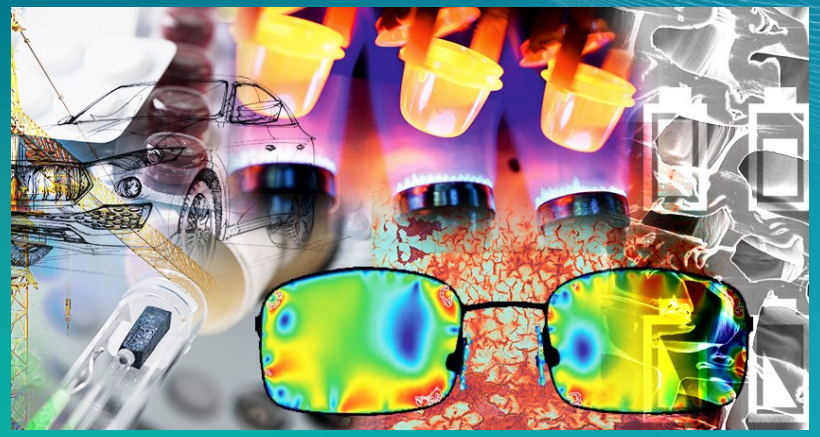
Lukas Gold, Simon Stier

# Ontologies for the Battery Value Chain

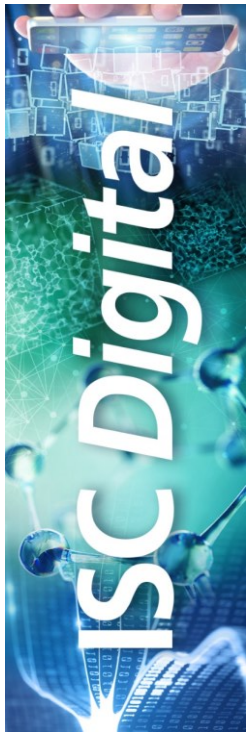


**Fraunhofer Institute for Silicate Research ISC**

# Applied Material Science

# Digital Transformation @ Fraunhofer ISC

## Mission




Cloud connection and international cross-linking

**Ontologies and semantic data spaces**

Hybrid information systems


**Machine readable**

**AI, ML & Modeling**

**Human operable**

Industry 4.0 (Lab & Fab)

