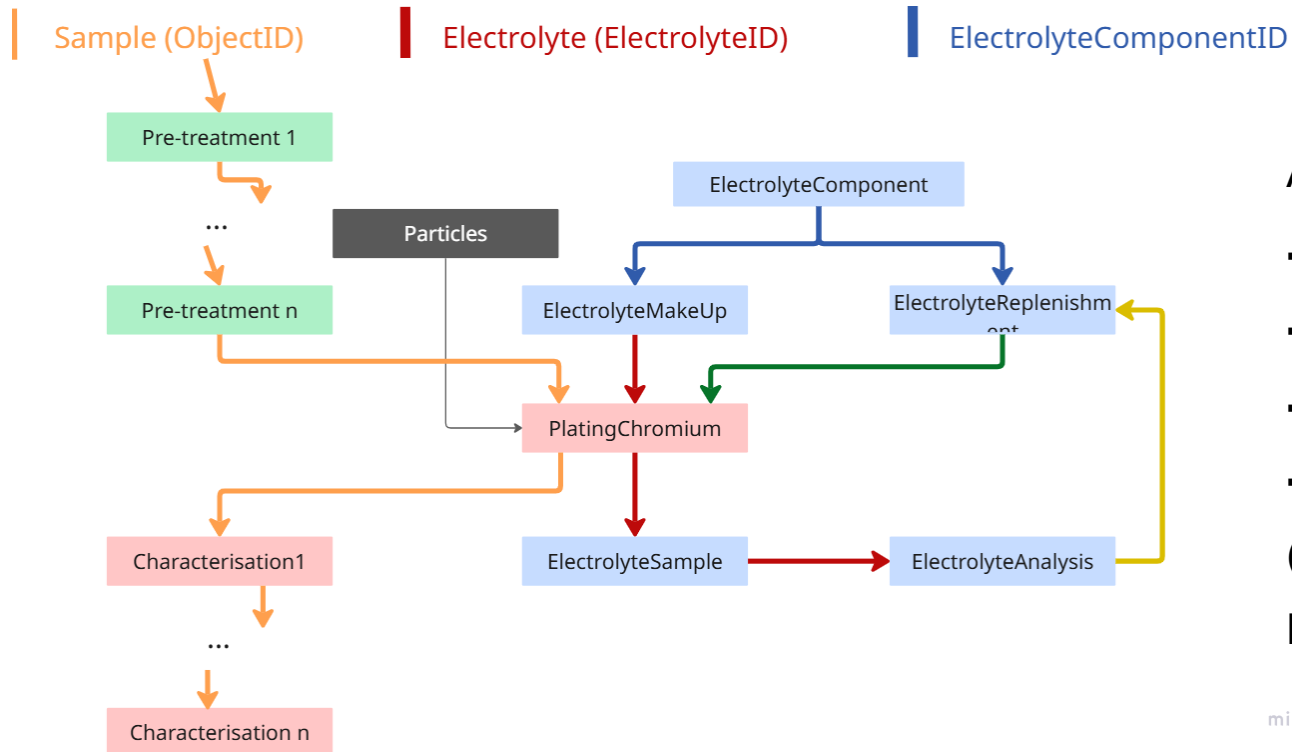
# Ontology-based data structures and workflows for electroplating



# Project goals



# PlatingOntology (PLATON)



Actual status:

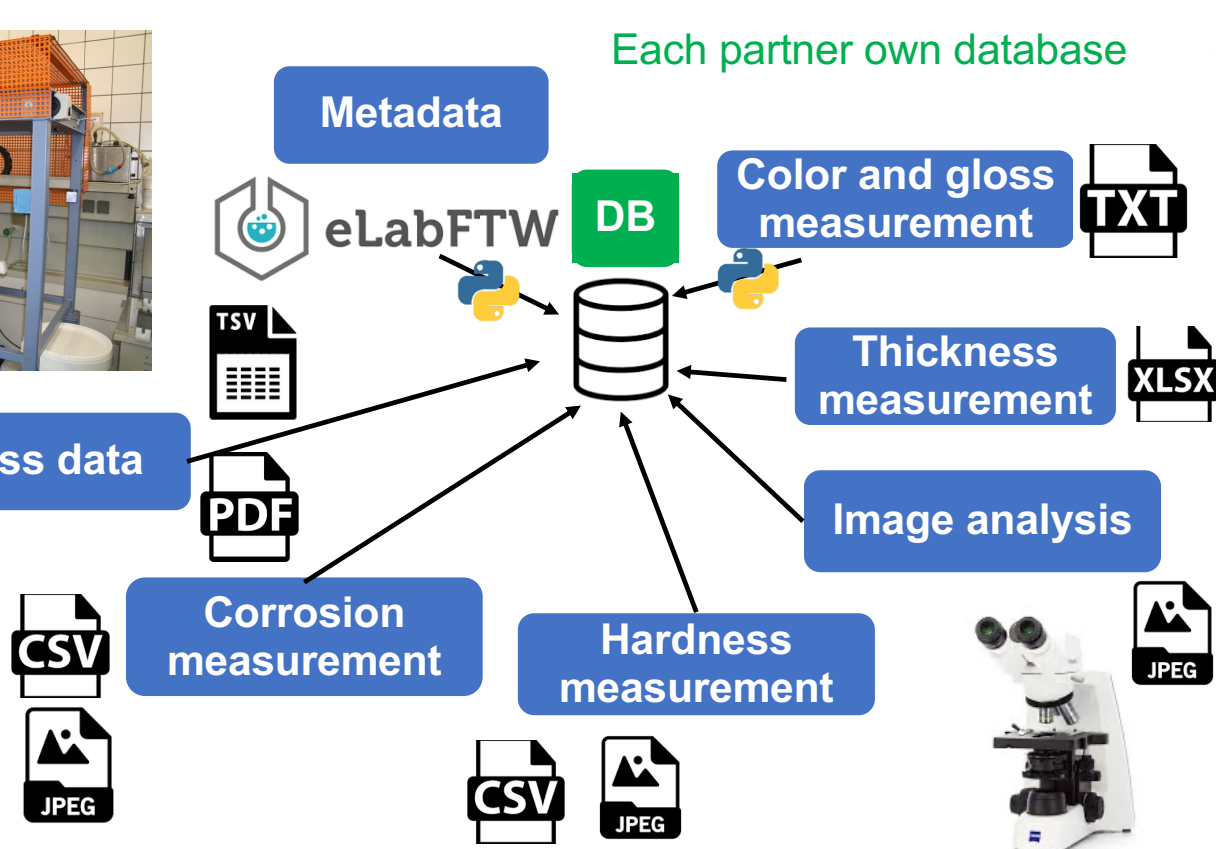
- 36 processes
- 1247 classes
- Based on mid level ontology BMWD
- Mapped on PMDco 3.0

