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Multi-level Circular Process Chain for Carbon and Glass Fibre Composites

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Deliverable D1.1: Data Management Plan

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SEN	Sensitive information	

Contents

1.	OBJECTIVE	3
2.	CHANNELS FOR OPEN ACCESS	4
3.	DATA FORMATS	5
4.	SOFTWARE AND INTEROPERABILITY	6
5.	LICENCES FOR DATA	7
6.	MC4 DATA SETS	8
7.	ALLOCATION OF RESOURCES	20
8.	DATA SECURITY	21
9.	CONCLUSIONS	22

1. OBJECTIVE

The objective of this deliverable is to describe the collection and use of data in the MC4 project and in particular how and which data will be made publicly available to other researchers after the end of the project. According to the "Horizon Europe Programme Guide"¹, we distinguish between two types of open access:

- Open access to peer-reviewed scientific publications: Open access is an obligation for scientific publications in Horizon Europe.
- Open access to research data: If data is needed to validate the results presented in a scientific publication, the publication of this data is obligatory. Additional research data may be published on a voluntary basis.

Open access to scientific publications and research data is regulated in article 17 in the Grant Agreement of the MC4 project.

During the project, data sets mainly will become available the form process parameters, material specifications, characterizations of materials and products made from recycled carbon and glass fibres. Apart from that there will also be personal data like contact information that is acquired at conferences and fairs. All these data will be collected on Profactor's file server to make them available for all partners during the project. Special care will be taken in case of personal data, that need to be managed in compliance with the general data protection regulation. Data that are very interesting for other researchers are the properties such as tensile strength, bending strength or fracture behaviour of the materials made from recycled carbon and glass fibres. To enable further research in this field we follow the FAIR principles² (FAIR stands for findable, accessible, interoperable, and reusable). Hence, data, including the necessary metadata, will be made available online at the end of the project in the "Zenodo research data repository".

Published data will be made available in aggregated form to avoid reverse engineering of information about production processes. For other data, especially CAD data of the parts that were produced from the recycled materials, the commercial interests of the industrial partners in the project require that these data do not become available in the public domain.

This document is a living document and will be updated over the course of the project. Whenever new types of data sets are identified, these will be added to create an updated version of the document.

¹ <u>https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-</u> 2027/horizon/guidance/programme-guide_horizon_en.pdf (26.7.2022)

² Wilkinson, M., Dumontier, M. Aalbersberg, I. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data 3, 160018 (2016). https://doi.org/10.1038/sdata.2016.18 (26.7.2022)

2. CHANNELS FOR OPEN ACCESS

Data channels for open access will be considered in two different approaches in the MC4 project. For publication of scientific papers, the focus will be put on conferences and journals that offer open access. For open access data it has to be kept in mind that large storage resources might be required in some cases. The MC4 project aims at taking advantage of the Zenodo research data repository³, a collaboration of the OpenAIREplus project for open access repositories, archives and journals and CERN. This data repository provides the possibility to upload research data and make them publicly accessible for download. It will be used for open access in the MC4 project. The maximum size of a single data set for upload to Zenodo is 50GB. This will be sufficient for the needs of the MC4 project. All uploads to Zenodo automatically receive a DOI (Digital Object Identifier). The ISO-standardized DOI system is administered by the International DOI Foundation⁴ and implements persistent identifiers for electronic documents. Therefore, it will be easy to reference and find data sets of the MC4 project.

The MC4 project website will contain links to all MC4 data sets that are uploaded to Zenodo. This will help researchers from all over the world to get direct access to research data provided by the MC4 project. However, as maintenance of the project website after the end of the project is not guaranteed over a longer period of time, the website itself will not be the major medium to host open access research data. With an upload of data to the Zenodo portal, accessibility of MC4 data is well ensured – even long after the end of the MC4 project.

³ <u>http://www.zenodo.org</u> (26.7.2022)

⁴ <u>http://www.doi.org</u> (26.7.2022)

3. DATA FORMATS

Initially, data formats used for data representation within the MC4 project (or at individual project partners) may be proprietary and/or of complex structure. However, when preparing data for open access, the goal is to use standard data formats that are well known and easy to handle. Any data that is present in a highly proprietary complicated format must be converted to easily readable data formats before publication. For example, .png-, .pdf- and .xlsx- files are favoured over complex proprietary binary formats. Every data set that is published will be accompanied by a simple "readme.txt" text file that provides general information about the data as well as a detailed description of the data format.

