

1. General Information

FWO project Title: Development of reliable ceramics for hard tissue replacements: tooth enamel-inspired interdisciplinary research

FWO project number: G057924N

Principal Investigator (PI): Fei Zhang

Name applicant

Fei Zhang, Stevan Čokić

Project Data Contact: Fei Zhang

Description: This project will use interdisciplinary approach within materials science and dentistry to (1) fully understand the features and mechanisms that control the survival resistance of tooth enamel; Small-scale in-situ experiments, micromechanics and fracture mechanics will be used, along with a range of advanced microstructural and chemical analyses, to quantitatively understand the comprehensive interplays between the chemical and microstructural features and the toughening and deformation properties of species-dependent tooth enamel over multiple length scales.

(2) synthesize novel ceramic building blocks that can be efficiently textured in a bioinspired architecture; ceramic fiber/rods will be synthesized by combining electrospinning, acetate precipitation and grain-boundary engineering.

(3) additively assemble the developed building blocks into tooth-enamel architecture, obtaining ceramic components and dental prostheses with unprecedented reliability. a hybrid UV-curing assisted direct ink writing (DIW) to print fully dense ceramics (zirconia, alumina, zirconia-alumina composites and hydroxyapatite) mimicking enamel's gradient architectures

Institution: KU Leuven

2. Data description

Will you generate/collect new data and/or make use of existing data?

- Generate new data

Describe in detail the origin, type and format of the data (per dataset) and its (estimated) volume.

Objective 1/WP1: Fully understand the resistance mechanisms of tooth enamel across species and the role of interfaces and orientation.

The data generated in this objective will be microscopy (SEM, TEM, CT) images and spectroscopies (Raman, XRD, FTIR) of the tooth enamel, and values of mechanical properties (hardness, toughness, bending strength). These spectroscopy and property data will be saved in CSV file format. Microscopy images in the TIF format will be saved. Videos in the MOV format will be generated for In-situ experiments.

<i>Equipment</i>	<i>Raw format</i>	<i>Exported format</i>
Scanning electron microscopy (SEM)	TIF or JPEG	TIF, JPEG or MOV
X-ray diffraction	ras	raw, csv
Micro-Raman spectroscopy Fourier Transform Infrared Spectroscopy (FTIR)	.OPUS	csv
Transmission electron microscopy (TEM)	TIF or JPEG	TIF or JPEG
Computed tomography	TIF	TIF, JPEG or MOV
Hardness, toughness, strength	csv	csv
In-situ mechanical test	csv, TIF	csv, TIF or MOV

Obj-2: Ceramic rods with multiple hierarchical levels, weak interfaces and tunable dimensions.

The data generated in this objective will be the characterization results of the synthesized particles, including particle size distribution, morphology by SEM and TEM, chemical composition by EDS and ICP, phase composition by XRD and Raman.

<i>Equipment</i>	<i>Raw format</i>	<i>Exported format</i>
Scanning electron microscopy (SEM)	TIF or JPEG	TIF or JPEG
X-ray diffraction	ras	raw, csv
Micro-Raman spectroscopy Fourier Transform Infrared Spectroscopy (FTIR)	.OPUS	csv
Thermogravimetric analysis	csv	csv
Transmission electron microscopy (TEM)	TIF or JPEG	TIF or JPEG
Particle size distribution	csv	csv
Inductively coupled plasma mass spectrometry (ICP)	csv	csv

Obj-3: Multi-material additive manufacturing (AM) of functionally graded tooth-inspired architectures and proof-of-concept

Data related to this objective are mostly the parameters used to make (3D-print) the samples and the characterization of the prepared samples, including different types of microscopy and the property results. The details of raw and exported data formats are listed below.

<i>Equipment</i>	<i>Raw format</i>	<i>Exported format</i>
RegenHu 3D-printer		jpg, csv
Debinding and sintering furnace	csv	csv
Scanning electron microscopy	TIF or JPEG	
X-ray diffraction	ras	raw, csv
Micro-Raman spectroscopy Fourier Transform Infrared Spectroscopy (FTIR)	.OPUS	csv
Thermogravimetric Analysis (TGA) and differential scanning calorimetry (DSC)	csv	csv
Transmission electron microscopy	TIF or JPEG	
Computed tomography	TIF	TIF, JPEG or MOV
Hardness, toughness, strength	csv	csv
In-situ mechanical test	csv, TIF	csv, TIF or MOV

3. Legal and ethical issues

Will you use personal data?

- No

Does your work possibly result in research data with potential for tech transfer and valorisation?

