



**Catena-X**  
Automotive Network

# IDTA 02035-6: Digital Battery Passport – Part 6 Material Composition

February 2026

## SPECIFICATION

Submodel Template of the  
Asset Administration Shell



Submodel Template

**IDTA** approved

- 100% AAS compliant
- Consistent & interoperable
- Released by the AAS experts

# IDTA 02035-6 V1.0

## Imprint

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# Chapter 1. General

## 1.1. About this document

This document is a part of an overall specification series [4]. Each part specifies the contents of a Submodel Template (SMT). The specifications of the Asset Administration Shell (AAS) are the basis for the Submodel Template specifications, see [3].

The target audience of the specification are developers and editors of technical documentation and manufacturer information, which are describing assets by means of the Asset Administration Shell (AAS) and therefore need to create a Submodel instance with a hierarchy of SubmodelElements. This document especially details on the question, which SubmodelElements with which semantic identification shall be used for this purpose.

This specification was created following the "semantic-driven workflow" as defined in [5] based on Aspect Models [6]. There is no central dictionary or repository for Aspect Models. In this specification the following sources are used for defining semantics:

- Aspect Models published at IDTA [7]: <https://github.com/admin-shell-io/smt-semantic-models>, models with namespace "io.admin-shell"
- Aspect Models published by the [BatteryPass Consortium](https://github.com/batterypass/BatteryPassDataModel) (closed project) [8]: <https://github.com/batterypass/BatteryPassDataModel>, models with namespace "io.BatteryPass"
- Aspect Models published at Tractus-X and used in standards published by [Catena-X](https://github.com/eclipse-tractusx/sldt-semantic-models) [9]: <https://github.com/eclipse-tractusx/sldt-semantic-models>, models with namespace "io.catenax"

## 1.2. Scope of the Submodel

This Submodel template aims to define the material composition data points of a Battery Passport conformant to DIN DKE SPEC 99100 and the corresponding EU regulations.

The battery passport consists of the following 7 parts:

```
Digital Battery Passport - Part 1: Digital Nameplate (IDTA-02035-1)
Digital Battery Passport - Part 2: Handover Documentation (IDTA-02035-2)
Digital Battery Passport - Part 3: Product Carbon Footprint (IDTA-02035-3)
Digital Battery Passport - Part 4: Technical Data (IDTA-02035-4)
Digital Battery Passport - Part 5: Product Condition (IDTA-02035-5)
Digital Battery Passport - Part 6: Material Composition (IDTA-02035-6)
Digital Battery Passport - Part 7: Circularity (IDTA-02035-7)
```

This specification is Part 5: Material Composition (IDTA\_02035-6).

## 1.3. Relevant standards for the Submodel Template

This submodel template fulfills the requirements for dynamic data attributes as defined in DIN DKE SPEC 99100 [1]. DIN DKE SPEC 99100 "is based on the European Union and key Member States current regulatory requirements for battery passport information. Mandatory information for the battery passport as stated in the EU Battery Regulation (EU)2023/1542, Article77 and AnnexXIII, as well as the Ecodesign for Sustainable Products Regulation (ESPR), is supplemented by recommendations to increase sustainability and circularity. [1]"

This document is valid for all battery categories. Please be aware that for battery categories that have stronger requirements like industrial batteries with battery management systems etc. some of the data points are specified as optional although mandatory per regulation.

## 1.4. Explanations on used UML diagrams

For clarity and an improved legibility readers suggested to go through this section at first before reading the following chapters.

UML diagrams feature box-like elements, called "classes". These classes, typically Submodels, SubmodelElementCollections or SubmodelElementLists, typically feature a set of Properties or further SubmodelElements. These elements can have specific cardinalities.

The single classes are hierarchally organized by aggregation relations, these can be seen as "contains" relation.

For a further overview on UML diagrams please refer to [2] and [3].

Further details about used table formats please refer to Annex A Explanations.

# Chapter 2. Information set for Submodel “MaterialComposition”

## 2.1. General

The "Material Composition" Submodel Template is part of the specification series for the Battery Passport.

### Property specification

See clause 3 "Information structures and attributes".