4. SOFTWARE AND INTEROPERABILITY

In some cases, it makes sense to provide data with software that is able to load the data and/or process the data in order to make it easier to work with them. From the current status within the project it is not yet completely clear, how and if such software can be provided with the data. For each data set there will be a decision if and how dedicated software can be provided together with the data set. Preferably, we promote Python as programming language to work with scientific open access data from the MC4 project. Since Python has become very popular as the language of choice in research, this would make it easy for a large number of researchers to get access to the data and use them.

5. LICENCES FOR DATA

For open access publication of pure data, the Creative Commons Attribution 4.0 International Public License (IPL)⁵ will be considered in the first place. This license essentially provides the right to freely copy and redistribute the material in any medium or format. Re-mixing, transforming, and building upon the material are explicitly permitted. This is granted for any purpose. The licensor cannot revoke these freedoms as long as the license terms are followed.

The use of the IPL is the preferred choice for data publication in the MC4 project. In specific cases a different license might be considered.

⁵ <u>https://creativecommons.org/licenses/by/4.0/legalcode (</u>26.7.2022)

6. MC4 DATA SETS

The following list includes the data sets that are expected to be acquired and/or used in the MC4 project. Each data set is defined by:

- Code: a code consisting of "MC4-" and a 4-letter code (e.g. "MC4-ABCD").
- Data set full name: a full name for the data set.
- Responsible beneficiary: the main responsible project partner.
- Description: a general description of the data set.
- Data Format: the expected format of the data.
- Data set size: the expected size of a single data set instance.
- Data sharing: information about whether the data set is confidential (not published) or published under open access criteria.

The subsequent list of data sets defines mainly the type of data. During the lifetime of the project it is expected that multiple instances for each data set will be acquired. For example, the vitrimerization process will be refined during the project and the process parameters of the first trials will differ from the parameters used towards the end of the project. In this case, the specific instances of data sets will additionally be tagged by

- a date when the data set was acquired and
- a textual description of the conditions/environment under which the data were captured or initially generated.

Multiple instances of a single type of data set will be tagged with a running number. For example, data sets for code "MC4-ABCD-1". Additionally, data sets that are uploaded to the Zenodo portal, will receive a unique DOI.

For the data sets listed below the entry, "Data sharing" describes whether data sharing is considered. "Publication" means that the plan is to publish the data set (or at least specific instances). "Confidential" means that the respective data set is not considered for publication.

Code	MC4-CIMG
Data set full name	Labelled FScan images
Responsible beneficiary	Profactor
Description	The data set contains the images of the FScan sensor (azimutal-, polar-, diffuse- and specular- image). An additional table contains a label for each image that descibes the defect show in the image (none, fuzzball,)
Data format	Bitmap images and an xlsx table for the labels
Data set size	> 1 GB
Data sharing	Publication

Code	MC4-CGRS
Data set full name	Labelled spectroscopy data
Responsible beneficiary	i-RED
Description	Spectroscopic data plus the labels (resin type, fiber composite material, etc.)

Data format	csv files
Data set size	< 100 MB
Data sharing	Publication

Code	MC4-CGSD
Data set full name	Sample descriptions
Responsible beneficiary	i-RED
Description	Descriptions / data sheets of the fiber composite materials provided by project partners
Data format	xlsx and pdf files
Data set size	< 10 MB
Data sharing	Publication

Code	MC4-CSFT
Data set full name	Material parameters of semi-finished textiles (nonwovens, slivers, tapes)
Responsible beneficiary	STFI
Description	The data set contains testing results on tensile strength, air permeability, thickness, mass per unit area.
Data format	xlsx or pdf file, REM images
Data set size	> 1GB
Data sharing	Confidential

Code	MC4-CFTC
Data set full name	Material parameters of finished textiles (composites)
Responsible beneficiary	STFI
Description	The data set contains testing results on stiffness, tensile strength, bending strength, fracture behaviour, fibre-matrix-adhesion, shear strength, compression strength etc.
Data format	xlsx or pdf file, REM images
Data set size	> 1GB
Data sharing	Confidential

Code	MC4-GSFT
Data set full name	Material parameters of recycled fibres material

Responsible beneficiary	3BFibreglass
Description	Data sets of mechanical properties of composite made of 3R resins compared with standard reference resins. Several glass fibers with different sizing chemistries will also be evaluated.
Data format	xlsx table with the data and statistical analysis report
Data set size	<1 GB
Data sharing	Publication

Code	MC4-CFMA
Data set full name	Material properties of finished materials: datasheet and product study comparison
Responsible beneficiary	Chomarat
Description	Product description of the composites reinforcement
Data format	PDF
Data set size	<200MB
Data sharing	Publication