(Janik Harter, Advanced Engineering Materials, 2026)

miro



# Data generation



# Data storage

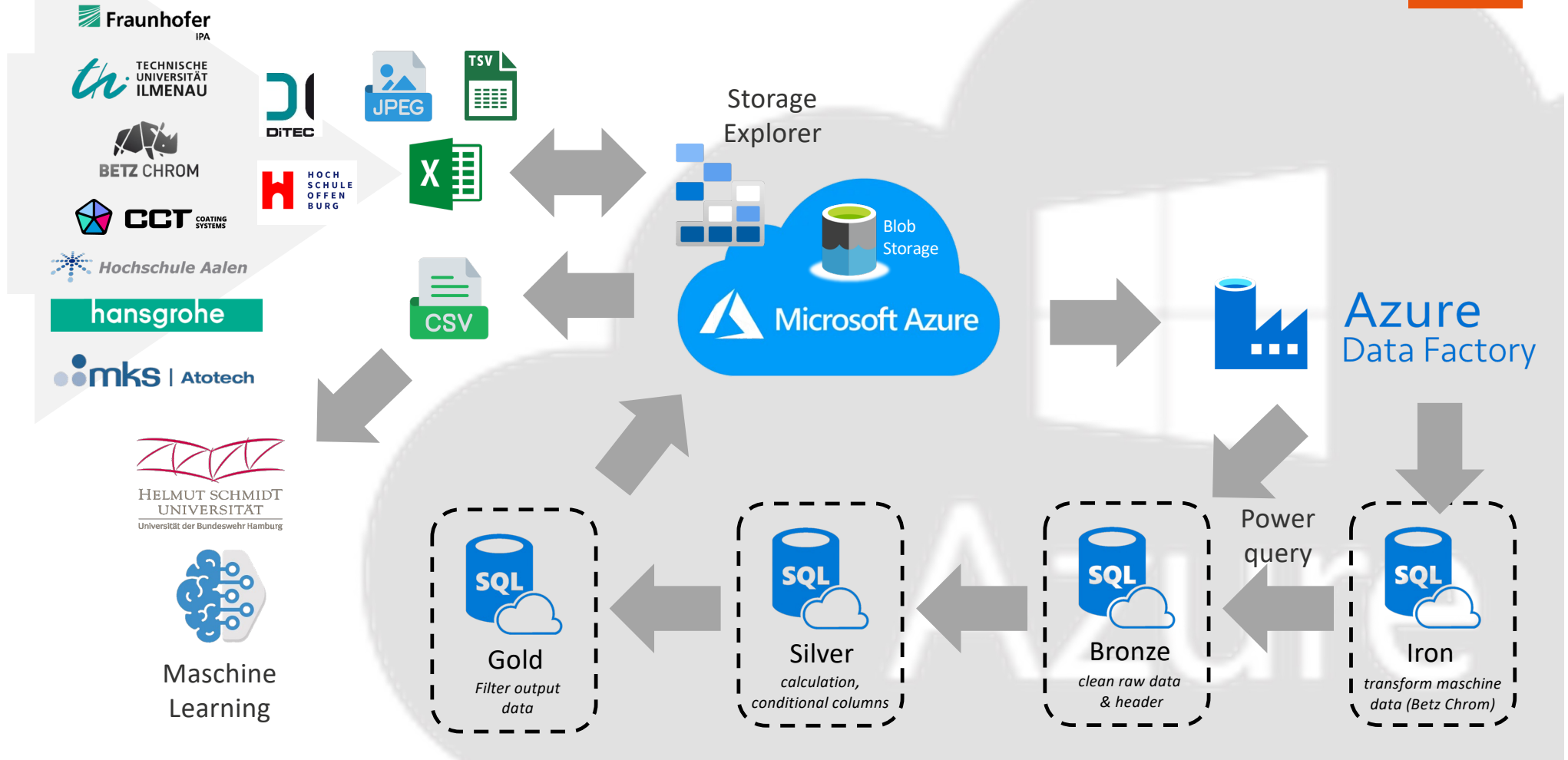


|                                                 | Graph Database                                                                                 | Relational Databases                                                                                                                                                                                         |
|-------------------------------------------------|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Structure                                       | Network-shaped                                                                                 | Tabular                                                                                                                                                                                                      |
| Flexibility                                     | High                                                                                           | Fixed structure                                                                                                                                                                                              |
| Data import/preparation<br>(DigiChrom specific) | Uniform input mask                                                                             | Mapping of partner data                                                                                                                                                                                      |
