PlasticsFatE

Improving our present understanding of the impact of micro- and nano-plastics and associated additives/adsorbed contaminants in the human body

Newsletter No.1 www.plasticsfate.eu

In this issue:

Glossary:

A/C – Adsorbed Contaminants

DSS – Decision Support System

JRC – Joint Research Centre of the EC

MCDA – Multi-Criteria Decision Tool

MNP – micro and nanoplastics

NTA – Nanoparticle Tracking Analysis

SOP – Standard Operating Procedure

WP – Work Package

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PlasticsFatE has received funding from the European Union's Horizon 2020 Research and Innovation programme, under the Grant Agreement number 965367

Welcome from our Scientific Coordinator

Rudolf Reuther, ENAS

Dear colleagues, Dear readers!

It's amazing, but we are already approaching the end of the first project year of PlasticsFatE, which means that we are leaving the important "starting" phase behind. This phase is always critical and needed, to carefully prepare and direct the planned work towards our main goal, which is to assess the impact of micro- and nano-plastics (MNP) on human health!

Organising and coordinating all the different tasks within and across the individual work packages (WPs) is always a challenging but also an essential part of any project and demands much care, good communication and not least enough time and patience.

Being aware of these "starting" conditions is an important lesson we can learn from previous projects and maybe one of the secrets behind any truly lasting and sustainable progress and success.

We are happy to provide you with the first PlasticsFatE Newsletter, which gives you hands-on information about the diversity of activities already going on in the project, and an idea of the many discussions and actions that have taken place also across the CUSP cluster since the project started, to bring plans, efforts, and disciplines into the right direction.

As you can see, various preliminary studies and investigations have been launched in the different WPs to tackle both basic and more practical issues, such as the preparation, selection and distribution of well-defined test samples that can meet experimental needs and demands coming from the various research tasks. This includes (a. o.) the testing and adapting of methods for the physicochemical and spectroscopic characterisation of MNP particles, or for developing harmonised protocols for sample treatment, dispersion and digestion, or for establishing suitable in vitro and in vivo assays and toxicological endpoints, to assess fate and effects of these particles in the human body, also down at the cellular and molecular level.

A first batch of representative test materials has been made available in WP1 and distributed to project partners for screening or homogeneity studies, or for testing the applicability of approaches to measure exposure metrics (such as size, shape, surface properties or dose/response ratios) or to characterise the human hazard of relatively simple but representative polymers, such as PE, PP and Eu-doped PS.

In WP2, a comprehensive review of the relevant scientific literature has been undertaken to map the occurrence of MNPs in the human diet, including drinking water, food packages, air, and personal care products, to get a better understanding of the type and scope of main human exposure routes, sources and levels for these tiny plastic particles. Results will guide the planned experimental and modelling work on the fate of MNPs and associated chemicals (such as plasticisers, stabilisers or flame retardants or environmental contaminants) in humans.

Also, in WP3, an intense discussion is still ongoing in identifying SOPs for advanced cell models and the experimental conditions to be considered (e.g., dispersion of particles in cell culture and test media, effects of particle properties and type of polymers, or the role of additives and contaminants), and first cytotoxicity and inflammation studies will soon start with HDPE particles < 5 um and Eu-doped polystyrene, to trace particles within tissues, organs and cells. PlasticsFatE will develop novel cell models that simulate the situation in the gastrointestinal and pulmonary tract and hold the promise to reduce *in vivo* studies that will be performed, also to verify the *in vitro* results.

Work is also advancing in WP4, where an evaluation of the applicability of already existing regulatory frameworks for developing new risk assessment strategies for MNP has been performed that take the specific properties of MNP particles into account. Here, two novel decision support systems (DSS) will be developed to support policy makers, regulators and industries in finding proper decisions for the safe and sustainable handling of plastic products along their life cycle.

Finally, WP5 has started to discuss the practical requirements for the case studies planned to test the feasibility of the developed methodology under more realistic conditions, which will include (bio-) monitoring studies at relevant workplaces in the manufacturing and recycling industry, and in wastewater treatment facilities. Another focus of these field studies will be on testing the capability of MNP particles to act as vector for pathogens.

All partners in PlasticsFatE are strongly committed to working closely together with their counterparts in the CUSP MNP cluster, a task that has been closely organised around different thematic working groups (on data, methods and materials, interlaboratory studies, exposure, risk and hazard aspects).

