Project BIOPTOUGH DMP (FWO template) - Flemish Standard Data Management Plan

Project supervisors (from application round 2018 onwards) and fellows (from application round 2020 onwards) will, upon being awarded their project or fellowship, be invited to develop their answers to the data management related questions into a DMP. The FWO expects a **completed DMP no later than 6 months after the official start date** of the project or fellowship. The DMP should not be submitted to FWO but to the research co-ordination office of the host institute; FWO may request the DMP in a random check.

At the end of the project, the **final version of the DMP** has to be added to the final report of the project; this should be submitted to FWO by the supervisor-spokesperson through FWO's e-portal. This DMP may of course have been updated since its first version. The DMP is an element in the final evaluation of the project by the relevant expert panel. Both the DMP submitted within the first 6 months after the start date and the final DMP may use this template.

The DMP template used by the Research Foundation Flanders (FWO) corresponds with the Flemish Standard Data Management Plan. This Flemish Standard DMP was developed by the Flemish Research Data Network (FRDN) Task Force DMP which comprises representatives of all Flemish funders and research institutions. This is a standardized DMP template based on the previous FWO template that contains the core requirements for data management planning. To increase understanding and facilitate completion of the DMP, a standardized **glossary** of definitions and abbreviations is available via the following link.

1. General Project Information	
Name Grant Holder & ORCID	Mahoor MEHDIKHANI, https://orcid.org/0000-0003-3989-2678
Contributor name(s) (+ ORCID) & roles	Yentl SWOLFS (https://orcid.org/0000-0001-7278-3022), supervisor
Project number[1] & title	12B0624N, Bone-inspired design of fiber-reinforced composites with optimal strength-toughness balance (BIOPTOUGH)
Funder(s) GrantID[2]	FWO (12B0624N)
Affiliation(s)	KU Leuven ROR[3] identifier: 05f950310
Please provide a short project description	Carbon fiber composites are strong and lightweight but suffer from brittleness and low damage tolerance. This hinders realizing their full sustainability potential. Nature can provide inspiration as there are many strong natural materials with a high damage tolerance. Bone is a good example. Next to its superb strength-toughness balance, bone has other unique features that can inspire the design of new materials with much higher performance and durability. They include superb properties with not-excellent constituents, hierarchical toughening mechanisms, efficient structure, and self-healing. Attempts so far failed to mimic all these features. Therefore, BIOPTOUGH aims to design and produce a carbon fiber-reinforced composite that incorporates the main engineering features of bone. It first employs cutting-edge image acquisition and processing tools for in-situ analysis of bone mechanics. Based on this knowledge and deep learning, finite element models are created to optimize the strength-toughness balance of bone-inspired composites. The optimized designs are realized using advanced manufacturing techniques such as 3D printing. Finally, the produced bone-inspired materials are tested with in-situ 3D imaging to verify the envisioned toughening mechanism. As the main result, BIOPTOUGH creates a bone-inspired composite, yielding a great strength-toughness balance, smart architecture, self-healing, and more efficient use of the constituents via its hierarchical optimized design.

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[1] "Project number" refers to the institutional project number. This question is optional since not every institution has an internal project number different from the GrantID. Applicants can only provide one project number.

[2] Funder(s) GrantID refers to the number of the DMP at the funder(s), here one can specify multiple GrantIDs if multiple funding sources were used.

[3] Research Organization Registry Community. https://ror.org/

2. 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[4].

				ONLY FOR DIGITAL DATA	ONLY FOR DIGITAL DATA	ONLY FOR DIGITAL DATA	ONLY FOR PHYSICAL DATA
Dataset Name	Description	New or Reused	Digital or Physical	Digital Data Type	Digital Data Format	Digital Data Volume (MB, GB, TB)	Physical Volume
X-ray computed tomography volumes	Reconstructed CT slices of in-situ scans from bone and bone-inspired composites specimens during loading	☒ Generate new data ☐ Reuse existing data	☒ Digital ☐ Physical	☐ Observational ☒ Experimental ☐ Compiled/ aggregated data ☐ Simulation data	☒ other: **.tif**	☐ < 100 MB ☐ < 1 GB ☐ < 100 GB ☒ < 1 TB ☐ < 5 TB ☐ < 10 TB	
Synchrotron computed tomography volumes	Reconstructed SRCT slices of in-situ scans from bone and bone-inspired composites specimens during loading	☒ Generate new data ☐ Reuse existing data	☒ Digital ☐ Physical	☐ Observational ☒ Experimental ☐ Compiled/ aggregated data ☐ Simulation data	☒ other: **.tif**	☐ < 100 MB ☐ < 1 GB ☐ < 100 GB ☐ < 1 TB ☐ < 5 TB ☒ < 10 TB	
DVC fields	Digital volume correlation (DVC) is applied to the in-situ 3D images (two abovementioned datasets) and the results will be saved as datasets.	☒ Generate new data ☐ Reuse existing data	☒ Digital ☐ Physical	☐ Observational ☐ Experimental ☐ Compiled/ aggregated data ☒ Simulation data	☒ other: **.csv, .am**	☐ < 100 MB ☐ < 1 GB ☐ < 100 GB ☐ < 1 TB ☒ < 5 TB ☐ < 10 TB	