Code	МС4-СРРМ
Data set full name	Manufacturing process parameters
Responsible beneficiary	FIDAMC
Description	Parameters of the manufacturing process of recycled carbon parts.
Data format	PDF
Data set size	<4GB
Data sharing	Confidential

Code	MC4-CFMR
Data set full name	Chemical recycling process required parameters
Responsible beneficiary	Gaiker
Description	Carbon fibre composite requirements (e.g.: size, resin and hardener type, thickness, etc.) for the fibre-matrix separation process.
Data format	.xlsx tables and .pdf files
Data set size	< 4 GB
Data sharing	Publication

Code	MC4-CFMS
Data set full name	Chemical recycling process parameters carbon
Responsible beneficiary	Gaiker
Description	Parameters (e.g.: time, temperature, pressure, catalyst, etc.) of the fibre-matrix separation process of carbon fibre parts.
Data format	.xlsx tables and .pdf files (if possible, accompanied by pictures (*.jpg / *.png))
Data set size	< 4 GB
Data sharing	Confidential

Code	MC4-CFMP
Data set full name	Properties of the recycled products
Responsible beneficiary	Gaiker
Description	Characterization of the products (CF and matrix) after the fibre-matrix separation process (e.g.: SEM and TGA of the obtained recycled CF; FTIR, DSC, viscosity, etc.) of the recovered matrix mixture).
Data format	.xlsx tables and .pdf files (if possible, accompanied by pictures (*.jpg / *.png))
Data set size	< 4 GB
Data sharing	Publication

Code	MC4-CCIU
Data set full name	Characterization of the uncured material
Responsible beneficiary	Gaiker
Description	Characterization of the uncured material (e.g.: size, thickness, resin type, etc.).
Data format	.xlsx tables and .pdf files (if possible, accompanied by pictures (*.jpg / *.png))
Data set size	< 4 GB
Data sharing	Publication

Code	MC4-CFPU
Data set full name	Recycling process parameters uncured carbon
Responsible beneficiary	Gaiker

Description	Parameters and conditions (e.g.: film removal, stoichiometry between the uncured material and the additional resin, etc.) of the recycling process of uncured material.
Data format	.xlsx tables and .pdf files
Data set size	< 4 GB
Data sharing	Confidential

Code	MC4-CCOU
Data set full name	Characterization of recycled materials from uncured materials
Responsible beneficiary	Gaiker
Description	Characterization and properties (e.g.: tensile and flexural strength, DSC and TGA, etc.) of the output material after recycling process of uncured material.
Data format	.xlsx tables and .pdf files (if possible, accompanied by pictures (*.jpg / *.png)
Data set size	< 4 GB
Data sharing	Publication

Code	MC4-GFMS
Data set full name	Chemical recycling process parameters for glass fibre/3R epoxy composites
Responsible beneficiary	Cidetec
Description	Parameters of the fibre-matrix separation process of glass fibre/3R epoxy composite parts and characterization of recovered fibre (FESEM micrograph, residue quantification via thermogravimetric analysis) and matrix (glass transition temperature).
Data format	Pictures (.pdf), raw data tables (.xlsx)
Data set size	<100 Mb
Data sharing	Confidential

Code	MC4-GCER
Data set full name	Characterization of 3R epoxy resin.
Responsible beneficiary	Cidetec
Description	Thermal properties (glass transition temperature, degradation temperature), temperature dependent stress relaxation and mechanical properties.

Data format	Pictures (.pdf), raw data tables (.xlsx)
Data set size	<100 Mb
Data sharing	Confidential (publication upon evaluation)

Code	MC4-GCTL
Data set full name	Characterization and thermoforming of optimized glass fiber/3R epoxy laminates
Responsible beneficiary	Cidetec
Description	Thermal properties (glass transition temperature), fibre volume content (FVC), mechanical data (tensile strength, compression, flexural, interlaminar shear strength).
Data format	Pictures (.pdf), raw data tables (.xlsx)
Data set size	<100 Mb
Data sharing	Confidential

Code	MC4-GVIT
Data set full name	Parameters of the vitrimerization process
Responsible beneficiary	CEA
Description	The data will consist of a report describing the material preparation for its vitrimerization, the vitrimerization process, and reshaping of the recycled matter to obtain a new part. The report will include requirements for the raw materials, processes & parameters, characterizations.
Data format	Word document
Data set size	10-100 MB
Data sharing	Confidential

