DiMad

Digital Material- and Process Design for Wire-based Additive Manufacturing

Project duration: 01.01.2023 – 31.12.2025

Material categories

Metals/Alloys: High-alloy steels (316L, Duplex ER2209)

General information

Application areas

Process optimization: Improved welding based additive manufacturing by developing methodology to predict material–process–property relationships, so that simulations and machine learning can accelerate process optimization.

Product Lifecycle

Manufacturing: Improve Wire Arc Additive Manufacturing (WAAM) and Wire Laser Additive Manufacturing (WLAM).

Approach

Experiments: Manufactured standard sample geometries of 316L steel, analysed microstructure of samples in detail.

Computer Simulations: Simulations of process temperatures hence microstructure.

Machine Learning/Statistical/Big data: Analysis of correlations between process parameters and manufacturing outcomes to optimize process state.

Semantic Interoperability

Aspects of digitalization

Procedures for ontology development: Development of a holistic WAAM / WLAM process ontology based on PMDco.

Data transformation using ontologies: Use ontologies to maintain knowledge while transforming data.

LLM integration: Consider LLM as a natural language interface for web-based graph database.

Workflows

Types of Workflows

Data acquisition from experiments: Characterization data - automated format translation from Word to C# and .NET. IR-camera, videos, scanned data, timeseries data (primarily WAAM) for current, voltage, wire feed and laser power.

Post-processing/analysis of raw data: Manual evaluation of characterized data.

Machine-learning: Under development; not yet clear how exactly the results of the machine-learning analyses are connected or fed back to other workflows.

Computer simulation pipelines: Process and microstructure simulations.

Publishing of workflow-related elements

Complete workflows: Microstructure solidification simulation of 316L steel during WAAM

Software packages: pyiron_micress implementing MicressJob

IT Architecture

Data-federation

Within own institution: Object storage (Kibana, ElasticSearch, S3).

With project partners: Cloud storage (ownCloud, NextCloud), graph database (Apache Jena).

PMD-S: AixViPMaP (SSO via PMD-S).

Use of PMD-Tools

Ontodocker

PMDco

pyiron

PMD-S

Workflowstore

SimStack

Full project information

https://material-digital.de/download/2024-09-10_InSuKa_Projektubersicht.pdf