The broad spectrum of goals and investigations, and the variety of methods we will test and use in PlasticsFatE is indeed an ambitious, complex and challenging task, but one that is urgently needed to create the reliable scientific data and knowledge that helps us to understand the complex behaviour of MNPs, and associated additives and contaminants, and how this controls their occurrence and effect on human populations today.

It is our hope that the knowledge we will produce, also within CUSP, will lead to the development of new risk assessment strategies that can be applied to MNPs and help to close some critical gaps we still face today in understanding the impact of these particles on human health.

Hope you enjoy this newsletter!

With best wishes,
Rudolf Reuther

From Kick-off until now:
Our first 10 months

PlasticsFatE Kicks-Off

More than 80 partners from 28 organisations and 11 countries took part in the PlasticsFatE kick-off meeting, held online from 28-29 April 2021.

Following a warm welcome from our Coordinators, Rudolf Reuther and Mark Morrison, we met our EC Project Officer, Laia Quirós from the new European Health and Digital Executive Agency (HaDEA), Advisory Board Members, and our Ethics Advisor.

Over two days, together we analysed our workplans, discussed our activities, and planned our internal interactions. We looked at our obligations to the EC and, importantly, we got to know each other as we embarked on this exciting project.

CUSP - The European Cluster on Health Impacts of Micro- and Nanoplastics

Together with our four sibling projects - AURORA, Imptox, PLASTICHEAL and POLYRISK - funded under the same EC call, we have formed the CUSP Cluster, comprising six working groups led by different projects, with representatives from each of the others:

- WG1 Analytical methods and representative materials – IMPTOX
- WG2 Data sharing – POLYRISK
- WG3 Inter-laboratory comparisons –PLASTICSFATE
- WG4 Exposure assessment –AURORA
- WG5 Risk assessment –PLASTICHEAL
- WG6 Communication and Dissemination –PLASTICSFATE

CUSP

www.cusp-research.eu

Since Kick-off

In addition to the Work Package updates that follow, PlasticsFatE has formed successful collaborations with PlasticsEurope, the University of British Columbia – which has led to workshops on analytics and mouse lung models - and are now working on new liaisons with complementary initiatives such as ILSI Europe Microplastics Initiative, and the EC NanoSafety Cluster, among others.

In recent weeks, we have worked on a joint document responding to the EC Call of evidence on impact assessment of microplastics pollution, highlighting the need to bridge knowledge gaps on potential health risks of the exposure to microplastics in the environment and how the CUSP projects are approaching this.

Our partners have had numerous external engagements: Antonio Pietroiusti from the University of Rome Tor Vergata presented our project at the "Ocean and nano plastic pollution" event organised by the Italian Ministry of Education and the UNESCO Italian Commission; we presented a PlasticsFatE Poster at EuroNanoForum 21; ASSOITTICA ITALIA, the Italian National Association of Fish Companies, contacted PlasticsFatE partner, Ecamricert, to arrange a webinar to introduce the challenge and aims of PlasticsFatE and speak about the characterisation of microplastics in fish; and we have been working with eNanomapper on data management systems. At the ImagineNano event Team GAIKER presented PlasticsFatE to a large number of participants, and we took part in a collaborative meeting with the Austrian MNP Network. PlasticsFatE partners have also produced some key publications, which you can find out about later in this newsletter.

Consortium Meetings

Our first General Assembly took place in December. Despite meticulous planning for a live gathering in Frankfurt, we were subject to COVID restrictions which necessitated an online event instead. This did, however, mean that more people could take part, and we engaged in in-depth cross-cutting issues that could be followed up more easily. Our forthcoming full consortium meeting will take place in June at JRC, Ispra, Italy, to coincide with our first in-person meeting with our CUSP counterparts, organised by JRC.

WP1: Material selection & physicochemical characterisation

Update from Anna Costa, ISTEC-CNR

Main goal: WP1 will produce a set of representative test materials and suitable methods for assessing the impact of MNPs and A/C on human health.

Key outcome: Provide a portfolio of characterised MNPs to be used in the PlasticsFatE project and make them available as benchmarking materials for future studies. WP1 will also provide protocols for material handling, sample preparation, physicochemical characterisation and testing of exposure, fate and hazard.

Achievements so far: WP1 has established the PlasticsFatE portfolio of MNPs, which provides different polymer types, sources/size, and use scenarios. The batch-to-batch reproducibility has been checked as well as the absence of endotoxin contamination. Samples have been distributed to partners for characterisation. We have also developed and tested protocols for milling and weathering plastics. We are conducting an ongoing dispersibility study to validate protocols for the preparation of stocks dispersions and their dilution in simulant fluids (working dispersions). Finally, we have tested methods for sample extraction from real matrices (filtering and human tissue digestion).

