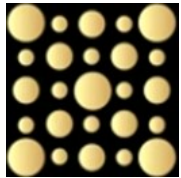


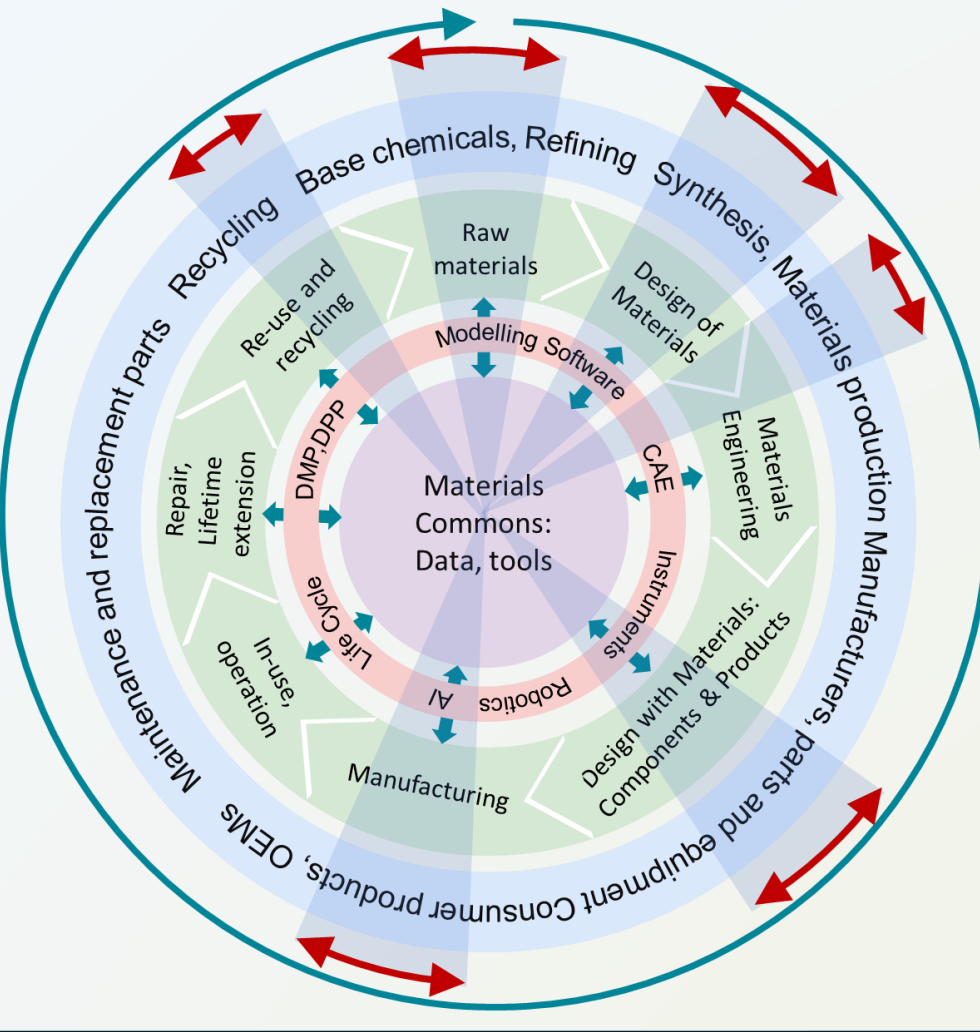
Semantic interoperability for a materials commons digital infrastructure



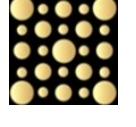
MaterialsCommons

Gerhard Goldbeck, EMMC ASBL

Contributors: Bernd Bayerlein (BAM), Marek Cebecauer (Heyrovsky Institute), Jesper Friis (SINTEF), Emanuele Ghedini (University of Bologna), Patrick Lambrix (Linköping University), Simon Stier (Fraunhofer ISC), and more



MaterialsCommons [1] is a European initiative to bring together shared digital resources, such as data and workflow tools and form a connected infrastructure across all stages of the life cycle that can be accessed through a single entry point.



