DATA MANAGEMENT PLAN

PLAN OVERVIEW

A Data Management Plan created using DMPonline.be

Title: FWO PhD fellowship (1130025N): Enabling the future generation of multi-material thermal protection systems by additive manufacturing

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Template: FWO DMP (Flemish Standard DMP)

Project abstract:
Thermal protection systems (TPS) are crucial aircraft and spacecraft components that protect the internal structure from the extreme aerothermal load during atmospheric flight or re-entry. Current main objectives of space industry, like manned interplanetary missions, reusable launch vehicles and safe return of cost effective nano-satellites, have raised the requirements for future generation lightweight structurally-integrated TPS. Additionally, international attention is being directed towards numerical modelling of re-entry conditions and the experimental validation of these simulations. Additive manufacturing (AM), as a non-traditional ceramic shaping technology, could be key in realizing complex-shaped highly-optimized future generation TPS. Moreover, the fabrication of multi-material ceramic-metal components with AM could revolutionize structural integration of TPS. Therefore, this project focusses on extending the material palette of AM towards ultra-high temperature ceramics and gaining a fundamental understanding of ceramic-metal multi-material AM. Furthermore, the potential of the geometrical freedom of AM related to active cooling designs will be investigated. Finally, this project aims at making an important contribution to the numerical modelling and validation of extreme aerothermal loading of TPS.

ID: 210782

Start date: 01-11-2024

End date: 31-10-2028

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1. RESEARCH DATA SUMMARY

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

Dataset number	Dataset Name	Description	New or reused	Digital or Physical	Digital Data Type	Digital Data format	Digital data volume (MB/GB/TB)	Physical volume
1.	Samples	Physical samples obtained after laser powder bed fusion, and/or furnace treatments	New	Physical	Experimental	/	/	Typical sample size is from 10x10x10 mm3 up to 100x100x100 mm3, and total sample number will be smaller than 10 000.
2.	Sample data	Physical measurements of the samples (dimensions, weight, ...)	New	Digital	Experimental	.xlsx	< 1 GB	/
3.	Job files	Files containing print job parameters and settings	New	Digital	Experimental	.cls; .cli; .magics; .lmg; .lmj	< 100 GB	
4.	Images	High-resolution macro and micro images (camera, OM, SEM) of samples	New	Digital	Experimental	.jpeg; .tiff	< 1 TB	/

5.	Analysis data	Data obtained from sample elemental analysis (XRD, SEM) or sample testing (thermo-mechanical testing)	New	Digital	Experimental	.xlsx; .csv; .txt; .raw; .brml; .jpeg	< 100 GB	/
6.	3D models	3D CAD models for sample preparation and simulation	New	Digital	Compiled/aggregated data	.stl; .par; .stp	< 100 GB	/
7.	3D simulations	3D FEM and CFD simulation results	New	Digital	Simulation data	.csv	< 1 TB	/
8.	Simulation code	Sets of code to support simulations	New	Digital	Software	.py	< 1 GB	/

If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

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Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

No

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, ...)? If so, please comment per dataset or data type where appropriate.

Yes.
Potential valoristion of results will be evaluated throughout the project, and depends on the results. If and when desired, IP rights may be claimed and/or protected through patent applications or other means, in consultation with Leuven Research & Development (LRD). Sections of the final dissertation that contain protected information will be placed under embargo.

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/Data transfer agreements/ research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

No

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

No

2. DOCUMENTATION AND METADATA

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g., in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, Codebook.tsv etc. where this information is recorded).

Dataset number	Dataset Name	Description	Documentation
1.	Samples	Physical samples obtained after laser powder bed fusion, and/or furnace treatments	Details about created parts are stored in standardized spreadsheets mentioning material, process parameters and machine properties/settings (including but not limited to: date of production, laser power, scan speed, powder supplier/size/material, machine, thermal cycle, furnace, ...)
2.	Sample data	Physical measurements of the samples (dimensions, weight, ...)	Measurement data is stored in standardized spreadsheets, mentioning, material, measurement device/settings, date of measurement
3.	Job files	Files containing print job parameters and settings	Job files will be referenced in the overviewing sample documentation spreadsheets (see 1.).
4.	Images	High resolution macro and micro images (camera, OM, SEM) of samples	For optical microscopy images, the machine automatically stores the following information: image type, dimensions, data, lighting settings, zoom, lens name, and tilt angle. For scanning electron microscopy images, the machine automatically includes parameters such as zoom level, beam voltage, image size, and image creation date. This data is stored in .txt files accompanying the image files. Figure naming will follow a consistent rule system (OM_JobName_SampleCode_ImageNumber or SEM_JobName_SampleCode_ImageNumber) that can easily be linked to the physical samples, for which the overviewing spreadsheets (see 1.) contain the details. Microscopic images always contain a scale.
5.	Analysis data	Data obtained from sample elemental analysis (XRD, SEM) or sample testing (thermo-mechanical testing)	For XRD, the results files (.raw) will be accompanied by the test setup file (.brml) that stores the following information: X-ray source characteristics, instrument geometry, detector type, scan parameters, environmental condictions, optics and splits. For SEM, elemental analysis results (.jpeg, .txt) are accompanied a test setup file (.txt) that stores the following information: electron beam characteristics, vacuum conditions, working distance, detector settings, sample