Plans: We now plan to optimise the strategy for the reduction of particle size from around 50 microns to 10 microns and below. In addition, we will be providing a technical data sheet including basic physicochemical properties of the PlasticsFatE materials portfolio. We will also simulate real exposure scenarios and improve knowledge on particle dispersibility and transformation.

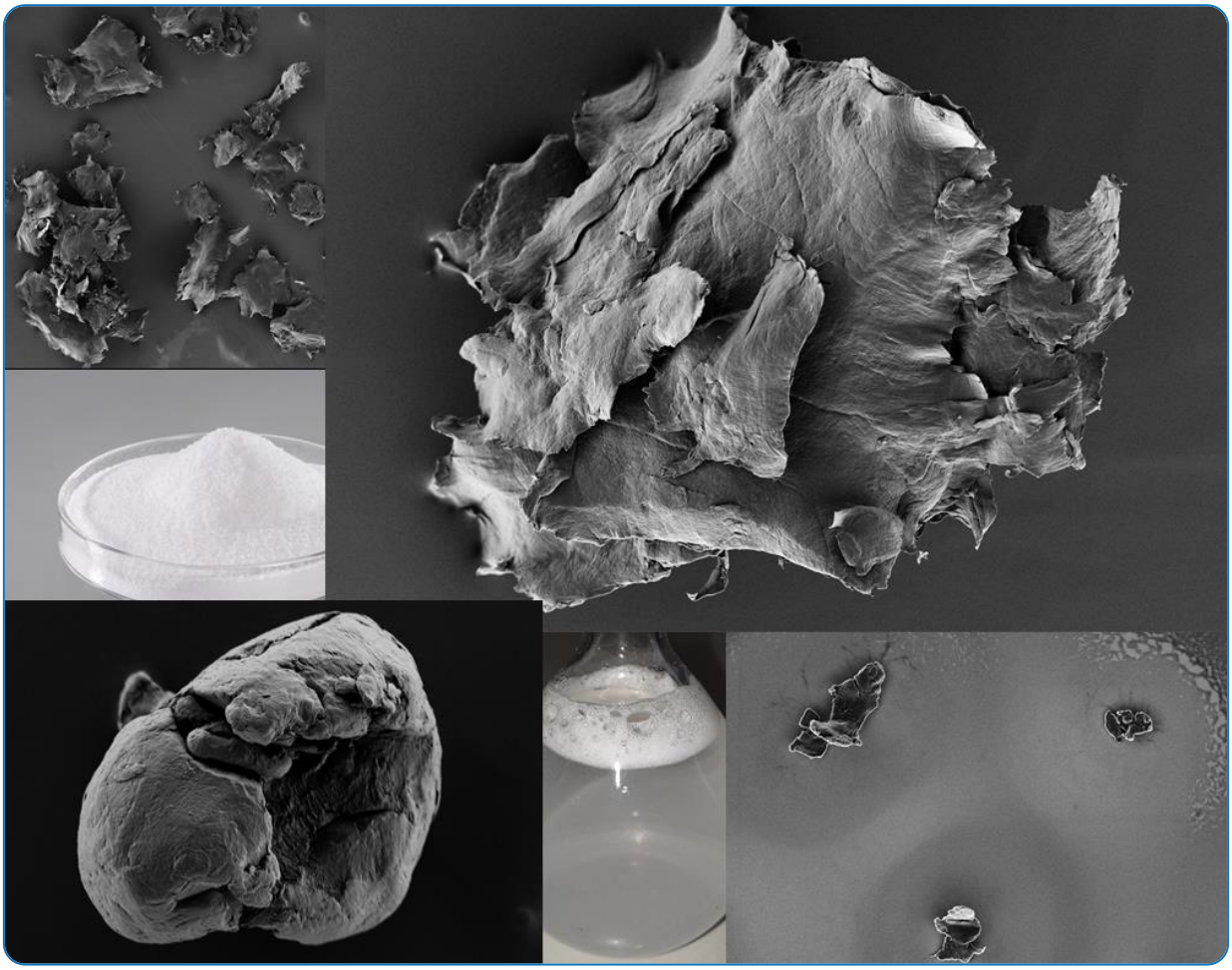


Image: MP/NP characterisation from dry state to wet dispersions

WP2: Exposure and fate assessment