## 2.2. Overview UML model

The SubmodelElements described in section 3 are structured in the following way (see Figure 1):

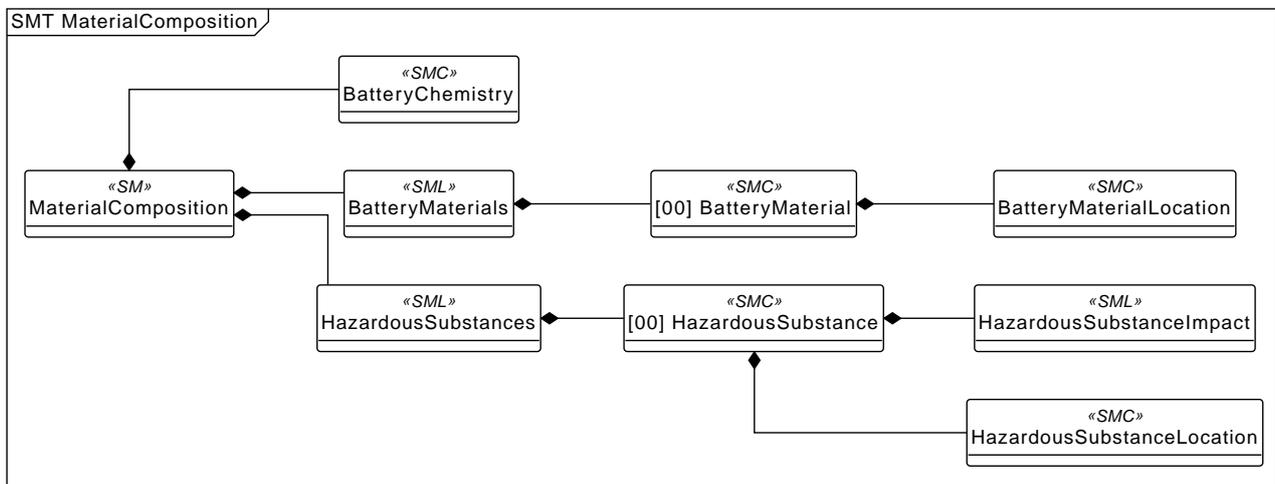


Figure 1. UML overview

# Chapter 3. Information structures and attributes

## 3.1. Properties of the Submodel “Material Composition”

Figure 2 shows the UML-diagram defining the relevant properties which need to be set.

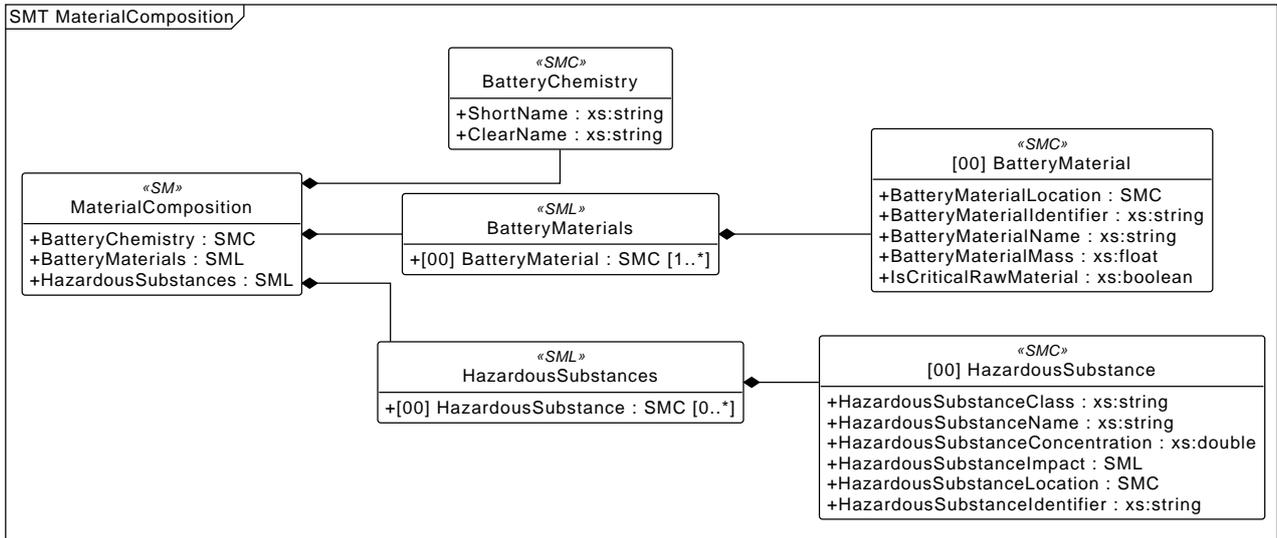


Figure 2. UML-Diagram for Submodel "MaterialComposition"