| Ontology                                        | Integrated                                                                                     | External (later mapping layer<br>over tables)                                                                                                                                                                |
| Interoperability                                | Must be tested                                                                                 |                                                                                                                                                                                                              |
| Queries                                         | SPARQL                                                                                         | SQL                                                                                                                                                                                                          |
| Software                                        | <br>GraphDB |  Azure<br>Data Factory  PostgreSQL |



# DigiChrom workflow

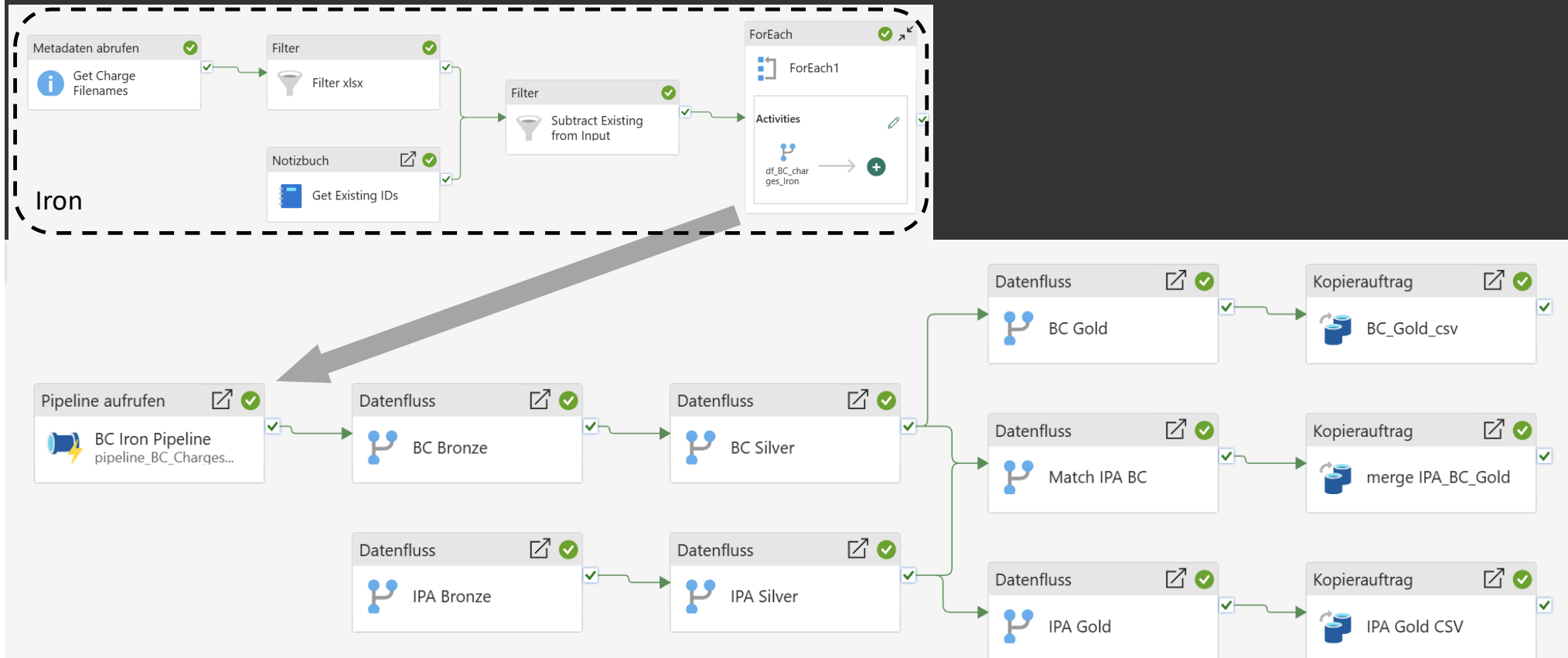
PlanB.  
the digital product factory



# Creating SQL-Databases

## DATA FACTORY

PlanB.