			preparation, image processing, and environmental conditions. For thermomechanical testing, the results files (.cvs) will be accompanied by the test setup file (.txt) that stores the following information: mechanical loading, thermal control (if applicable), test environment, sample preparation, measurement parameters, calibration, test duration, test date, instrument settings. File naming will follow a consistent rule (XRD_JobName_SampleCode_TestCode or SEM_JobName_SampleCode_TestCode or for other tests ..._JobName_SampleCode_TestCode) that can easily be linked to the physical samples, for which the overviewing spreadsheets (see 1.) contain the details.
6.	3D models	3D CAD models for sample preparation and simulation	3D model files will be referenced in the overviewing sample documentation spreadsheets (see 1.).
7.	3D simulations	3D FEM and CFD simulation results	For 3D simulations, the results files (.csv) will be accompanied by a simulation setup file (.txt) that stores the following information: initial conditions, material properties, boundary conditions, mesh and discretization, solver settings, coupling approach, environmental conditions, process-specific parameters and model formulation details.
8.	Simulation code	Sets of code to support simulations	Simulation code files will be referenced in the 3D simulation documentation files (see 7.)

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

No.
An own-defined standard spreadsheet is created for the storage of information about a sample fabrication and analysis. This format can be appended with sheets referring to specific test procedures. This allows a clear link between a sample (and its production parameters) and the analysis performed on this sample (and the relevant test parameters).

3. DATA STORAGE & BACK-UP DURING THE RESEARCH PROJECT

Where will the data be stored?

The data is stored at a dedicated location on the KUL NAS servers (with automatic back-up procedures), secured and managed by the central ICTS service of KU Leuven.

How will the data be backed up?

Offline backup creation on a separate hard drive is performed quarterly.

Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely.
If no or insufficient storage or backup capacities are available, then explain how this will be taken care of.

Yes.
Sufficient storage & backup capacity (2 TB) is allocated to the research project on both KUL NAS servers and a separate hard drive.

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

No sensitive data will be created in this project.
Separate file sharing folders are provided by the university, ensuring no shared access to the data, unless specifically required.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

The expected cost for data storage during the project is not expected to exceed €100/year, which will be covered either by the FWO bench fee or AM research group financial reserves.

4. DATA PRESERVATION AFTER THE END OF THE RESEARCH PROJECT

Which data will be retained for at least five years (or longer, in agreement with other retention policies that are applicable) after the end of the project? In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies…).

No data requiring restrictions on data preservations will be generated, thus all data can be stored for the required 10 years according to the KU Leuven RDM policy.

Where will these data be archived (stored and curated for the long-term)?

The data will be stored on the university's central servers (with automatic back-up procedures) for at least 10 years, conform the KU Leuven RDM policy.

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

The KU Leuven offers backed up cold storage of data at €99,55/TB/year. The expected cost for cold storage of the data after the project is therefore not expected to exceed €100/year, which will be covered by the AM research group financial reserves. If the amount of data to be stored exceeds 2 TB, additional storage will be purchased and covered by the AM research group financial reserves.

5. DATA SHARING AND REUSE

Will the data (or part of the data) be made available for reuse after/during the project? In the comment section please explain per dataset or data type which data will be made available.

Yes, in an Open Access repository

If access is restricted, please specify who will be able to access the data and under what conditions.

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Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)? Please explain in the comment section per dataset or data type where appropriate.

No

Where will the data be made available? If already known, please provide a repository per dataset or data type.

1. The data will be shared on the KU Leuven Research Data repository (known as RDR), which can be found here: https://rdr.kuleuven.be
2. The repository has limited space for fee-less sharing of data. Hence, the largest file types (ultra-high-resolution microstructural images and simulation data) will only be available upon request.

When will the data be made available?

1. In case the data is used for a publication, the data will be made available for use after the final publication
2. In other cases, the dataset will be made available after the public defense of the FWO fellow's thesis dissertation

Which data usage licenses are you going to provide? If none, please explain why.

The datasets will be made available under a CC-BY-NC-4.0 license, meaning free sharing and adaptation of data is allowed provided that they give appropriate credit to the creators, but commercial use is prohibited.

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

Yes.
The KU Leuven Research Data repository (known as RDR) uses a DIO identifier.

What are the expected costs for data sharing? How will these costs be covered?

1. The datasets are believed to stay within the 50 GB free limit of the RDR, meaning that no extra costs are expected.

2. In case a larger set of data is created, part of the allocated project budget can be used to cover these costs

6. RESPONSIBILITIES

Who will manage data documentation and metadata during the research project?

Waut Declercq - FWO fellow

Who will manage data storage and backup during the research project?

Waut Declercq - FWO fellow

Who will manage data preservation and sharing?

Brecht Van Hooreweder - PI / PhD promotor

Who will update and implement this DMP?

The PI bears the end responsibility of updating & implementing this DMP.