|                         |  |                    |              |
|-------------------------|--|--------------------|--------------|
| <b>idShort:</b>         | <b>MaterialComposition</b>   |                    |              |
| <b>Class:</b>           | Submodel   |                    |              |
| <b>semanticId:</b>      | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#MaterialComposition  |                    |              |
| <b>Parent:</b>          | -  |                    |              |
| <b>Explanation:</b>     | Mandatory data: Battery chemistry; critical raw materials; materials used in the cathode, anode, and electrolyte; hazardous substances; impact of substances on the environment and on human health or safety. |                    |              |
| <b>Element details:</b> | -  |                    |              |
| <b>[SME type]</b>       | <b>semanticId</b>  | <b>[valueType]</b> | <b>card.</b> |
| <b>idShort</b>          | <b>Description@en</b>  | <b>example</b>     |              |
| [SMC]                   | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#batteryChemistry   | []<br>2 elements   | 1            |
| BatteryChemistry        | Composition of a product in general terms by specifying the cathode and anode active material as well as electrolyte.<br><br>DIN DKE Spec 99100 chapter reference: 6.5.2                                       |                    |              |

|                              |  |                  |   |
|------------------------------|--|------------------|---|
| [SML]<br>BatteryMaterials    | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#batteryMaterials<br><br>"Component materials used" (No. 17.a-c): Naming the materials (as a composition of substances) in cathode, anode, electrolyte according to public standards, including specification of the corresponding component (i.e., cathode, anode, or electrolyte). We suggest a reporting threshold of 0.1 % weight by weight.<br><br>DIN DKE Spec 99100 chapter reference: 6.5.3-6.5.4 | []<br>1 elements | 1 |
| [SML]<br>HazardousSubstances | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstances<br><br>"Hazardous substances" (No 20.a-e): Name (agreed substance nomenclature, e.g. IUPAC or chemical name) all hazardous substance (as 'any substance that poses a threat to human health and the environment'). Suggested above 0.1 % weight by weight within each (sub-)component.<br><br>DIN DKE Spec 99100 chapter reference: 6.5.4 - 6.5.6                                    | []<br>1 elements | 1 |

## 3.2. Properties of the SMC "BatteryChemistry"

Figure 3 shows the UML-diagram for **SMC BatteryChemistry**.

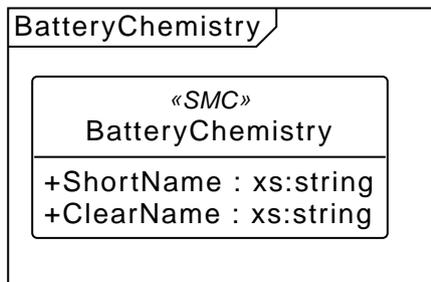


Figure 3. UML-Diagram for SMC "BatteryChemistry"

Data points related to battery chemistry.

|                         |  |
|-------------------------|--|
| <b>idShort:</b>         | <b>BatteryChemistry</b>  |
| <b>Class:</b>           | SubmodelElementCollection  |
| <b>semanticId:</b>      | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#batteryChemistry |
| <b>Parent:</b>          | MaterialComposition  |
| <b>Explanation:</b>     |  |
| <b>Element details:</b> | -  |

| [SME type]          | semanticId   | [valueType]  | card. |
|---------------------|--|--|-------|
| idShort             | Description@en   | example  |       |
| [Prop]<br>ShortName | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#shortName<br><br>Short name. | [String]<br><br>NMC  | 1     |
| [Prop]<br>ClearName | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#clearName<br><br>Clear name. | [String]<br><br>Lithium nickel<br>manganese<br>cobalt oxides | 1     |

### 3.3. Properties of the SML "BatteryMaterials"

Figure 4 shows the UML-diagram for SML batteryMaterials.