**IoT / OPC UA**

**Automation & Robotics**

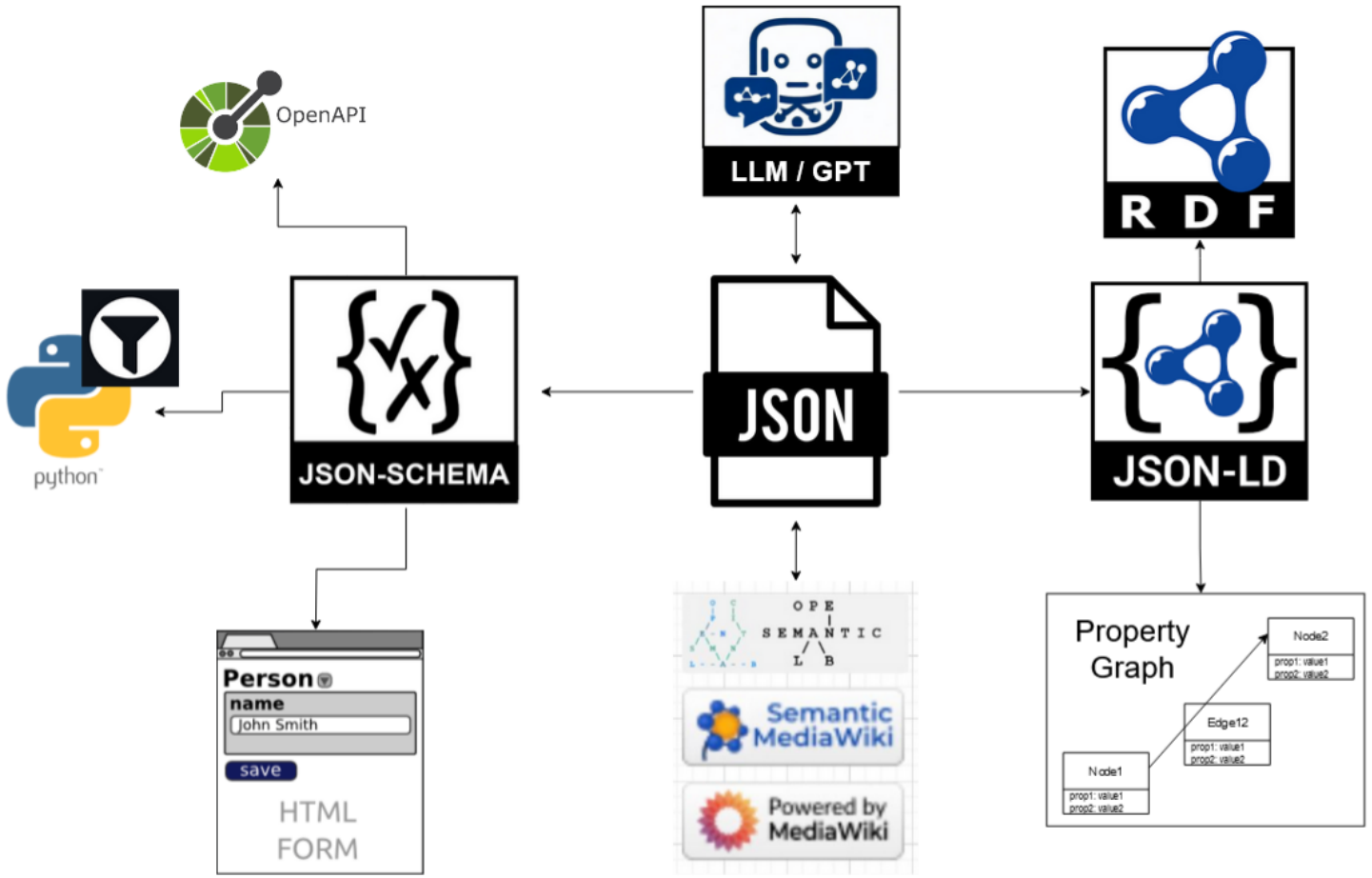
**Manual Tasks**

# Motivation

## FAIR Data Principles

**FAIR Data**
**F**indable
**A**ccessible
**I**nteroperable
**R**eusable
go-fair.org

## Reuse of Established Technologies

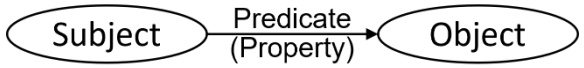


# Theoretical Background

## Taxonomy & Ontology

### Semantic triple



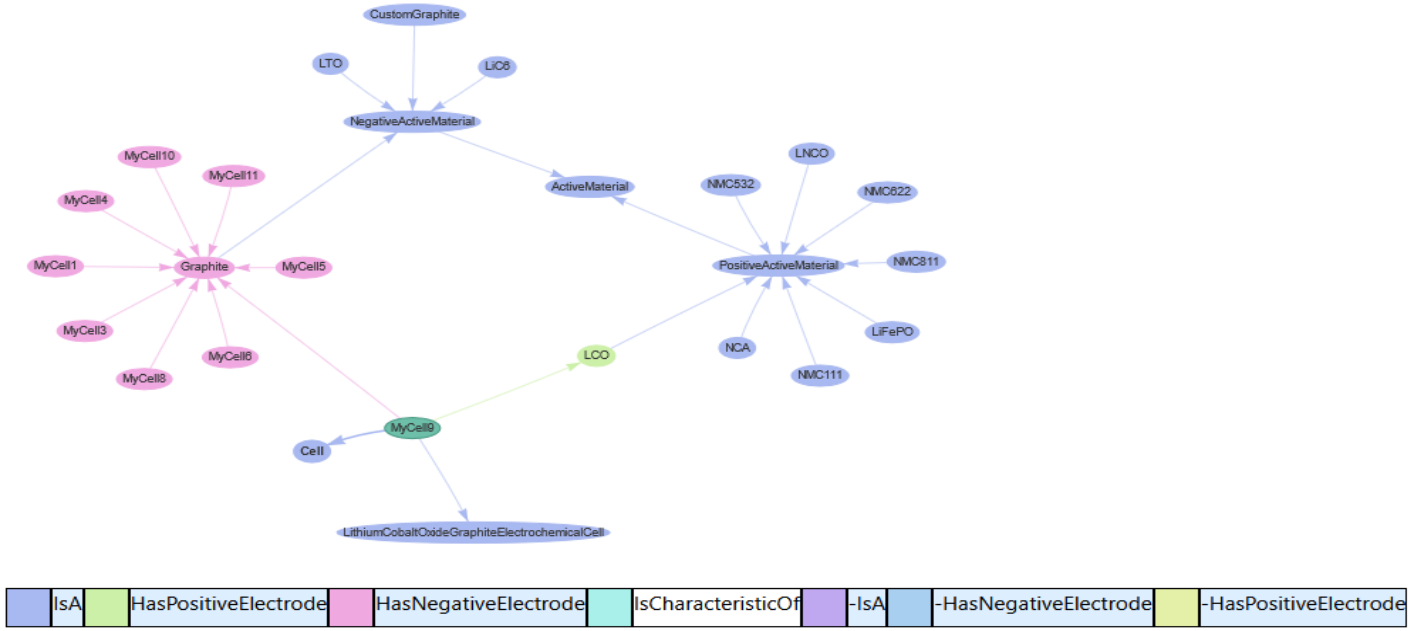

### Taxonomy

- Solely build on «IsA» relations