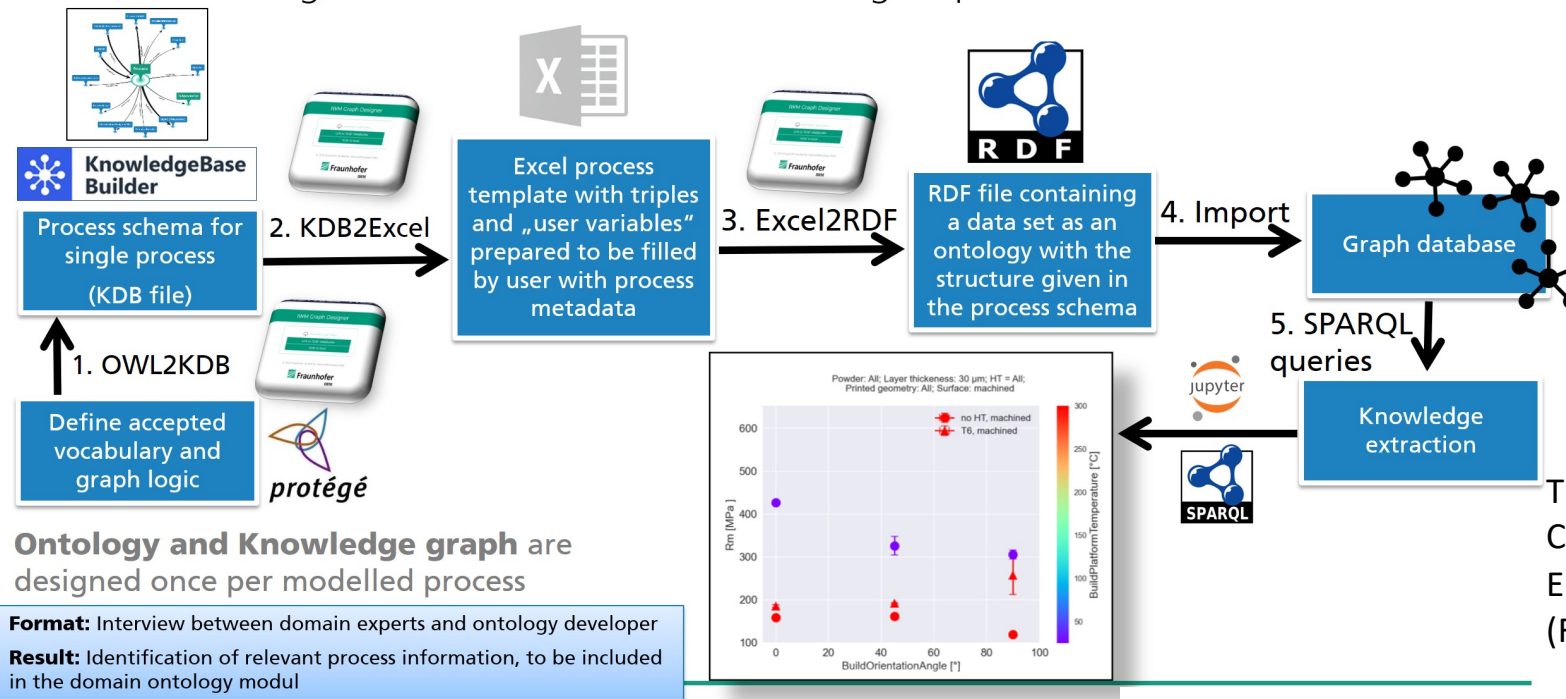


# Creating Graph database



## Semantic data structures

Process data digitalization workflow to create digital process chains



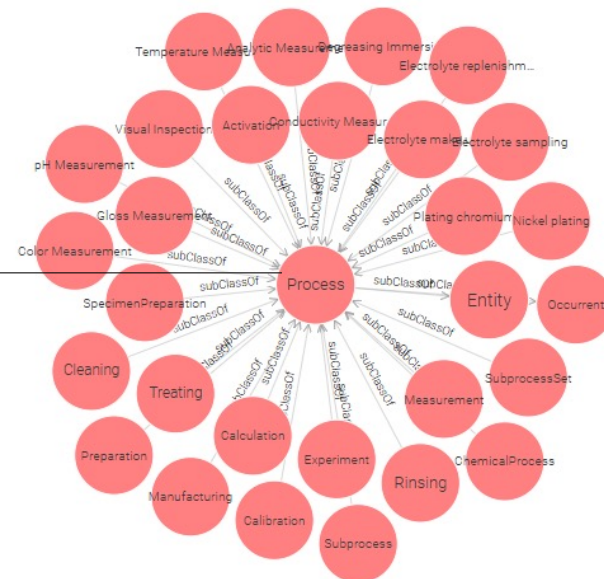
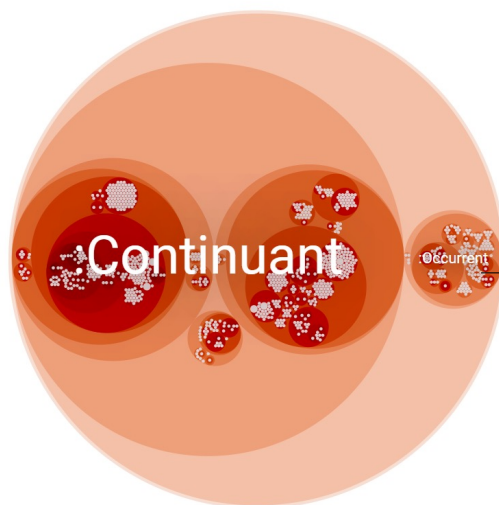
Thanks to  
Christoph Schweitzer  
Elena Garcia Trelles  
(Fraunhofer IWM)