MaterialsCommons Partners

SINTEF

Technical University of Denmark

Trinity College Dublin

University of Cambridge

UK Research and Innovation - STFC

The European Materials Modelling Council

Université catholique de Louvain

Commissariat à l'énergie atomique et aux énergies alternatives

Centre national de la recherche scientifique

Tekniker

IMDEA Materials Institute

Barcelona Supercomputing Center



VTT Technical Research Centre of Finland

CSC – IT Center for Science

Linköping University

Fraunhofer

Karlsruhe Institute of Technology

Humboldt University of Berlin

Bundesanstalt für Materialforschung und -prüfung

J. Heyrovsky Institute of Physical Chemistry

Materials Center Leoben

Paul Scherrer Institute

National Research Council of Italy

Politecnico di Torino

Politecnico di Milano

University of Bologna

Associated Partners

SIEMENS

BOSCH

SALZGITTER WANNESMANN FORSCHUNG

CSIC

7P

KIT

I-FEVS

ArceclorMittal

voestalpine

Baltronics

PHASETREE

Applus IMA

Applus laboratories

SCHAEFFLER

Infineon

hereon

CEMEA

mo makers

Associated Collaborators

soitec

TECEuroLab

IMA

ICN2

Prima Additive

ESRF

matnex

APEIRON

AI

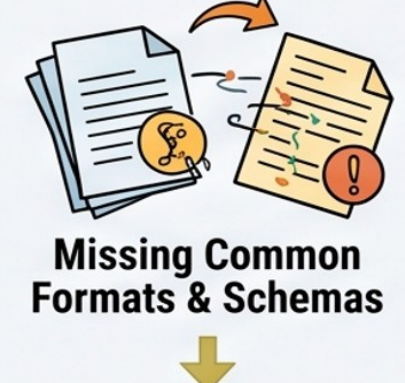
gM



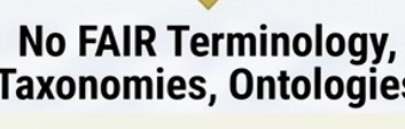
LIMITATION 1:
NO COHERENT ANNOTATION PRACTICES



Lack of Agreed Data-Models



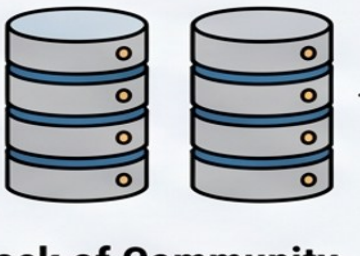
Missing Common Formats & Schemas



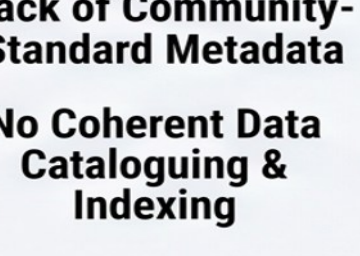
No FAIR Terminology, Taxonomies, Ontologies