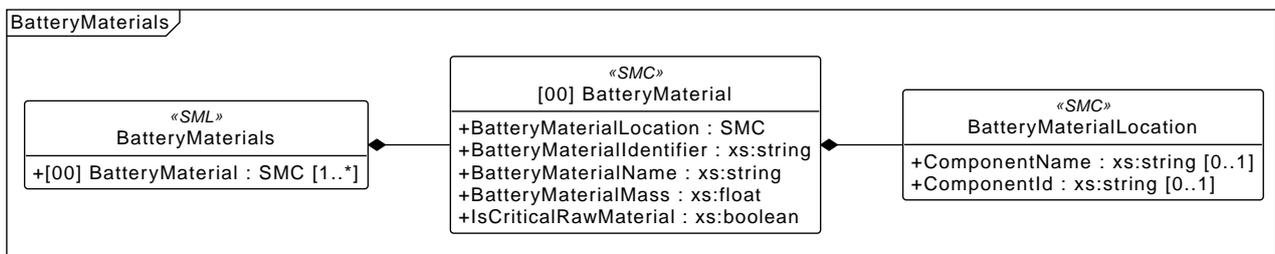


Figure 4. UML-Diagram for SML "BatteryMaterials"

Data points related to a list of battery materials.

| <b>idShort:</b>          | <b>BatteryMaterials</b>   |                      |       |
|--------------------------|---|----------------------|-------|
| <b>Class:</b>            | SubmodelElementList   |                      |       |
| <b>semanticId:</b>       | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#batteryMaterials                            |                      |       |
| <b>Parent:</b>           | MaterialComposition   |                      |       |
| <b>Explanation:</b>      |   |                      |       |
| <b>Element details:</b>  | orderRelevant=No, typeValueListElement=SubmodelElementCollection  |                      |       |
| [SME type]               | semanticId  | [valueType]          | card. |
| idShort                  | Description@en  | example              |       |
| [SMC]<br>BatteryMaterial | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#BatteryMaterial<br><br>Material of battery. | []<br><br>5 elements | 1..*  |

### 3.4. Properties of the SML "HazardousSubstances"

Figure 5 shows the UML-diagram for SML hazardousSubstances.

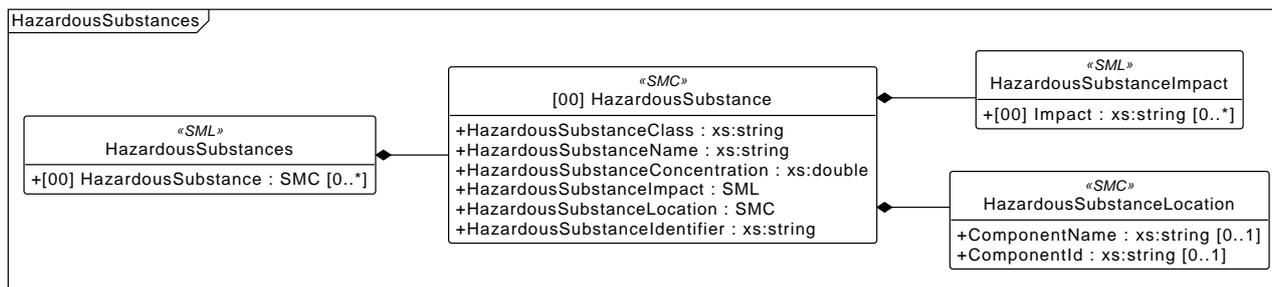


Figure 5. UML-Diagram for SML "HazardousSubstances"

Data points related to a list of hazardous substances.

|                         |   |                  |       |
|-------------------------|---|------------------|-------|
| <b>idShort:</b>         | <b>HazardousSubstances</b>  |                  |       |
| <b>Class:</b>           | SubmodelElementList   |                  |       |
| <b>semanticId:</b>      | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstances   |                  |       |
| <b>Parent:</b>          | MaterialComposition   |                  |       |
| <b>Explanation:</b>     |   |                  |       |
| <b>Element details:</b> | orderRelevant=No, typeValueListElement=SubmodelElementCollection  |                  |       |
| [SME type]              | semanticId  | [valueType]      | card. |
| idShort                 | Description@en  | example          |       |
| [SMC]                   | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#HazardousSubstance  | []<br>6 elements | 0..*  |
| HazardousSubstance      | "Hazardous substance" (No 20.a-e): Name (agreed substance nomenclature, e.g. IUPAC or chemical name) a hazardous substance (as 'any substance that poses a threat to human health and the environment'). Suggested above 0.1 % weight by weight within each (sub-)component.<br><br>DIN DKE Spec 99100 chapter reference: 6.5.4 - 6.5.6 |                  |       |

### 3.5. Properties of the SMC "BatteryMaterial"

Figure 6 shows the UML-diagram for SMC BatteryMaterial.