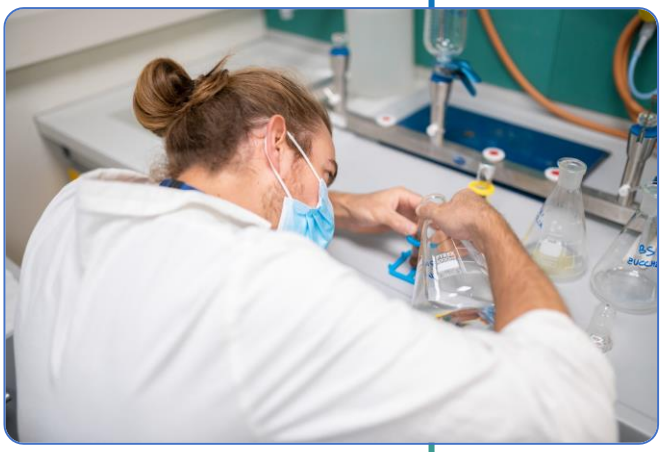
Update from Raquel Portela, CSIC

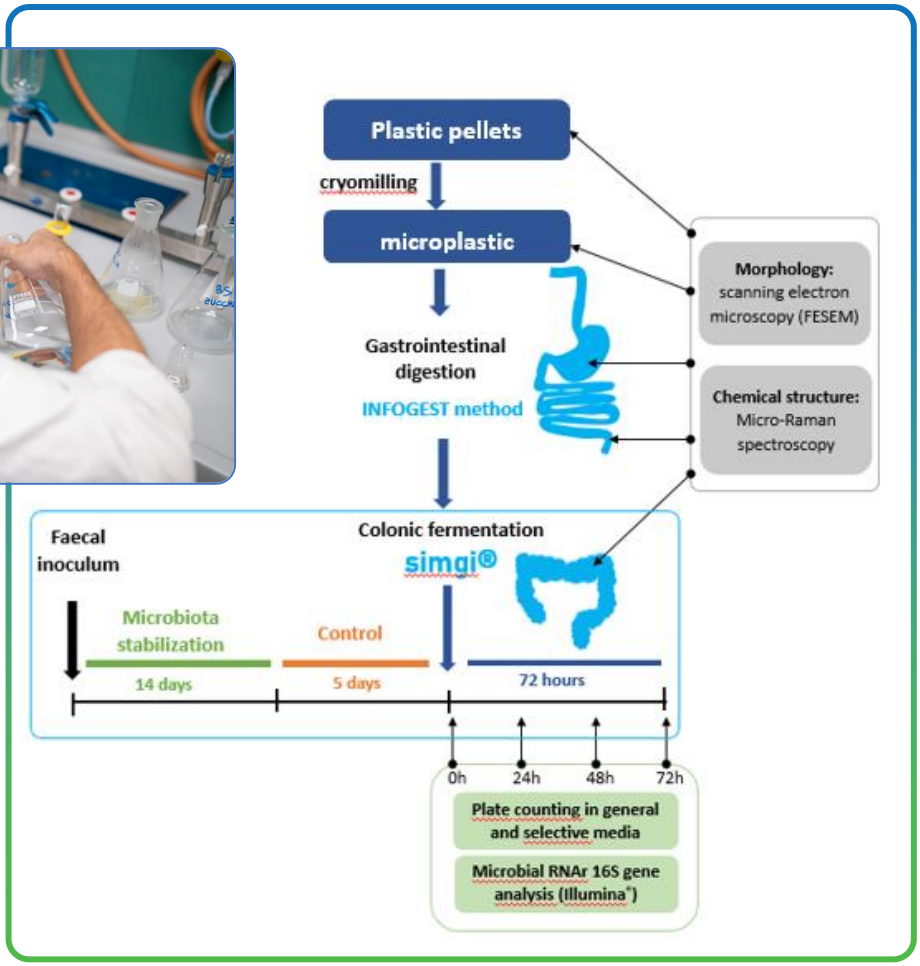
Main goal: WP2 is identifying key sources and exposure levels for MNPs and related A/Cs, and possible fate scenarios.

Key outcome: We will produce a new comprehensive database and knowledge on exposure levels and fate of MNPs and A/C in various sources and matrices (e.g. foods, drinks, human tissues, air) based on robust and validated models, test methods, protocols and strategies as well as a critical review of the literature.