- A classification in a hierarchical system

### Ontology = Taxonomy + Extra Relations

- Structures and formalized knowledge
- Instances of concepts
- Linked and inherited ontologies

Ontology example

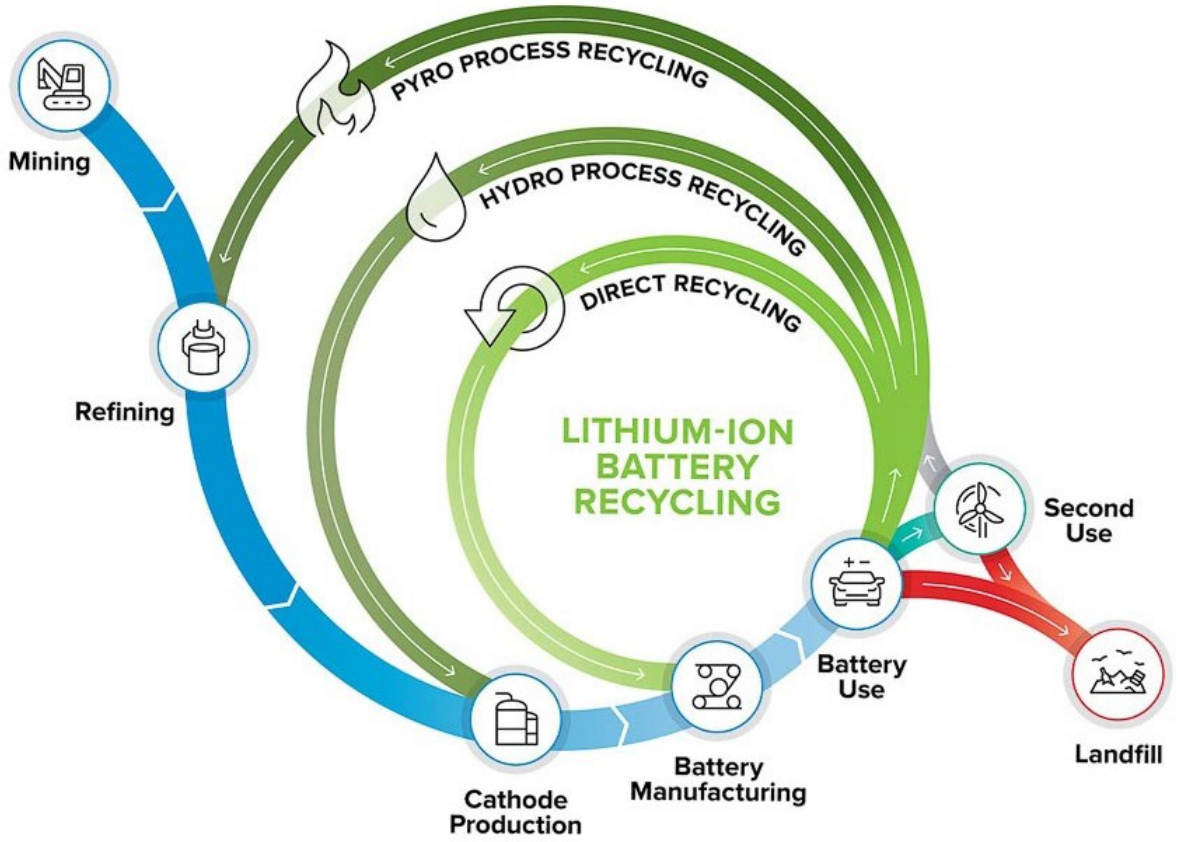


# Concept
## Overview

### Focus of the Battery Value Chain Ontology BVCO

- Material Sourcing and Refinement Process
- (Active) Material Synthesis Process
- Battery Cell Production
- Testing
- Usage & Life
- Recycling




