DiMAT

Holistic digital transformation
of the SMEs manufacturing industry

Enhancing Ontological Standardization in Materials Science: A Collaborative Effort

DIN

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In today's fast-paced manufacturing environment, digital tools must adapt to a variety of applications, each with unique requirements. The DiMAT project has taken on the challenge of developing comprehensive solutions that can streamline diverse materials manufacturing processes. Central to this effort is the use of a common terminology/ontology, which are instruments that facilitate the categorisation and interconnection of data in a meaningful manner, thereby ensuring the efficient organisation of information. The efficient and prudent usage of ontologies and their concepts is therefore fundamental to ensuring that materials and process data is handled in accordance with the FAIR principles.

However, the creation of terminology and ontologies presents its own set of difficulties. While the traditional top-down method for ontology development starts with broad terminological concepts and narrows them down, it often proves time-consuming. In contrast, the bottom-up approach begins with specific examples and builds connections to broader ideas; though quicker, it lacks standardized guidelines for term definition, leading to inconsistencies. To address these challenges for terminology creation in the materials science domain, DIN and Fraunhofer IWM launched the CEN Workshop "Terminology Definition for Domain Ontologies in Materials Science" (CEN/WS OntoWF), bringing together experts from DiMAT and collaborators across Europe. This initiative seeks to foster the development of consistent terminology for bottom-up ontology development in materials science through a CEN Workshop Agreement (CWA), offering guidelines for terminology definition, review and approval workflows, and technical implementation principles.

[1] Four foundational principles – Findability, Accountability, Interoperability, and Reusability – that serve to guide sustainable scientific data management (see Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data 3, 160018 (2016). https://doi.org/10.1038/sdata.2016.18)

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Ontological Standardization: Bridging Global Guidelines and Sector-Specific Needs

Efforts to standardize data organization and communication globally have taken significant strides, as demonstrated by the publication of four international standards on top-level ontologies by ISO/IEC JTC 1/SC 32 “Data Management and Interchange”. These standards – ISO/IEC 21838 part 1 through 4 – range from general requirements to specific provisions for top-level ontologies like BFO (Basic Formal Ontology) and DOLCE (Descriptive ontology for linguistic and cognitive engineering), providing broad guidelines for data categorization across various domains. Concurrently, initiatives are underway to develop mid-level ontologies for specific sectors, like EMMO (Elementary Multiperspective Material Ontology) and PMDco (Platform MaterialDigital Core Ontology). Despite these advancements, tailored solutions remain necessary in specialized areas where existing ontologies fall short.

The bottom-up approach applied in the DiMAT project offers a promising strategy for crafting customized materials-centred ontologies that cater precisely to industry-specific needs. The development of a CEN Workshop Agreement (CWA) is vital for translating this method into standard practice, enhancing consistency and interoperability in ontology development.

Fast-Tracking Innovation through CEN Workshop Agreements

A CEN Workshop Agreement (CWA) serves as a flexible and swift solution for immediate market needs in rapidly evolving sectors. When new solutions lack the stability required for formal European Standards, CWAs provide an adaptable framework developed by Workshops open to direct participant involvement from interested parties globally. This enables rapid agreement on methods and guidelines essential for interoperability and market acceptance of new technologies. Although not formally recognized as European Standards, CWAs act as stepping stones towards future standardization activities, helping industries adopt innovations without lengthy procedures and driving progress across European markets and beyond.

Participate in shaping the final document

The CEN Workshop “Terminology Definition for Domain Ontologies in Materials Science” represents an exemplary European interdisciplinary collaborative effort, with 23 members from diverse backgrounds across Europe participating in this consortium. Since its kick-off in May, the workshop has organized four meetings to advance its objectives. This has led to the development of a draft document, structured into three distinct sections: guidelines for terminology definition, workflows for the review and approval of terminology, and guidelines for technical implementation. An annex provides a practical example of a technical implementation, offering invaluable insights to users.

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The work is managed in three subgroups, which are focussing on (i) terminology definition, (ii) review and approval workflows, and (iii) technical implementation, all within the materials science domain. Fraunhofer IWM is leading the first two subgroups, drawing on their experiences and their expertise from the terminology development for the DiMAT toolkit Cloud Materials Database (Di^{CMDB}).

With the draft document now published, it presents a prime opportunity for external stakeholders to engage directly with the process. To ensure that the final document is as comprehensive and applicable to various user groups as possible, feedback is enthusiastically welcomed. Interested parties are encouraged to submit comments using the form provided by CEN/CENELEC at **https://www.cencenelec.eu/news-events/news/2025/workshop/2025-11-19-ontologies/** with the deadline set for 19th of December 2025.
By contributing insights and suggestions through this open commenting period, participants can play a pivotal role in refining these guidelines, ensuring their relevance and efficacy in advancing ontology standardization. This collective engagement will ultimately enhance consistency, interoperability, and innovation within materials science and beyond.

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