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[4] Add rows for each dataset you want to describe.

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.	NA
Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? If so, please describe these issues further and refer to specific datasets or data types when appropriate.	☐ Yes, human subject data ☒ Yes, animal data ☒ Yes, dual use ☐ No If yes, please describe: A part of the study is performed on the mechanics of bone, but the bone samples are obtained from a butcher, so **no ethical issues** are present. The other part of the study deals with carbon-fiber composites, which are considered dual-use materials. However, the project has received a **positive advice** from the Ethical committee on Dual use, Military use & Misuse (EC DMM) of KU Leuven.

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[5] These data are generated by combining multiple existing datasets.

Will you process personal data[6]? If so, briefly describe the kind of personal data you will use. Please refer to specific datasets or data types when appropriate. If available, add the reference to your file in your host institution's privacy register.	☐ Yes ☒ No If yes: - Short description of the kind of personal data that will be used: - Privacy Registry Reference:
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 ☒ No If yes, please comment:
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 to what data they relate and what restrictions are in place.	☐ Yes ☒ No If yes, please explain:
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 to what data they relate and which restrictions will be asserted.	☐ Yes ☒ No If yes, please explain:

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[6] See Glossary Flemish Standard Data Management Plan

3. 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).	1. For the X-ray CT volumes: source and detector configurations, sample dimensions, and load and displacement levels for each scan plus the scan settings (including power and voltage, voxel size, exposure time, nr of projections, and source and detector position). The scan settings are generated automatically by the scan software, which will be appended to the documentation. 2. For the synchrotron CT volumes: similar to item 2 plus the beam type (monochromatic vs. white beam) and the camera type and settings. 3. For the DVC data: sample dimensions and load and displacement levels of each DVC field, displacement initialization details, type of DVC (local vs. global), and the subvolume size.
Will a metadata standard be used to make it easier to **find and reuse the data**? If so, please specify which metadata standard will be used. If not, please specify which metadata will be created to make the data easier to find and reuse. *REPOSITORIES COULD ASK TO DELIVER METADATA IN A CERTAIN FORMAT, WITH SPECIFIED ONTOLOGIES AND VOCABULARIES, I.E. STANDARD LISTS WITH UNIQUE IDENTIFIERS.*	☒ Yes ☐ No If yes, please specify (where appropriate per dataset or data type) which metadata standard will be used: The CT scanners generate standard metadata along with the resulting images. It includes scan settings, i.e. power and voltage, voxel size, exposure time, nr of projections, source and detector position, etc. For the CSV and TIFF data, the ISA-Tab standard, developed at the University of Oxford, will be followed. For the CT data, we will follow the NeXus standard, which was developed specifically for this type of data.

4. Data Storage & Back-up during the Research Project	
Where will the data be stored?	All the data will be stored on a few HDDs and backed up on our research group NAS system.

How will the data be backed up? *What storage and backup procedures will be in place to prevent data loss? Describe the locations, storage media and procedures that will be used for storing and backing up digital and non-digital data during research.[7]* *Refer to institution-specific policies regarding backup procedures when appropriate.*	Besides backing up the full data on our NAS system, I will back up a selection of the useful data on OneDrive. This will include CT volumes of critical loading steps. I will make this backup everytime we acquire any new data.
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 ☐ No If yes, please specify concisely: We have enough space on our NAS for the mentioned data. Moreover, my personal OneDrive has 2TB of available space for the backup of the selected data. 1-2 extra external HDDs will be purchased.
How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons? *Clearly describe the measures (in terms of physical security, network security, and security of computer systems and files) that will be taken to ensure that stored and transferred data are safe. [7]*	Our data is not highly sensitive. Anyway, access to our NAS is limited to a few people in the group. The selected data on OneDrive is only accessible by me.
What are the expected costs for data storage and backup during the research project? How will these costs be covered?	Since we do not see any need for extra storage at the moment, we do not anticipate any costs. Just, 1-2 external HDDs will be purchased, which are inexpensive and can be purchased from the project bench fee.