© https://cicenergigune.com/en/blog/battery-recycling-industry-europe

# Concept

## Components: Base and Extension

- **EMMO:** Elementary Multiperspective Material Ontology
  github.com/emmo-repo/EMMO
- **BattINFO:** Battery INterFace Ontology
  github.com/BIG-MAP/BattINFO
- **GPO:** General Process Ontology
  github.com/General-Process-Ontology/ontology
- **BVCO:** Battery Value Chain Ontology
  github.com/Battery-Value-Chain-Ontology/ontology

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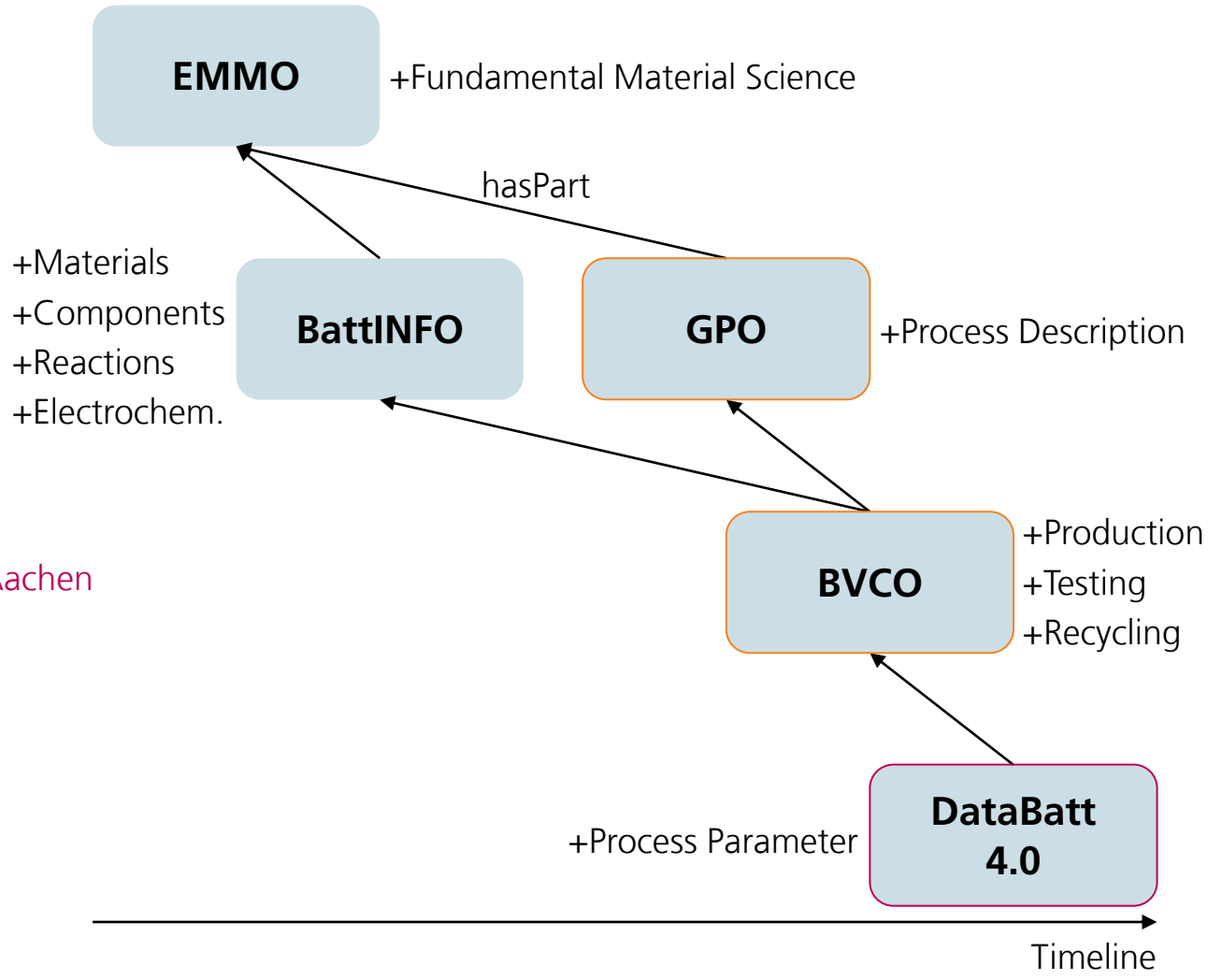
- **DataBatt-4-0:** The Process Paramater Ontology
  github.com/DataBatt-4-0/ontology