Code	MC4-CNWP
Data set full name	Parameters of the nonwoven processes
Responsible beneficiary	STFI
Description	The data set contains parameters of the manufacturing of nonwoven materials (speed, material feeding, mass per unit area, stitching density, stitching depth, needle length, energy consumption data).
Data format	xlsx or pdf files
Data set size	> 1 GB
Data sharing	Confidential

Code	MC4-CCMP
Data set full name	Parameters of the composite manufacturing process.
Responsible beneficiary	STFI
Description	The data set contains parameters of the manufacturing of composites (temperature, pressure, heating and cooling rate, energy consumption).
Data format	xlsx or pdf files
Data set size	> 1 GB
Data sharing	Confidential

Code	MC4-CDPA
Data set full name	Part designs
Responsible beneficiary	Amura
Description	CAD designs. The CAD files contain the necessary views as well as the layers and 3D development for the interpretation by any production department of the proposed part. In the PDFs you can find the technical requirements in the workstations and the descriptions of the production processes.
Data format	CAD (DWG and DXF) and PDF
Data set size	Approx. 3 GB
Data sharing	Publication

Code	MC4-GDPV
Data set full name	Part designs
Responsible beneficiary	VDL Fibertech Industries
Description	CAD designs and ply-books of the parts made from recycled materials.
Data format	Ply-books 2D in DXF format (*.dxf) and CAD designs 3D in STEP format (*.stp)
Data set size	Approx. 100 MB
Data sharing	Confidential

Code	MC4-CDPM
Data set full name	Part designs
Responsible beneficiary	MANAGING COMPOSITES

Description	CAD designs, 2D Technical Drawings and ply-books of the parts, tooling and auxiliary tooling made from recycled materials. Building books with the post processing. Drilling, machining, finishing.
Data format	CATIA 3D & 2D format (CADPart/CADProduct/.drw) /Step(.stp)/PDF
Data set size	> 1GB
Data sharing	Confidential

Code	MC4-CDPF
Data set full name	Designs of recycled parts
Responsible beneficiary	FIDAMC
Description	CAD designs of the parts made from recycled materials
Data format	.CADPart or .CADProduct
Data set size	<4GB
Data sharing	Confidential

Code	MC4-GDPL
Data set full name	Part designs
Responsible beneficiary	LAB23
Description	CAD designs and ply-books of the parts made from recycled materials
Data format	.stp, .dwg and .pdf files
Data set size	< 2GB
Data sharing	Confidential

Code	MC4-CFPA
Data set full name	Properties of finished parts
Responsible beneficiary	Amura
Description	The technical requirements for both the materials and the final piece. Brightness, resistance to the environmentetc
Data format	.pdf files
Data set size	Approx. 1GB
Data sharing	Publication

Code	MC4-GFPV

Data set full name	Properties of finished parts
Responsible beneficiary	VDL Fibertech Industries
Description	Requirement specification with technical requirements and visual appearance criteria.
Data format	PDF File (*.pdf) and if necessary accompanied by pictures (*.jpg)
Data set size	50 MB
Data sharing	Publication

Code	MC4-GFPM
Data set full name	Properties of finished parts
Responsible beneficiary	MANAGING COMPOSITES
Description	Visual appearance, quality zones depending if the area is visible or not, dimension reports.
Data format	PDF File (.pdf) and .jpg for the pictures
Data set size	100 MB – 500 MB
Data sharing	Publication/Confidential

Code	MC4-CFPF
Data set full name	Properties of finished parts
Responsible beneficiary	FIDAMC
Description	Mechanical testing of samples from the aerospace part obtained, such as visual inspection or nondestructive testing (NDT).
Data format	PDF
Data set size	<4GB
Data sharing	Publication

Code	MC4-GFPL
Data set full name	Properties of finished parts
Responsible beneficiary	LAB23
Description	Results of the mechanical testing, visual inspection, nondestructive and destructive testing of the final products.
Data format	.pdf files
Data set size	< 4GB

Data sharing	Confidential
Code	MC4-CMSA
Data set full name	Material specifications
Responsible beneficiary	Amura
Description	The minimum requirements for the materials to be used in the manufacture of the final piece will be indicated so that said piece is capable of exceeding the specifications of the sector; durability, ease in production, finishetc
Data format	PDF file
Data set size	Approx. 1GB
Data sharing	Publication