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[7] Source: Ghent University Generic DMP Evaluation Rubric: https://osf.io/2z5g3/

5. 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...).	The selected data, which was stored also on OneDrive, will be retained for 5 years after the end of the project. This will include all the optical images and CT volumes of critical loading steps. If the fellow (Mahoor Mehdikhani) leaves KUL before the end of the retention period, the responsibility will be transferred to the PI, i.e. Prof. Yentl Swolfs.
Where will these data be archived (stored and curated for the long-term)?	On the NAS and the external HDDs.
What are the expected costs for data preservation during the expected retention period? How will these costs be covered?	Since the selected data will be stored locally on two different storages, there is no costs associated with it.

6. Data Sharing and Reuse	
Will the data (or part of the data) be made available for reuse after/during the project? Please explain per dataset or data type which data will be made available. *NOTE THAT 'AVAILABLE' DOES NOT NECESSARILY MEAN THAT THE DATA SET BECOMES OPENLY AVAILABLE, CONDITIONS FOR ACCESS AND USE MAY APPLY. AVAILABILITY IN THIS QUESTION THUS ENTAILS BOTH OPEN & RESTRICTED ACCESS. FOR MORE INFORMATION: HTTPS://WIKI.SURFNET.NL/DISPLAY/STANDARDS/INFO-EU-REPO/#INFOEUREPO-ACCESSRIGHTS*	☒ Yes, in an Open Access repository ☐ Yes, in a restricted access repository (after approval, institutional access only, …) ☐ No (closed access) ☐ Other, please specify:
If access is restricted, please specify who will be able to access the data and under what conditions.	
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 per dataset or data type where appropriate.	☐ Yes, privacy aspects ☐ Yes, intellectual property rights ☐ Yes, ethical aspects ☐ Yes, aspects of dual use ☐ Yes, other ☒ No If yes, please specify:
Where will the data be made available? If already known, please provide a repository per dataset or data type.	In an Open Access repository I have already stored three datasets, similar to what I will create in BIOPTOUGH, on Mendeley Data, for which I have also published three data articles in Data in Brief Journal. I will do the same (storing on Mendeley Data and publishing data articles) for the current project.

When will the data be made available? *THIS COULD BE A SPECIFIC DATE (DD/MM/YYYY) OR AN INDICATION SUCH AS 'UPON PUBLICATION OF RESEARCH RESULTS'.*	Upon publication of the research results I will try to make the data publicly available during the project along with publication of the results.
Which data usage licenses are you going to provide? If none, please explain why. *A DATA USAGE LICENSE INDICATES WHETHER THE DATA CAN BE REUSED OR NOT AND UNDER WHAT CONDITIONS. IF NO LICENCE IS GRANTED, THE DATA ARE IN A GREY ZONE AND CANNOT BE LEGALLY REUSED. DO NOTE THAT YOU MAY ONLY RELEASE DATA UNDER A LICENCE CHOSEN BY YOURSELF IF IT DOES NOT ALREADY FALL UNDER ANOTHER LICENCE THAT MIGHT PROHIBIT THAT.* *EXAMPLE ANSWER: E.G. "DATA FROM THE PROJECT THAT CAN BE SHARED WILL BE MADE AVAILABLE UNDER A CREATIVE COMMONS ATTRIBUTION LICENSE (CC-BY 4.0), SO THAT USERS HAVE TO GIVE CREDIT TO THE ORIGINAL DATA CREATORS." [8]*	Both Mendeley Data and Data in Brief article are open access. Therefore, the data will be accessible for public.
Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, please provide it here. *INDICATE WHETHER YOU INTEND TO ADD A PERSISTENT AND UNIQUE IDENTIFIER IN ORDER TO IDENTIFY AND RETRIEVE THE DATA.*	☐ Yes ☐ No If yes:
What are the expected costs for data sharing? How will these costs be covered?	Mendeley Data provides 10 GB of free space, which I believe is enough for the selected data for public access. Data in Brief publication has a cost of 700 USD, which will be paid from the project bench fee.

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[8] Source: Ghent University Generic DMP Evaluation Rubric: https://osf.io/2z5g3/

7. Responsibilities	
Who will manage data documentation and metadata during the research project?	Mahoor Mehdikhani
Who will manage data storage and backup during the research project?	Mahoor Mehdikhani
Who will manage data preservation and sharing?	Mahoor Mehdikhani
Who will update and implement this DMP?	Mahoor Mehdikhani – The PI (Prof. Yentl Swolfs) bears the end responsibility of updating & implementing this DMP.