LIMITATION 2:
ISOLATED DATASETS & LOW FAIR



Lack of Community-Standard Metadata



No Coherent Data Cataloguing & Indexing



LOW LEVEL OF FAIRNESS



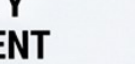
LIMITATION 3:
NON-INTEROPERABLE R&D & INDUSTRIAL ECOSYSTEMS



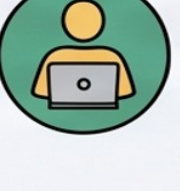
R&D COMMUNITY DATA MANAGEMENT



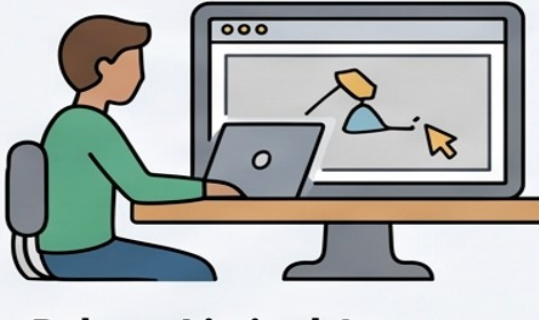
INDUSTRIAL DATA ECOSYSTEMS



BARRIERS TO INTEGRATED DECISIONS



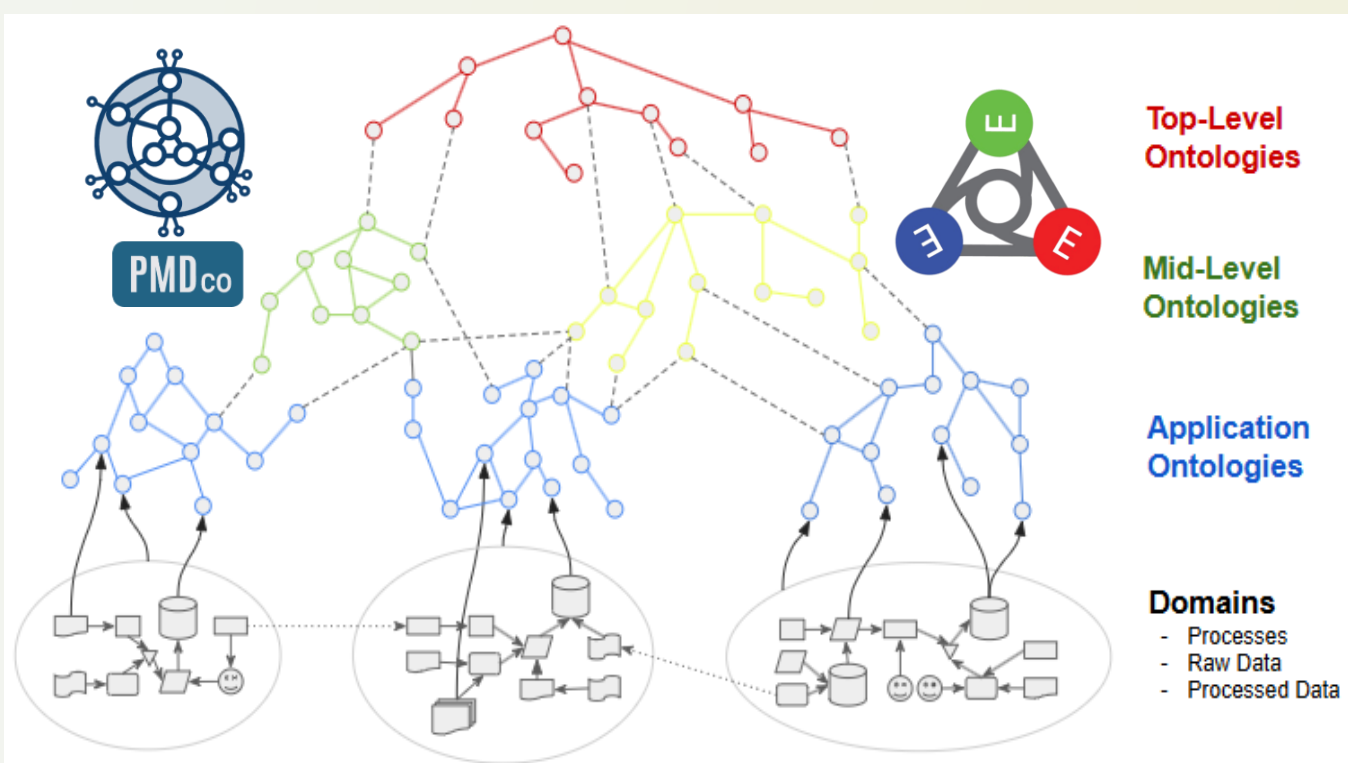
LIMITATION 4:
LIMITED END-USER APPLICATIONS



Rely on Limited Apps or IT Projects



Difficult to Aggregate & Analyse Heterogeneous Data



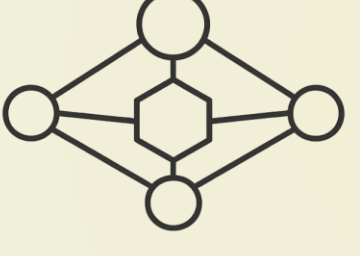
Top-Level Ontologies

Mid-Level Ontologies

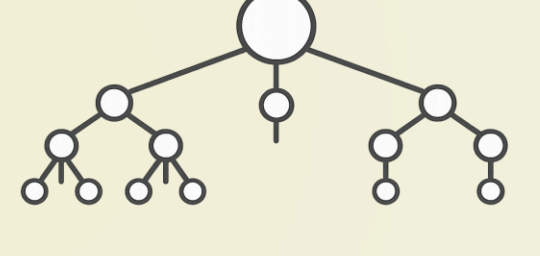
Application Ontologies

Domains

- Processes
- Raw Data
- Processed Data



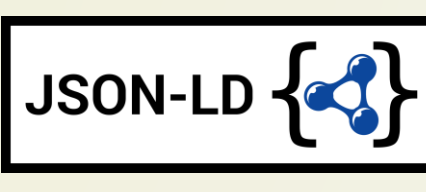
Semantic patterns and taxonomies:



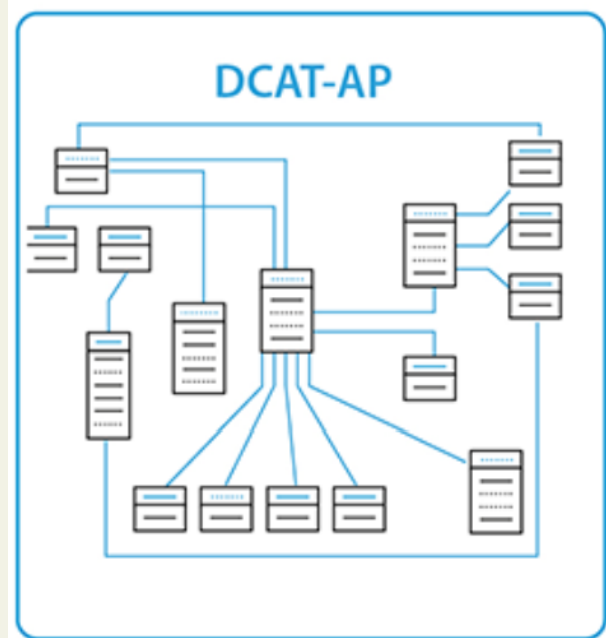
agnostic of top level ontology, but with implementations in EMMO [2] and PMDco [3] frameworks.



