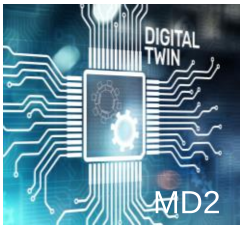
HybridDigital

Digitalization for efficient process selection and design of hybrid structures based on experimental and synthetic data

MATERIALDIGITAL



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Project duration: 01.01.23 - 31.12.25

Material categories **Hybrid materials**
Metals/Alloys: Steel
Composites: Carbon-fibre reinforced polymer

General information

Application areas

Process optimization: Faster process parameter selection by avoiding trial and error approaches. Enhance material properties (e.g. stiffness) by selecting suitable processing parameters.
Material prediction: Multiple sources based on which material properties are predicted (experimental data, simulated data -> input for ML). Predicted: Stiffness, Modulus, Fatigue behaviour.
Improved information along life cycle: Quick identification of complications in the process chain to avoid production downtime if necessary.
Quality control: Identify potential causes for differences from expected performance (e.g. mismatching autoclave temperatures).

Product Lifecycle

Raw materials: Quickly obtain expected material properties early in the design process to avoid cost-intensive adjustments afterwards.
Refining/Processing: Parameters for processing.
Manufacturing: Avoid production downtime.

Approach

Experiments: Standardised test for the tensile, fatigue and bonding strength with different standards like ISO, DIN and ASTM.
Computer Simulations: Structural deformation, acoustic behaviour & static and cyclic strength.
Machine Learning/Statistical/Big data: Train ML Model with structured data (from experiments and simulation).
Coupled: ML algorithms take as an input experimental and simulated data.

Semantic Interoperability

Aspects of digitalization

Data transformation using ontologies: Drop result file of experiment x/process steps y at azure -> auto-parse and structure material/process properties. Drop result from simulation (deformation/acoustics) -> auto parse and structure information. Automatically transform raw files to FAIR data, whereas the FAIR data then drive several workflows (e.g. material performance prediction using ML).
LLM integration: Studies with mappers (unstructured data to taxonomy) and auto-create taxonomy.

Workflows

Types of workflows

Data acquisition from experiments: Every stakeholder drops their data to the azure blob storage for further processing. Dropped file in Azure Blob Storage should be automatically parsed and transformed to FAIR Data (GraphDB).
Machine-learning: Run ML on FAIR data queried from triplestore (e.g. to correlate surface preparation and resulting material properties).
Computer simulation pipelines: E.g. structural deformation & acoustic behaviour. Results from simulations (e.g. stiffness of hybrid material) are automatically parsed and transformed to FAIR data.

Use of PMD-Tools

Ontodocker | PMDco | pyiron | PMD-S | Workflowstore | SimStack

Full project information

https://material-digital.de/download/2025-01-14_HybridDigital_Projektubersicht.pdf