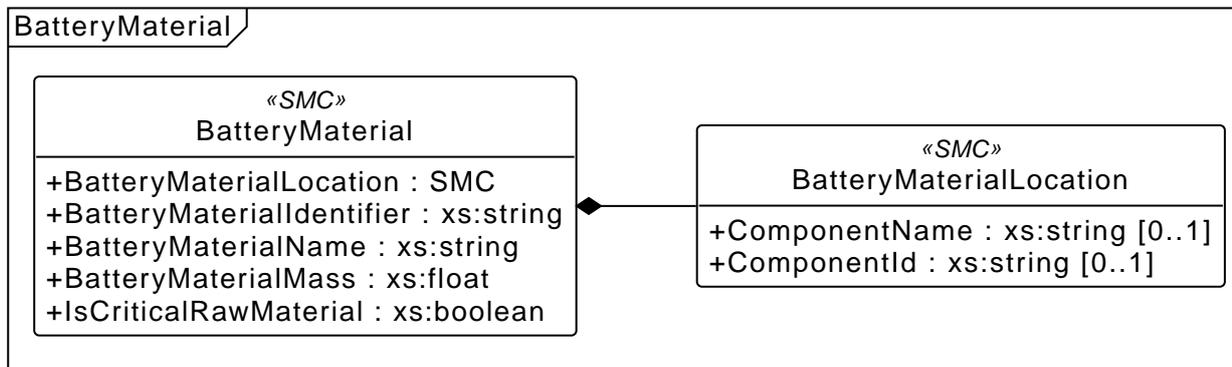


Figure 6. UML-Diagram for SMC "BatteryMaterial"

Data points related to a battery material.

|                            |  |                  |       |
|----------------------------|--|------------------|-------|
| <b>idShort:</b>            | <b>BatteryMaterial</b>   |                  |       |
| <b>Class:</b>              | SubmodelElementCollection  |                  |       |
| <b>semanticId:</b>         | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#BatteryMaterial  |                  |       |
| <b>Parent:</b>             | BatteryMaterials   |                  |       |
| <b>Explanation:</b>        |  |                  |       |
| <b>Element details:</b>    | -  |                  |       |
| [SME type]                 | semanticId   | [valueType]      | card. |
| idShort                    | Description@en   | example          |       |
| [SMC]                      | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#batteryMaterialLocation  | []<br>2 elements | 1     |
| BatteryMaterial Location   | Battery component that relates to the material.  |                  |       |
| [Prop]                     | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#batteryMaterialIdentifier  | [String]         | 1     |
| BatteryMaterial Identifier | supplementalSemanticId: <a href="https://www.cas.org/cas-data/cas-registry">https://www.cas.org/cas-data/cas-registry</a> , urn:irdi:0173-1#02-ABH034#003<br><br>Registration number of an international designation standard (CAS = Chemical Abstracts Service) for chemical substances. For each chemical substance registered in the CAS database (also biosequences, alloys, polymers) there is a unique CAS number. | 7439-93-2        |       |

|        |  |                     |   |
|--------|--|---------------------|---|
| [Prop] | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#battery<br>MaterialName<br>supplementalSemanticId: urn:irdi:0173-1#02-AAN920#003<br>Clear name of Material.<br>Alphanumeric character string which describes the object.   | [String]<br>Lithium | 1 |
| [Prop] | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#battery<br>MaterialMass<br>Weight of component material.   | [Float]             | 1 |
| [Prop] | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#isCriticalRawMaterial<br>RawMaterial<br>The battery passport must contain information on the critical raw materials present in the battery.<br>The information on the critical raw materials must also be provided on the battery label. Per Annex VI, Part A(10), critical raw materials must be reported if present in the battery in a concentration of more than 0,1 % weight by weight. | [Boolean]<br>true   | 1 |

### 3.6. Properties of the SMC "HazardousSubstance"

[UML\_for\_SMC\_hazardousSubstance] shows the UML-diagram for **SMC HazardousSubstance**.