[GF7\\_public / IWM-GDTool · GitLab](#)

3

© Fraunhofer





Name

Size

|                                     |                                                               |           |
|-------------------------------------|---------------------------------------------------------------|-----------|
| <input type="checkbox"/>            | <input type="checkbox"/> merged_all.ttl                       | 72.93 mb  |
| <input checked="" type="checkbox"/> | Imported successfully in 2m 51s.<br>Added 1305304 statements  |           |
| <input type="checkbox"/>            | <input type="checkbox"/> BWMD_Ontologie+Platon_20251023_2.owl | 665.24 kb |
| <input checked="" type="checkbox"/> | Imported successfully in 1s.<br>Added 6198 statements         |           |

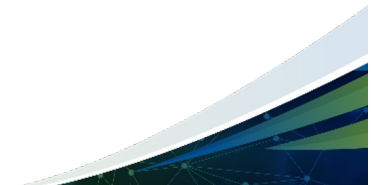
Actual status:

Data from 1 partner

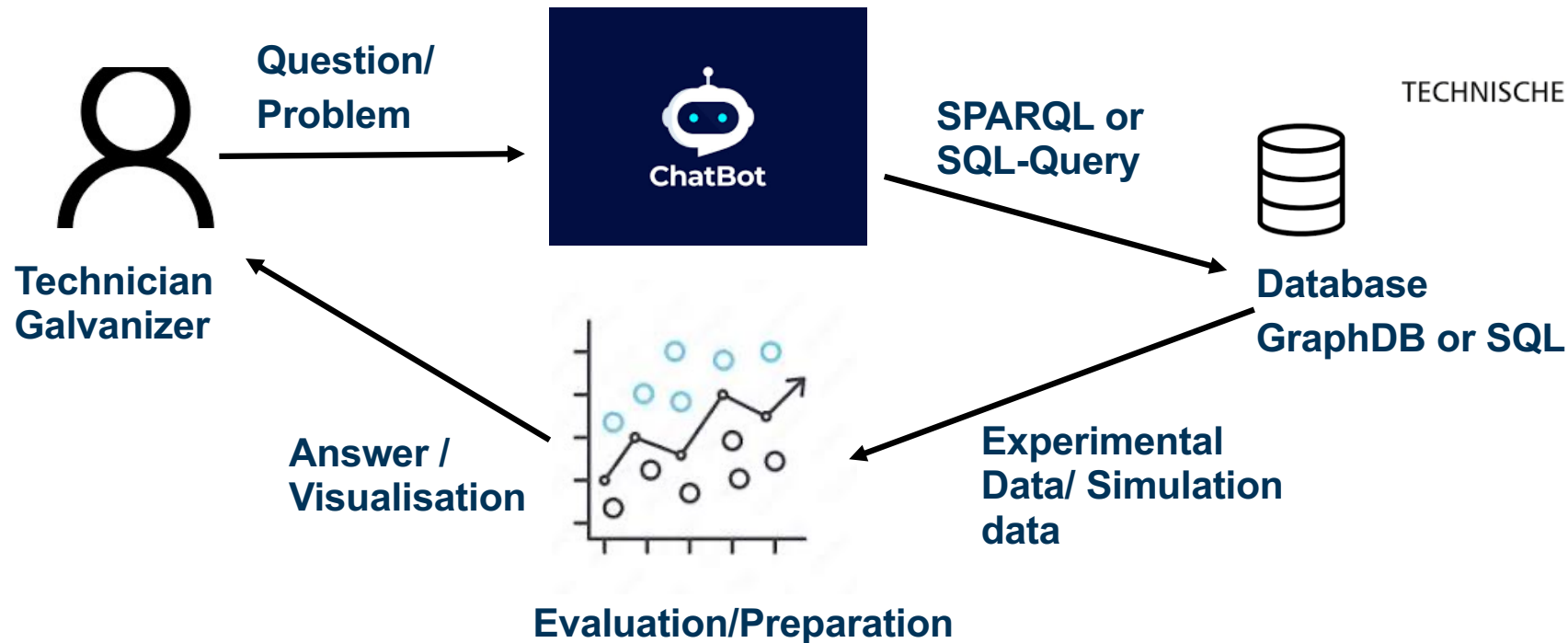
323 experiments/plated layers



# Use Case - DigiChrom



# Use Case



 TECHNISCHE UNIVERSITÄT  
ILMENAU

[DigiChrom – Dual Chatbot](#)



# Chatbot Color



## DigiChrom – GraphDB & SQL Chatbot

How is the mean color for TUI0014 in SCI modus?