RWTH Aachen



# Concept

## Progress Report

**BVCO**

### Process Description

| Cell type | Laboratory | Industrial |
|---|---|---|
| Coin | ✗ | ✗ |
| Pouch | ✓ | ✓ |
| Prismatic | ✗ | ✓ |
| Cylindrical | ✗ | ✓ |
| Laboratory | ✗ | |

**Open for Contributions**

**DataBatt 4.0**

### Inputs

- Batteries & Supercaps Paper
- DataBatt
- KIproBatt

InZePro

Integration of Vocabulary

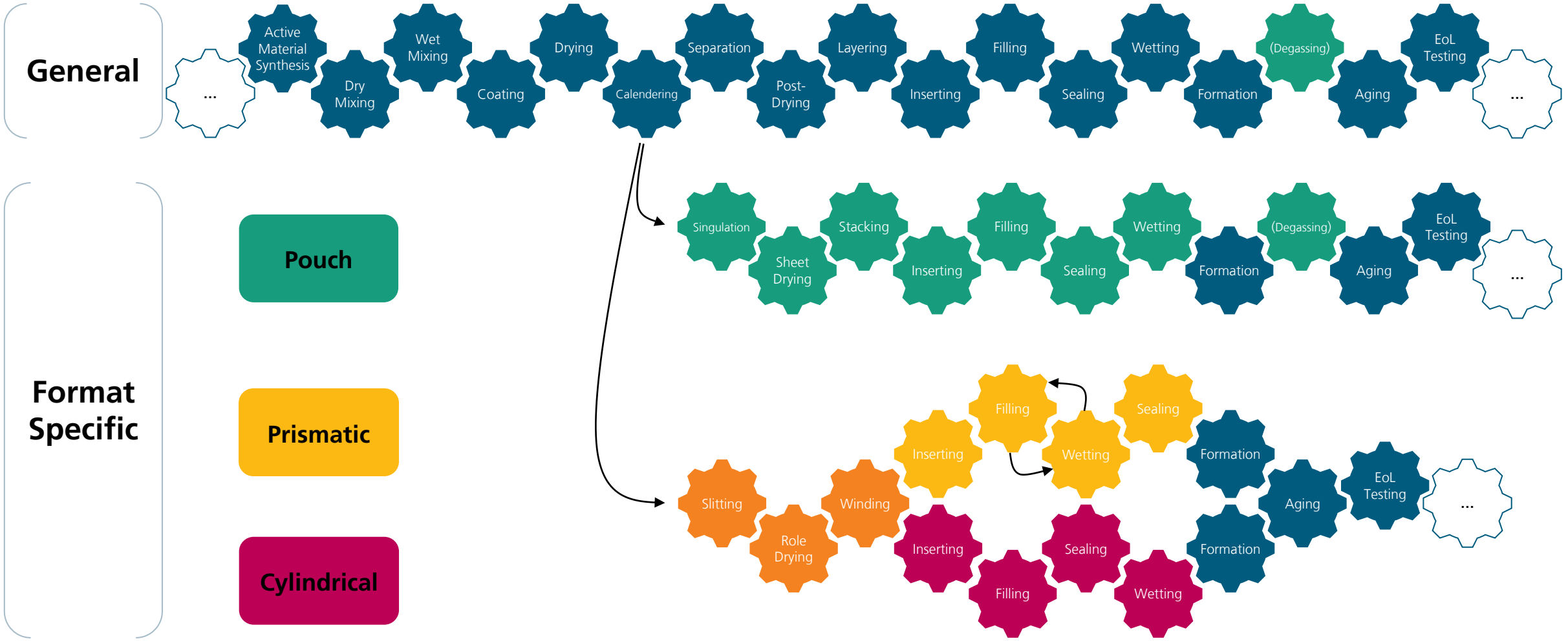

Definition

### Parameters

- Machine Parameters - externally controlled
- Process Parameters - cannot be controlled
- Structure Parameters - resulting output properties