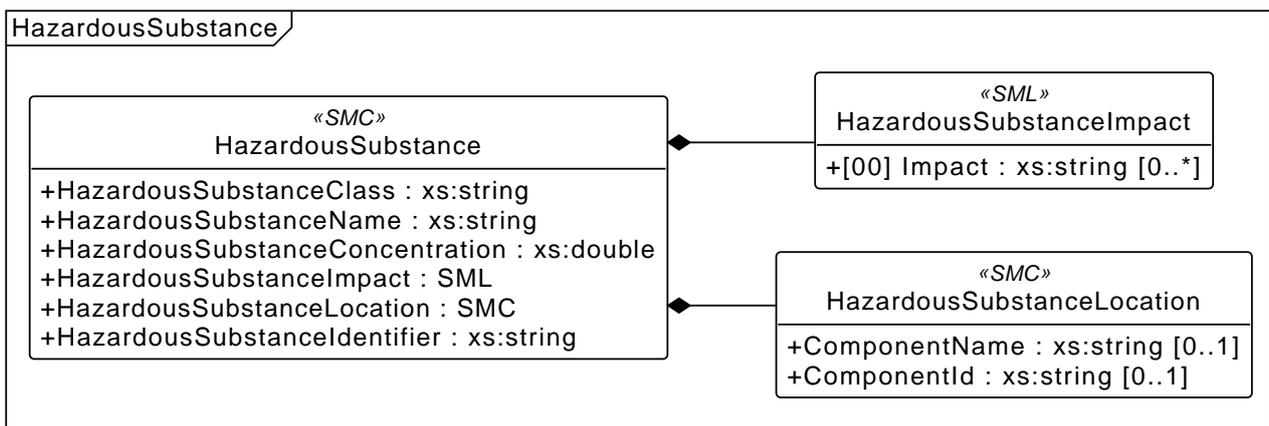


Figure 7. UML-Diagram for SMC "HazardousSubstance"

Data points related to a hazardous substance.

|                    |  |
|--------------------|--|
| <b>idShort:</b>    | <b>HazardousSubstance</b>  |
| <b>Class:</b>      | SubmodelElementCollection  |
| <b>semanticId:</b> | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#HazardousSubstance |

|   |  |                  |       |
|---|--|------------------|-------|
| <b>Parent:</b>                            | HazardousSubstances  |                  |       |
| <b>Explanation:</b>                       |  |                  |       |
| <b>Element details:</b>                   | -  |                  |       |
| [SME type]                                | semanticId   | [valueType]      | card. |
| idShort                                   | Description@en   | example          |       |
| [Prop]<br>HazardousSubstanceClass         | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstanceClass<br><br>Battery Regulation narrows reporting to substances falling under defined hazard classes and categories of the CLP regulation.   | [String]         | 1     |
| [Prop]<br>HazardousSubstanceName          | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstanceName<br><br>Clear name of hazardous substance.   | [String]         | 1     |
| [Prop]<br>HazardousSubstanceConcentration | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstanceConcentration<br><br>Concentration of hazardous substance.   | [Double]         | 1     |
| [SML]<br>HazardousSubstanceImpact         | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstanceImpact<br><br>Impact statements based on, e.g., REACH or GHS for all hazard classes applicable to substances in the battery.   | []<br>1 elements | 1     |
| [SMC]<br>HazardousSubstanceLocation       | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstanceLocation<br><br>Hazardous substances (No. 19-23): Location on a (sub-)component-level of all hazardous substances (as 'any substance that poses a threat to human health and the environment'). Suggested via a unique identifier or nomenclature. | []<br>2 elements | 1     |
| [Prop]<br>HazardousSubstanceIdentifier    | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstanceIdentifier<br><br>supplementalSemanticId: <a href="https://www.cas.org/cas-data/cas-registry">https://www.cas.org/cas-data/cas-registry</a><br><br>CAS identifier of hazardous substance.  | [String]         | 1     |

For hazardousSubstanceClass the following values are allowed:

- "AcuteToxicity"

- "SkinCorrosionOrIrritation"
- "EyeDamageOrIrritation"

### 3.7. Properties of the SMC "BatteryMaterialLocation"

Figure 8 shows the UML-diagram for SMC `BatteryMaterialLocation`.