Senden

?paramSet bwmd:hasPart ?parameter .

```
# L*
OPTIONAL { ?parameter a bwmd:L ;      bwmd:hasValue ?L_value . }
# a*
OPTIONAL { ?parameter a bwmd:a ;      bwmd:hasValue ?a_value . }
# b*
OPTIONAL { ?parameter a bwmd:b ;      bwmd:hasValue ?b_value . }
# DeltaE00
OPTIONAL { ?parameter a bwmd:DeltaE00 ; bwmd:hasValue ?dE_value . }

FILTER(CONTAINS(?objectID, "TUI0014"))

}
GROUP BY ?objectID
ORDER BY ?objectID
```

Antwort:

| objectID | L          | a         | b       | DeltaE00     |  |  |  |
|----------|------------|-----------|---------|--------------|--|--|--|
| TUI0014  | 8.2129e+01 | -5.06e-01 | 9.2e-02 | 2.159194e+00 |  |  |  |

### SQL-Ausgabe:

➡ Frage: How is the mean color for TUI0014 in SCI modus?

```
SQL:
SELECT
  AVG(f."L*(D65)") AS mean_L,
  AVG(f."a*(D65)") AS mean_a,
  AVG(f."b*(D65)") AS mean_b
FROM digichrom.farbe f
JOIN digichrom.versuch v ON f.versuchid = v."Versuch ID"
WHERE v."Versuch" = 'TUI0014' AND f."Glanzkomponente" = 'SCI';
```

Antwort:

|                     |                       |                      |
|---------------------|-----------------------|----------------------|
| mean_l              | mean_a                | mean_b               |
| 82.1290000000000000 | -0.506000000000000000 | 0.092000000000000000 |



# Chatbot thickness



## DigiChrom – GraphDB & SQL Chatbot

How is the mean chromium thickness at temperature [°C] 55, time 8 min and pH 3.4?

Senden

|         |                               |                               |              |
|---------|-------------------------------|-------------------------------|--------------|
| TUI2261 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 4.42482e-01  |
| TUI2262 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2262 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 1.83234e-01  |
| TUI2263 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2263 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 3.312013e-01 |
| TUI2264 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2264 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 3.070053e-01 |
| TUI2265 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2265 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 1.149607e-01 |
| TUI2266 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2266 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 4.95714e-01  |
| TUI2267 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2267 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 2.008407e-01 |
| TUI2268 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2268 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 5.974513e-01 |
| TUI2269 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2269 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 1.46304e-01  |
| TUI2270 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2270 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 2.742387e-01 |
| TUI2271 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2271 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | -2.86e-04    |
| TUI2272 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | µm           |
| TUI2272 | https://www.iwm.fraunhofer... | https://www.iwm.fraunhofer... | 1.918827e-01 |

### SQL-Ausgabe:

➡ Frage: How is the mean chromium thickness at temperature [°C] 55, time 8 min and pH 3.4?

SQL:

```
SELECT AVG(sd."Schichtdicke Cr") AS mean_chromium_thickness
FROM digichrom.schichtdicke sd
JOIN digichrom.versuch v ON sd.versuchid = v."Versuch ID"
WHERE v."Temperatur IST [°C]" = 55
      AND v."Expositionszeit IST [min]" = 8
      AND v."pH IST" = 3.4;
```

Antwort:

```
mean_chromium_thickness
0.21239541512915129151
```



# Chatbot electrolyte composition



## DigiChrom – GraphDB & SQL Chatbot

How was the electrolyte of TUI0080?

Senden

```
OPTIONAL {  
  ?component bwmd:hasIdentifier ?unitID .  
  ?unitID a bwmd:Unit ;  
  bwmd:hasStringLiteral ?Unit .  
}  
FILTER(CONTAINS(?ObjectID, "TUI0080"))  
}  
ORDER BY ?ObjectID ?ComponentName
```

Antwort:

| ObjectID | ComponentName           | Quantity | Unit |
|----------|-------------------------|----------|------|
| TUI0080  | TriMac BLUE Additive RM | 0        | mL/L |
| TUI0080  | TriMac BLUE Brightner   | 0        | mL/L |
| TUI0080  | TriMac BLUE Buffer      | 90       | g/L  |
| TUI0080  | TriMac BLUE CS          | 175      | g/L  |
| TUI0080  | TriMac BLUE Complexor   | 20       | mL/L |
| TUI0080  | TriMac BLUE Initial     | 50       | mL/L |
| TUI0080  | TriMac BLUE Replenisher | 0        | mL/L |
| TUI0080  | TriMac BLUE Wetter      | 0        | mL/L |
| TUI0080  | Trimac Blue Chrome      | 150      | mL/L |
| TUI0080  | Trimac Blue Stabilizer  | 0        | mL/L |

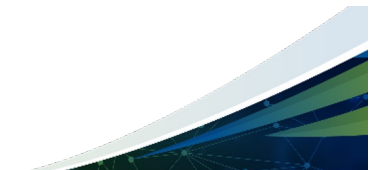
### SQL-Ausgabe:

→ Frage: How was the electrolyte of TUI0080?

```
SQL:  
SELECT v."Chromelektrolyt ID", c."Chromelektrolyt"  
FROM digichrom.versuch v  
JOIN digichrom.chromelektrolyte c ON v."Chromelektrolyt ID" = c."Chromelektrolyt ID"  
WHERE v."Versuch" = 'TUI0080';
```

Antwort:

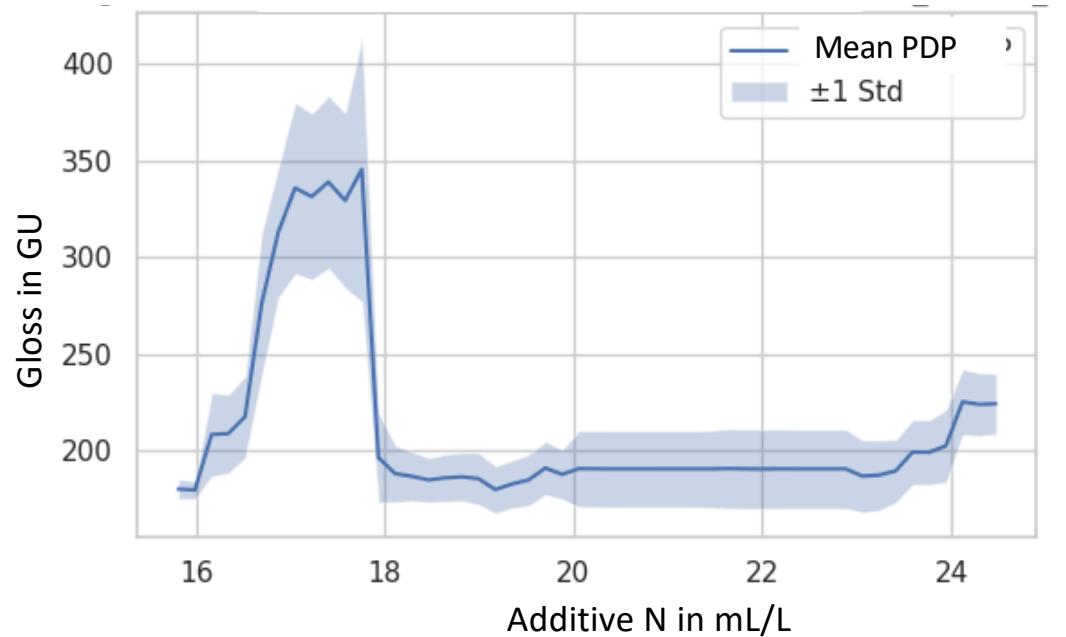
Chromelektrolyt ID Chromelektrolyt  
11 TriMac Blue



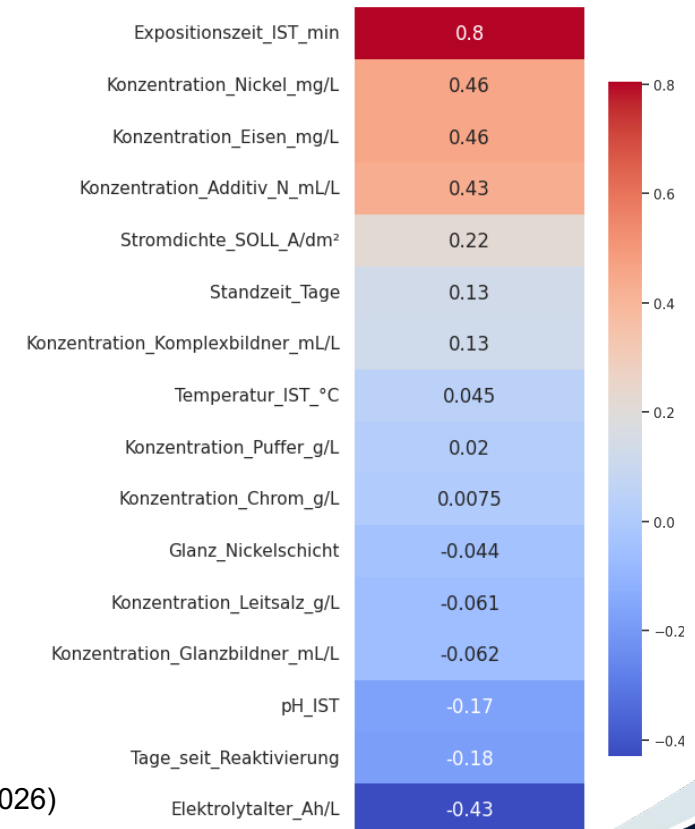
# Machine Learning



Partial Dependence Plot



Impact of Features



(Christopher Mai, Advanced Engineering Materials 2026)