# Two Level Structure

## Production Process Steps



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# Concept

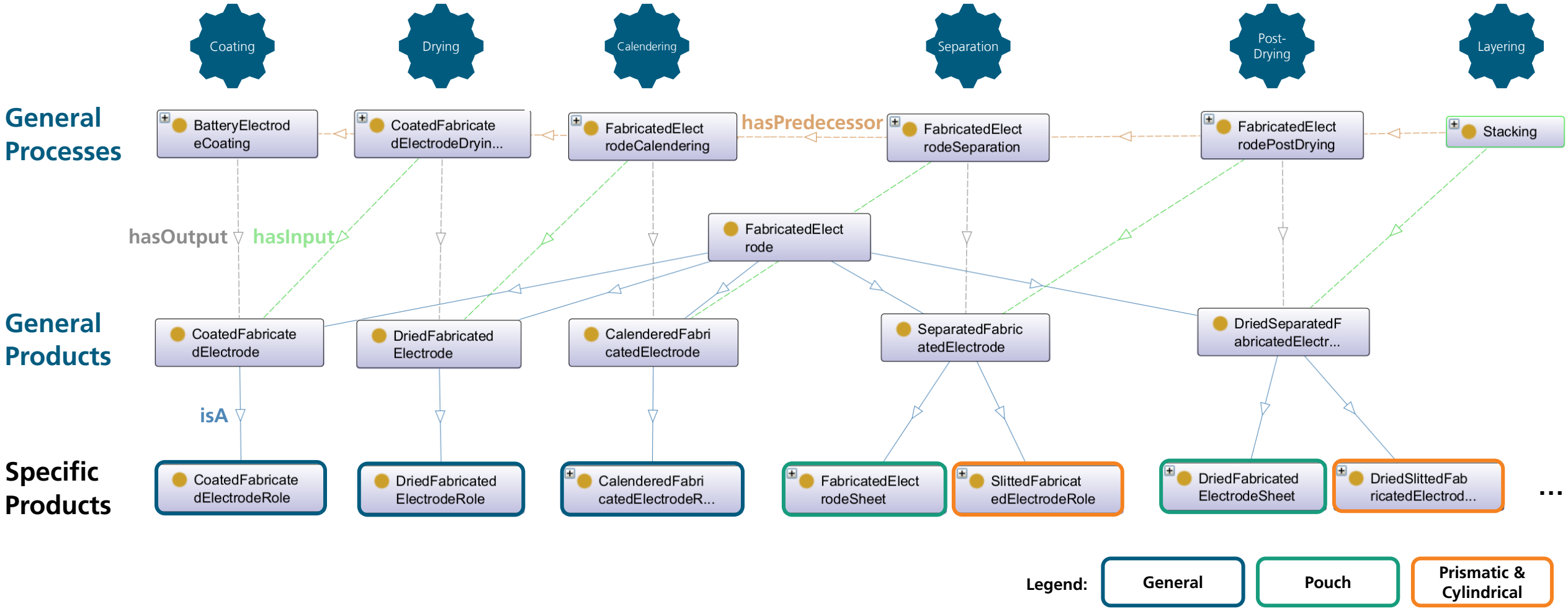
## Naming Convention – Example: Electrodes

### Fabricated Electrode vs. Electrode

- Fabricated Electrode (FE) = Current Collector Foil + Coating
- Electrode = FE in Contact with Electrolyte + Electrochemical Activity = Participant in Electrochemical Process