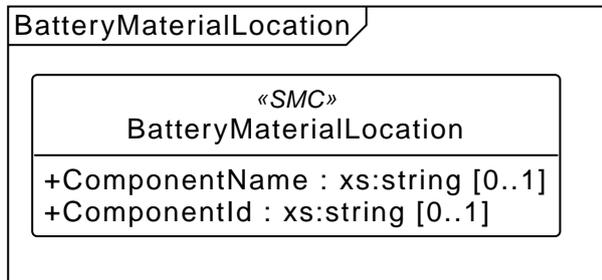


Figure 8. UML-Diagram for SMC "BatteryMaterialLocation"

Data points related to battery material location.

|                         |   |             |       |
|-------------------------|---|-------------|-------|
| <b>idShort:</b>         | <b>BatteryMaterialLocation</b>  |             |       |
| <b>Class:</b>           | SubmodelElementCollection   |             |       |
| <b>semanticId:</b>      | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#batteryMaterialLocation |             |       |
| <b>Parent:</b>          | BatteryMaterial   |             |       |
| <b>Explanation:</b>     |   |             |       |
| <b>Element details:</b> | -   |             |       |
| [SME type]              | semanticId  | [valueType] | card. |
| idShort                 | Description@en  | example     |       |
| [Prop]                  | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#componentName           | [String]    | 0..1  |
| ComponentName           | Name of component.  | Anode       |       |
| [Prop]                  | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#componentId             | [String]    | 0..1  |
| ComponentId             | Identifier of the component.  |             |       |

### 3.8. Properties of the SML "HazardousSubstanceImpact"

Figure 9 shows the UML-diagram for SML `HazardousSubstanceImpact`.

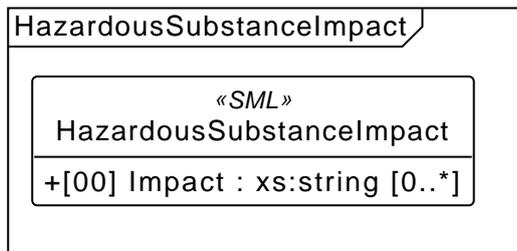


Figure 9. UML-Diagram for SMC "HazardousSubstanceImpact"

Data points related to a list of hazardous substances impacts.

|                         |  |             |       |
|-------------------------|--|-------------|-------|
| <b>idShort:</b>         | <b>HazardousSubstanceImpact</b>  |             |       |
| <b>Class:</b>           | SubmodelElementList  |             |       |
| <b>semanticId:</b>      | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstanceImpact |             |       |
| <b>Parent:</b>          | HazardousSubstance   |             |       |
| <b>Explanation:</b>     |  |             |       |
| <b>Element details:</b> | orderRelevant=No, typeValueListElement=Property, valueTypeListElement=xs:string              |             |       |
| [SME type]              | semanticId   | [valueType] | card. |
| idShort                 | Description@en   | example     |       |
| [Prop]                  | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#Impact                   | [String]    | 0..*  |
| Impact                  | Impact.  |             |       |

### 3.9. Properties of the SMC "HazardousSubstanceLocation"

Figure 10 shows the UML-diagram for SMC HazardousSubstanceLocation.

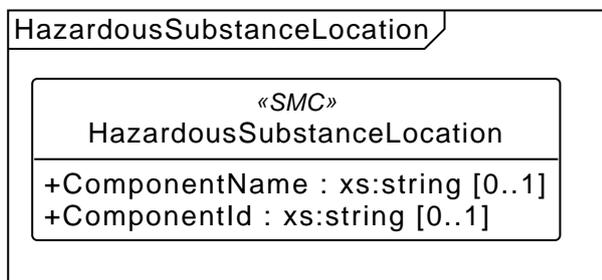


Figure 10. UML-Diagram for SMC "HazardousSubstanceLocation"

Data points related to hazardous substance location.