MaterialDigital General Assembly 2025, 27.11.2025



Dr. Christoph Baumer

# Optimization Box



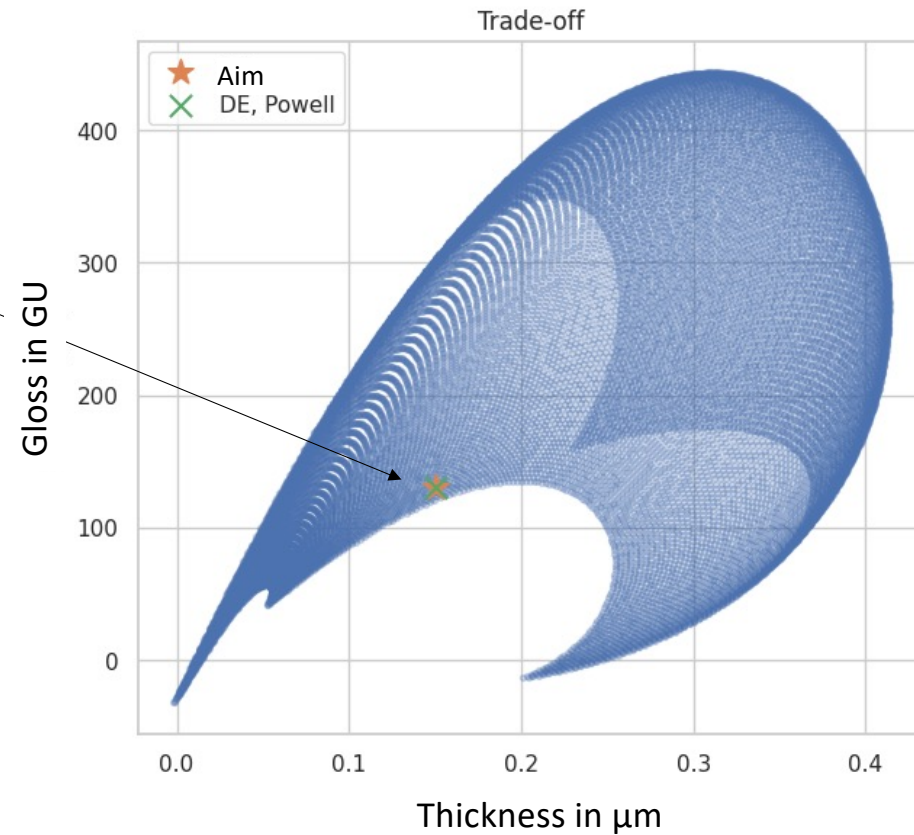
Targets: Thickness  
Gloss

Variable:

- Electrolyte use life: 28
- Additive: 26

Fix:

- Temperature: 55°
- Chromium concentration: 10.5 g/L



MaterialDigital General Assembly 2025, 27.11.2025

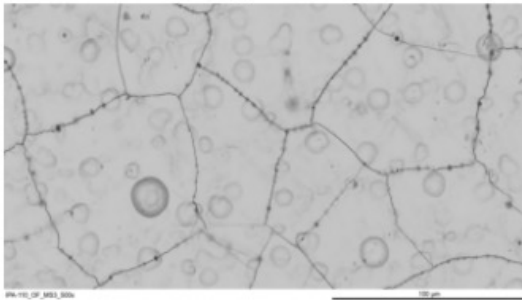


Dr. Christoph Baumer



# Image analysis

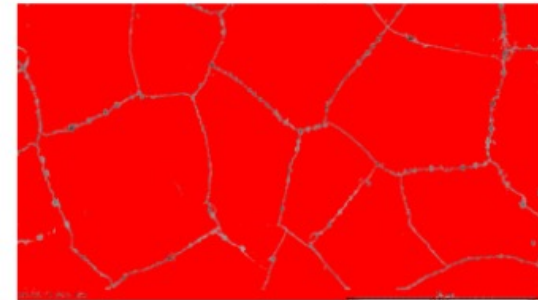
Originalbild



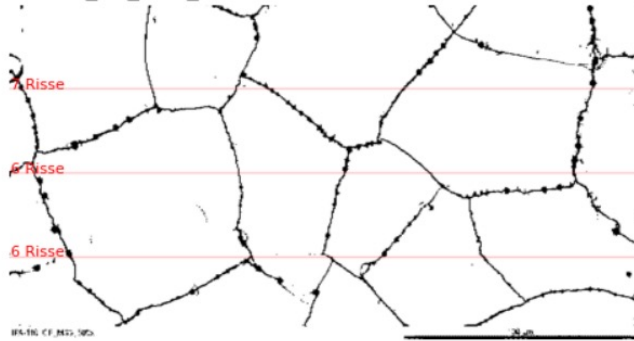
Vorhersagemaske



Overlay



IPA-110\_OF\_MS3\_500x.tif - Durchschnitt Risse/Linie: 6.33



- Image analysis for counting the crack density of hard chrome layers
- Deep Learning: Extracting crack masks through image segmentation



# Outlook



- Improvement of chatbots/query systems
- Integration of graphical analyses and machine learning results
- Possibly application of RAG(Retrieval Augmented Generation) or finetuning
- Expansion of the GraphDB with data from additional partners
- Generation of a larger database
- Measurements regarding the composition and structure of the layers
- Process – Structure - Properties



Thank you!