# Two Level Structure

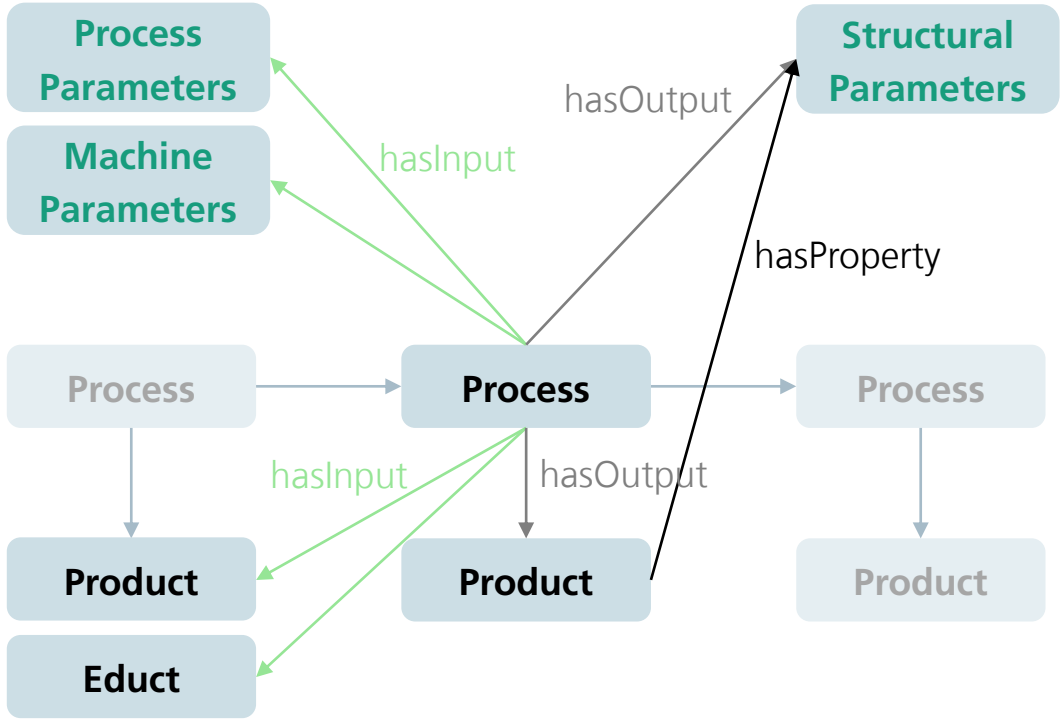
## Process Products / Handover Objects




**Legend:** General | Pouch | Prismatic & Cylindrical

# Two Level Structure

## Parameters




### Description of Input and Output

- Machine Parameters - externally controller
- Process Parameters - cannot be controlled
- Structure Parameters - resulting output properties