|                 |                                   |  |  |
|-----------------|-----------------------------------|--|--|
| <b>idShort:</b> | <b>HazardousSubstanceLocation</b> |  |  |
| <b>Class:</b>   | SubmodelElementCollection         |  |  |

|                         |   |                       |       |
|-------------------------|---|-----------------------|-------|
| <b>semanticId:</b>      | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#hazardousSubstanceLocation                      |                       |       |
| <b>Parent:</b>          | HazardousSubstance  |                       |       |
| <b>Explanation:</b>     |   |                       |       |
| <b>Element details:</b> | -   |                       |       |
| [SME type]              | semanticId  | [valueType]           | card. |
| idShort                 | Description@en  | example               |       |
| [Prop]<br>ComponentName | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#componentName<br><br>Name of component.         | [String]<br><br>Anode | 0..1  |
| [Prop]<br>ComponentId   | urn:samm:io.admin-shell.idta.batterypass.material_composition:1.0.0#componentId<br><br>Identifier of the component. | [String]              | 0..1  |

# Annex A. Explanations on used table formats

## 1. General

The used tables in this document try to outline information as concise as possible. They do not convey all information on Submodels and SubmodelElements. For this purpose, the definitive definitions are given by a separate file in form of an AASX file of the Submodel template and its elements.

## 2. Tables on Submodels and SubmodelElements

For clarity and brevity, a set of rules is used for the tables for describing Submodels and SubmodelElements.

- The table heads abbreviate 'cardinality' with 'card'.
- The tables often place two informations in different rows of the same table cell. In this case, the first information is marked out by sharp brackets [] form the second information.
- The types of SubmodelElements are abbreviated (see [Table 1](#)):

Table 1. Abbreviations for SubmodelElements

| SME type | SubmodelElement type         |
|----------|------------------------------|
| Blob     | Blob                         |
| Cap      | Capability                   |
| Ent      | Entity                       |
| Evt      | Event                        |
| File     | File                         |
| MLP      | MultiLanguageProperty        |
| Opr      | Operation                    |
| Prop     | Property                     |
| Range    | Range                        |
| Ref      | ReferenceElement             |
| Rel      | RelationshipElement          |
| RelA     | AnnotatedRelationshipElement |
| SMC      | SubmodelElementCollection    |
| SME      | SubmodelElement              |
| SML      | SubmodelElementList          |

- Multi-language strings are represented by the text value, followed by '@'-character and the ISO 639 language code: example@EN.
- The [valueType] is only given for Properties.

# Annex B. Changes to the submodel template

## General

This annex lists the changes from version to version of the Submodel, together with major changes in the overall document.

## Changes Version 1.0

- First Version conformant to DIN DKE SPEC 99100

# Bibliography

- [1] DIN DKE SPEC 99100, "Requirements for data attributes of the battery passport". February 2025.
- [2] "OMG Unified Modeling Language (OMG UML)", Formal/2017-12-05, Version 2.5.1. December 2018. [Online] Available: <https://www.omg.org/spec/UML/>
- [3] "Specification of the Asset Administration Shell", Publisher: Industrial Digital Twin Association (IDTA). [Online]. Available: <https://industrialdigitaltwin.org/en/content-hub/aasspecifications>
- [4] "Submodel Templates", Publisher: Industrial Digital Twin Association (IDTA). [Online]. Available: <https://industrialdigitaltwin.org/en/content-hub/submodels>
- [5] "How-to create a Submodel Template Specification", Publisher: Industrial Digital Twin Association (IDTA). June 2025. V1.1. [Online]. Available: [https://industrialdigitaltwin.org/en/wp-content/uploads/sites/2/2025/06/IDTA\\_How-to-write-a-SMT-v1.1.pdf](https://industrialdigitaltwin.org/en/wp-content/uploads/sites/2/2025/06/IDTA_How-to-write-a-SMT-v1.1.pdf)
- [6] "Semantic Aspect Meta Model (SAMM)", V2.2.0. [Online]. Available: <https://eclipse-esmf.github.io/samm-specification/2.2.0/index.html>
- [7] "Semantic Aspect Models - smt-semantic-models", Publisher: Industrial Digital Twin Association (IDTA). [Online]. Available: <https://github.com/admin-shell-io/smt-semantic-models>
- [8] "Semantic Aspect Models - BatteryPassDataModel", Publisher: BatteryPass Consortium. [Online]. Available: <https://github.com/batterypass/BatteryPassDataModel>
- [9] "Semantic Aspect Models - Tractus-X - sldt-semantic-models", [Online]. Publisher: Catena-X. [Online]. Available: <https://github.com/eclipse-tractusx/sldt-semantic-models>