Achievements so far: Within task 2.1: we have conducted a critical review of exposure levels and sources for MNPs in food, drinks, air, personal care products, and their transmission to humans. This is almost ready for submission. We have also published a review: From properties to toxicity: Comparing microplastics to other airborne microparticles; doi: https://doi.org/10.1016/j.jhazmat.2021.128151. Within task 2.3 we have written a publication about the measurement of nanoplastics using NTA. In task 2.4, the following paper has been published: Tamargo, A.; Molinero, N.; Reinosa, J. J.; Alcolea-Rodriguez, V.; Portela, R.; Bañares, M. A.; Fernández, J. F.; Moreno-Arribas, M. V. PET Microplastics Affect Human Gut Microbiota Communities during Simulated Gastrointestinal Digestion, First Evidence of Plausible Polymer Biodegradation during Human Digestion. Sci. Rep. 2022, 12 (1), 1–15. https://doi.org/10.1038/s41598-021-04489-w.

Plans: We now aim to focus on environmental fate, human exposure and toxicokinetic modelling of plastics (T2.2); the experimental evaluation of exposure levels of plastics in food, drinks, inhalation air and personal care products (T2.3); and of plastics fate in humans (T2.4).





Images:

Above: WP2 in action, courtesy of ECSIN-Ecamricert

Right: From the paper produced within T2.4

WP3: Hazard Assessment

Update from Anani Afanou, STAMI

Main goal: WP3 is focused on the development of *in vitro/in vivo* models and characterising the hazard effects of MNPs and A/Cs in the human body. This addresses the need to have validated models to better study and understand the likely short and long-term impacts of micro- nano plastic particles present in different matrices on human health from different environments. We will also use labelled MNPs to assess the passage through biological barriers and the translocation through different tissues in *in vitro* and *in vivo* models.

Key outcome: The main outcome will be the generation of a comprehensive new database and knowledge on adverse effects of MP/NP and A/C based on robust and validated models, test methods, protocols and inter-lab studies.

Achievements so far: We have now reached a common understanding of the DOA and goals in the WP and completed the first draft of the mandatory and optional SOPs. In addition, WP3 has established the list of cell models and cell lines projected for use in the *in vitro* studies. Eu-labelled polystyrene particles have been distributed to contributing partners for particle characterisation and cellular responses. Regular meetings have been held, as well as a physical meeting organised in Paris on 14th October 2021. Finally, requests of plastics from each partner were sent to WP1, who distributed the first batches accordingly.

Plans: In the short term, we will review the drafts of SOPs. We will also test the dispersion and the behaviour of the plastic particles in cell culture media. We aim to agree on the characteristics (Source, Passage number etc..) of cell lines that will be used by project partners (eg. A549, Caco-2, THP1); and we will perform the first cytotoxicity and inflammation studies with HDPE (D50: 5µm) particles and Europium doped PS.