Code	MC4-GMSV
Data set full name	Material specification for parts made of recycled materials
Responsible beneficiary	VDL Fibertech Industries
Description	Technical datasheet containing: color, mechanical properties, machinability and other characteristics.
Data format	PDF File (*.pdf) and if necessary accompanied by pictures (*.jpg)
Data set size	50 MB
Data sharing	Publication

Code	MC4-CMSA
Data set full name	Material specification for parts made of re-shapeable resin (3R)
Responsible beneficiary	MANAGING COMPOSITES
Description	Mechanical Properties, processability properties, safety datasheet
Data format	PDF File (.pdf) / Excel Sheet (.xls)
Data set size	100 MB
Data sharing	Confidential

Code	MC4-CPSA
Data set full name	Process specification for parts made of re-shapeable resin infusion and re-shape

Responsible beneficiary	MANAGING COMPOSITES
Description	Manufacturing procedure / manufacture Safety considerations.
Data format	PDF File (.pdf) / Excel Sheet (.xls)
Data set size	100MB
Data sharing	Confidential

Code	MC4-CMSF
Data set full name	Technical characterization of the scrap material
Responsible beneficiary	FIDAMC
Description	Characterization of the material to be recycled in order to get information about the format and size of the parts as well as other relevant parameters during the manufacturing process.
Data format	.xlsx tables and pdf
Data set size	<4GB
Data sharing	Confidential (depends of data providers)

Code	MC4-GMSL
Data set full name	Recycled material specification for production use
Responsible beneficiary	LAB23
Description	Identification of the recycled material that will be suitable for use: dimensions, format
Data format	.xlsx and/or .pdf files
Data set size	< 1GB
Data sharing	Confidential

Code	MC4-CMSS
Data set full name	Material specification for carbon fibres
Responsible beneficiary	STFI
Description	The data set contains testing results on fibre fineness, fibre length, fibre diameter, tensile strength, fibre surface etc.
Data format	xlsx or pdf file, REM images
Data set size	> 1 GB

Data sharing	Confidential
Code	MC4-CMSC
Data set full name	Material specification for recycled raw materials of STFI for Chomarat
Responsible beneficiary	Chomarat
Description	Textile construction (non woven, UD, sliver) defined in area weight, width, fiber type, binder type, fiber length, fiber orientation, packaging, mechanical properties (Tensile' Modulus and strength, elongation)
Data format	PDF
Data set size	<200MB
Data sharing	Confidential

Code	MC4-CGLC
Data set full name	Life cycle analysis data inventory and impact assessment results
Responsible beneficiary	IRES
Description	The dataset contains inventory data for input/output material, energy and waste flows for defined system boundaries of each case study and impact assessment results.
Data format	.xlsx tables
Data set size	<5 MB
Data sharing	Confidential (depends on data providers if data can be published or not)

Code	MC4-CGLC
Data set full name	Contact data
Responsible beneficiary	Techtera
Description	Contact details (first name, name, position, phone number, email address, organization) of persons interested in the MC4 technologies (met during events).
Data format	xlsx table
Data set size	< 1MB
Data sharing	confidential

7. ALLOCATION OF RESOURCES

The costs of providing FAIR data in the MC4 project will not be extensive. Due to the use of the Zenodo repository, no additional costs for infrastructure concerning storage and online availability of the data will occur. All partners need to define clear interfaces within the project to prepare the data for easy reuse. If the definition of internal interfaces is done in a good way, this will ease preparations for data publication. We therefore expect that all efforts will be covered by the activities within the individual technical work packages and/or the dissemination work package.

As a coordinator, Profactor will be responsible for keeping an overview and guiding data management across the whole project. However, individual partners are associated to data sets and declared "responsible beneficiary" as specified in the tables above. As such, partners are expected to supervise data acquisition, storage, and documentation for "their" data sets. In case specific versions of data sets that allow interesting (scientific) insights are identified, these will be presented and discussed in the regular telephone conferences or at general meetings. The respective responsible beneficiaries will drive activities for publication of data sets (preparation of scientific publications, upload to online repository, etc.)

8. DATA SECURITY

Open Data in the MC4 project will be uploaded to the Zenodo repository. Zenodo stores its data in the CERN Data Center. We consider this a highly trustable host. Loss of data – even in a long-time perspective – is very unlikely.

9. CONCLUSIONS

Open access is obligatory for scientific publications and corresponding data that is required for validation of these publications. The data management plan for the MC4 project lists all data sets that are expected to be generated over the duration of the project. A total of 40 types of data sets was identified and a plan for publication is given for each. While the project website will be used to promote publications, the Zenodo repository will be used as the major host for publicly available research data.