### Top Level

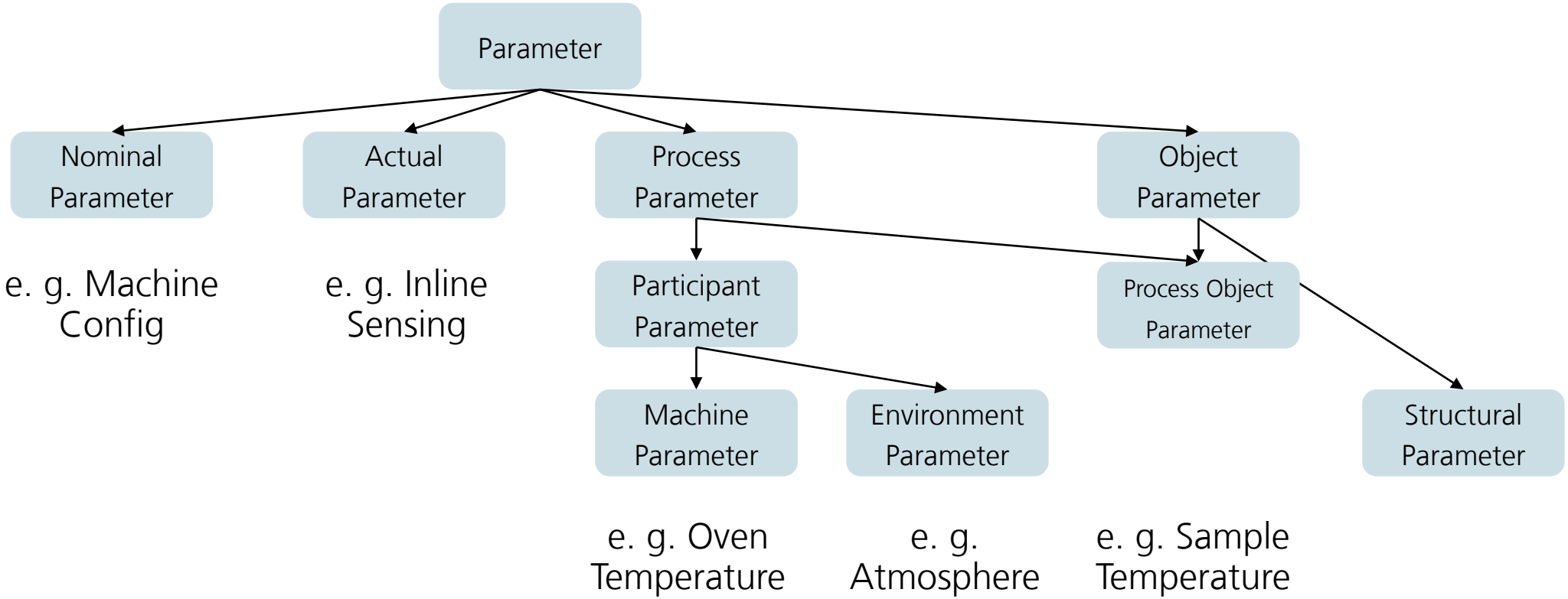
- General Processes
- General Products

### Second Level

- Format Specific Processes
- Format Specific Product (Properties)

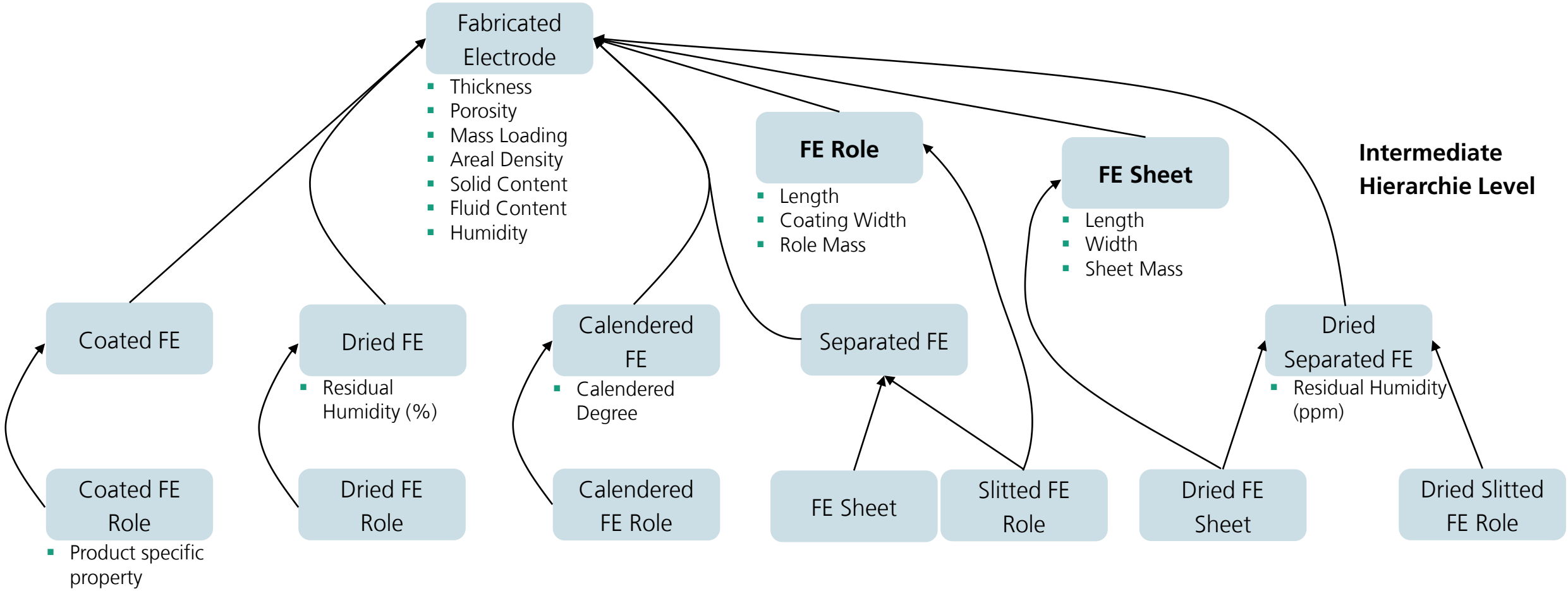
# Two Level Structure

## Parameters – Process and Machine Parameters



# Two Level Structure

## Parameters – Stucture Parameters – Example: Electrodes



# Summary
## And Outlook

### Done

- Setup of Ontologies
  - BVCO
  - DataBatt4.0


### Ongoing

- Extension of Ontologies → «Living Document»
- Integration of Parameters
- Input for BattINFO on Testing
- OpenSemanticLab Development

onto-wiki.eu

github.com/OpenSemanticLab

# Contact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**github.com/OpenSemanticLab**