Schemas



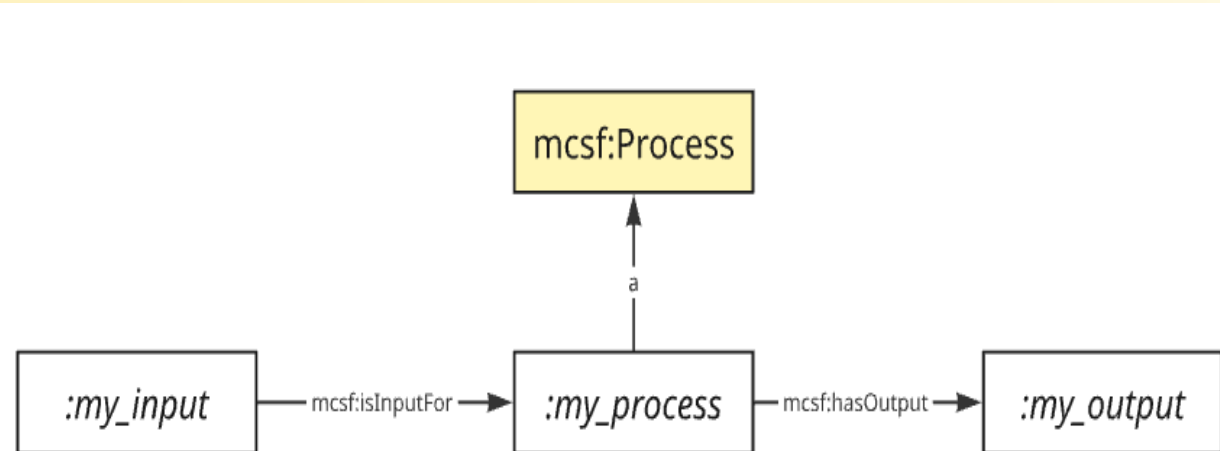
JSON-LD



MaterialsDCAT-AP

The **MaterialsCommons Semantic Foundation** consists of a comprehensive, well-documented set of metadata schemas, taxonomies, ontologies, and **semantic patterns**. Tools for mapping semantic assets to data sources and applications will be developed, e.g. actionable linked data using JDON-LD implementations will be created. In order to support a standardised data cataloguing across different materials science domains, MaterialsCommons will develop **Materials DCAT-AP**, a DCAT application profile [4] for the field.

Semantic patterns are re-usable building blocks for common materials science concepts and workflows, such as the description of a process with input and output or of a measurement result as a quantity with value and units. While the semantic patterns are agnostic of top level ontology, MaterialsCommons will provide implementations within both the EMMO [2] and PMDco [3] frameworks. Semantic patterns support high-quality ontological modelling, ensure **consistency**, **clarity** in knowledge representation, **reusability**, **constraints** (e.g., via SHACL shapes), and enable **semantic scalability**.



Example of a semantic pattern for processes with input and output

ACTIONABLE LINKED DATA & STANDARDS



JSON-LD implementations of Schema



Connections to: RO-Crate (Research Communities)



Connections to: AAS (Industrial Data Ecosystems)

KEY OUTCOMES & STAKEHOLDER SUPPORT

Curated Asset Repository (KG, Schemas, Metadata)

User-Accessible Toolbox & Web-based Service Discovery Portal

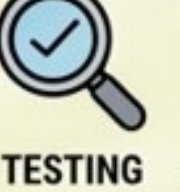
Semantic & Natural Language Search & Visualization



FABRICATION



CHARACTERISATION



TESTING



MODELLING



PROCESSING

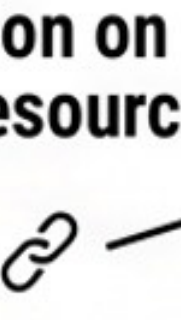
All resources will be connected and accessible via**MaterialsCommons Knowledge Graph**.



MATERIALSCOMMONS KNOWLEDGE GRAPH (MCKG)



Information on Available Resources



Links

References:

[1] MaterialsCommons project: <https://www.materialscommons.eu/>

[2] Elementary Multiperspective Material Ontology (EMMO): <https://github.com/emmo-repo/EMMO>

[3] PMD Core Ontology: <https://github.com/materialdigital/core-ontology>

[4] How to create your DCAT-AP profile: <https://semiceu.github.io/DCAT-AP-reuse-guidelines/>



Co-funded by the European Union

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