Will IP restrictions be claimed for the data you created? If so, for what data and which restrictions will be asserted?

- Besides the usual dissemination via publications, conferences and networking, other channels including patent and product industrialization will be considered. In this project, patent will be considered first. Based on protected IP, commercialization will be considered in collaboration with the industry or via spin-off in following projects. Tech transfer and valorisation are not direct goals of this project. But if such an A meeting will be planned with the the KU Leuven tech transfer office to investigate patentability and the conclusions of that discussion will be appended to this data management plan.

Do existing 3rd party agreements restrict dissemination or exploitation of the data you (re)use? If so, to what data do they relate and what restrictions are in place?

- No

4. Documentations (What documentation will be provided to enable reuse of the data collected/generated in this project?)

4.1. Internal

Working data (temporary versions, digital notebooks) will be stored on the server. Protocols will be saved as well in the form of pdf files. In addition, regular reports based on the data will be generated using Microsoft Word. PowerPoint files will be used for presentation at regular internal meetings. In both the Word reports and Powerpoint presentations, the file names of the raw data files will be included.

4.2. External

- Publications of results in scientific publications.

Data in brief will be published.

Will a metadata standard be used?

- Yes

An overview file that contains references to the raw data files will be regularly used. During each experiment, a detailed logbook will be used (different logbooks for the different experimental setups). Logbooks will contain the date, a brief description of the performed experiment, the parameters used for each measurement, as well as the names of all the saved files. The names of the files will be structured in a comprehensible way: system studied/date/main parameters used. In addition, data will be stored in a folder per experimental setup, the type of investigated system and the corresponding date. In this way, by tracking the corresponding logbook notes, each file can be easily found on the local computers controlling the setup and on the server of the laboratory.

The analysis files will contain notes describing the analysis procedure and mention which original data files are included. A readme file describing the goal of the experiment and the analysis procedure will be stored in the folder where the data is saved.

5. Data storage and backup during the FWO project

Where will the data be stored?

The data will be stored via a cloud storage solution that allows sharing with the researchers involved in the project. Copies can be made and kept on personal devices.

How is backup of the data provided?

Data in the home directory of the users is backed up periodically. Snapshots of the home directories are also taken. The important data will be stored on the university's central servers with automatic daily back-up procedures.

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

The expected costs for data storage will not exceed a few hundred for hard disks and solid-state storage drives. This will be covered by the working means of the project.

Data security: how will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

Password protected user accounts ensure that only the persons of the account can access the working data. The data generated during the project will be systematically transferred to the cloud storage server. Only the researcher and (co)-promotors will have access to the shared folders where the data, reports and presentations will be stored.

6. Data preservation after the FWO project

Which data will be retained for the expected 5 year period after the end of the project? In case only a selection of the data can/will be preserved, clearly state the reasons for this (legal or contractual restrictions, physical preservation issues, ...).

All the generated data will be stored on the cloud storage server for a period of 5 years after the end of the project.

Where will the data be archived (= stored for the longer term)?

All the generated data will be stored on the cloud storage server for a period of 5 years after the end of the project. Beyond 5 years after the end of the project, one of the following options will be picked (1) continuation of storing the data on the cloud storage server or (2) transferring the data to the KU Leuven central servers for archiving.

What are the expected costs for data preservation during the retention period of 5 years? How will the costs be covered?

No additional costs are expected at this moment.

7. Data sharing and reuse

Are there any factors restricting or preventing the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)?

No

The data can be reused within future projects.

Which data will be made available after the end of the project?

The written reports and Powerpoint presentations summarizing the results obtained can be made available. The (raw) data used in publications can be made available on a repository, if e.g. requested by the Editors or Publisher of a scientific journal.

Where/how will the data be made available for reuse?

Upon request by email

When will the data be made available?

Description of the full scientific method and results will be made available upon publication of the research results.

Who will be able to access the data and under what conditions?

Upon request or within research group, access to the samples and data can be granted.

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

No costs associated with data sharing.

8. Responsibilities

Who will be responsible for data documentation & metadata?

The promotors and the researchers involved (mainly PhD students and postdocs) on the project are responsible for data documentation & metadata.

Who will be responsible for data storage & back up during the project?

The promotors and the researchers of the project.

Who will be responsible for ensuring data preservation and reuse ?

The promotors and the researchers involved in this project will be jointly responsible.

Who bears the end responsibility for updating & implementing this DMP?

The promotors and the researchers bear the end responsibility of updating & implementing this DMP.