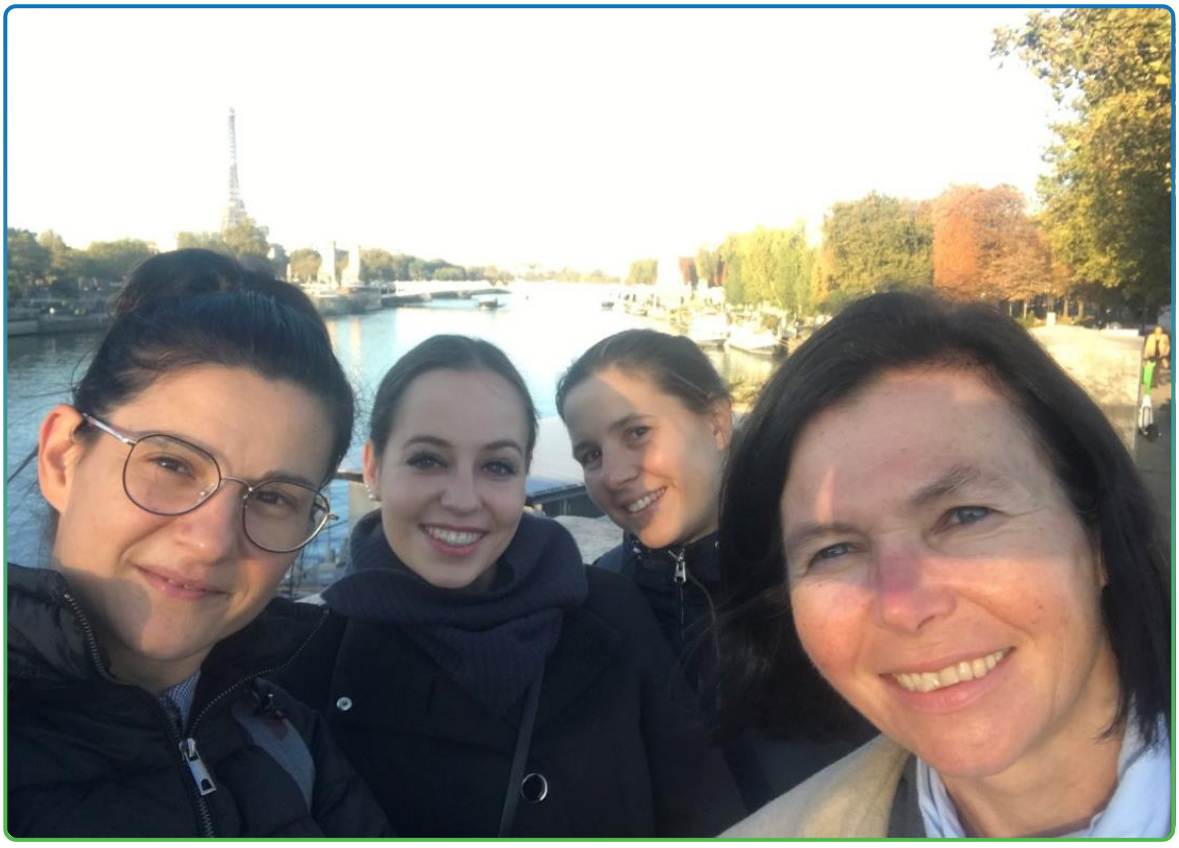


Image: Participants from University of Ljubljana (UL) at WP3 meeting in Paris (14th October 2021)

WP4: Risk assessment and management

Update from Dana Kuehnel, UFZ

Main goal: WP4's fundamental goal is to take up the research results from WP1-3, CUSP, and beyond, to derive strategies for risk assessment and decision support for MNPs.

Key outcome: We aim to ensure that the human and environmental risk assessment strategies are adopted, taking into account the special features of MNPs and A/Cs. We will also produce decision support tools to facilitate decision making related to MNPs for stakeholders

Achievements so far: WP4 has made a compilation of existing regulatory documents applicable to microplastic particles of various origin to define the *status quo.* This was submitted as Deliverable 4.1. Regarding data collection and research data management, we have compiled relevant data as well as organised data transfer and the organisation of data. Moreover, we have compiled the data needs for MCDA and DSS, and of researchers and projects outside PlasticsFatE working in the field and that may provide additional data, in cooperation with CUSP WG5. We have also embarked on plans for a joint workshop with WP6 involving PlasticsFatE partner Dechema. The workshop will focus on the data needs for decision support tools (MCDA and DSS).

Plans & announcements: There will be a joint WP4-WP6 workshop aiming at familiarising all PlasticsFatE partners with the tools developed in WP4, the data needed for establishing these tools, and discussing data collection and transfer.

Further details and an agenda will follow in due course.

WP5: Case Studies

Update from Arantxa Ballesteros, ITENE

Main goal: The main goal is to demonstrate, through three different case studies, the performance and applicability of the strategies and methodologies generated in WP1-WP4 for MNP particles regarding: 1) identification, quantification and detection, 2) occupational exposure monitoring and bio-monitoring, 3) potential of plastic particle surfaces to act as vectors for pathogens through microbial colonisation and 4) investigations on long-term effects in the human body.

Key outcome: Recommendations and guidelines to improve current risk assessment strategies and management practices.

Achievements so far: Since the work in WP5 builds on the developments and achievements in the other WPs, the work is weighted more towards the end of the project. So far, work has been done on a protocol for ethical committee needed to perform bio-monitoring studies at plastics recycling and wastewater treatment plants, as well as on a draft for a methodology strategy for biomonitoring and study on long-term effects. Microorganisms have also been selected for pathogen and microbial colonisation studies.

Plans: In the short term, the next steps are focused on the one hand, on getting a close look at the state of the art of the methodologies and strategies to be validated (T5.1); and on the other hand, to begin experimental studies related to pathogens (T5.2) and environmental organisms (T5.3).

Images:
Above: Occupational exposure monitoring devices
Below: Nanoparticle-aerosol chamber

WP6: Dissemination, exploitation and impact of results

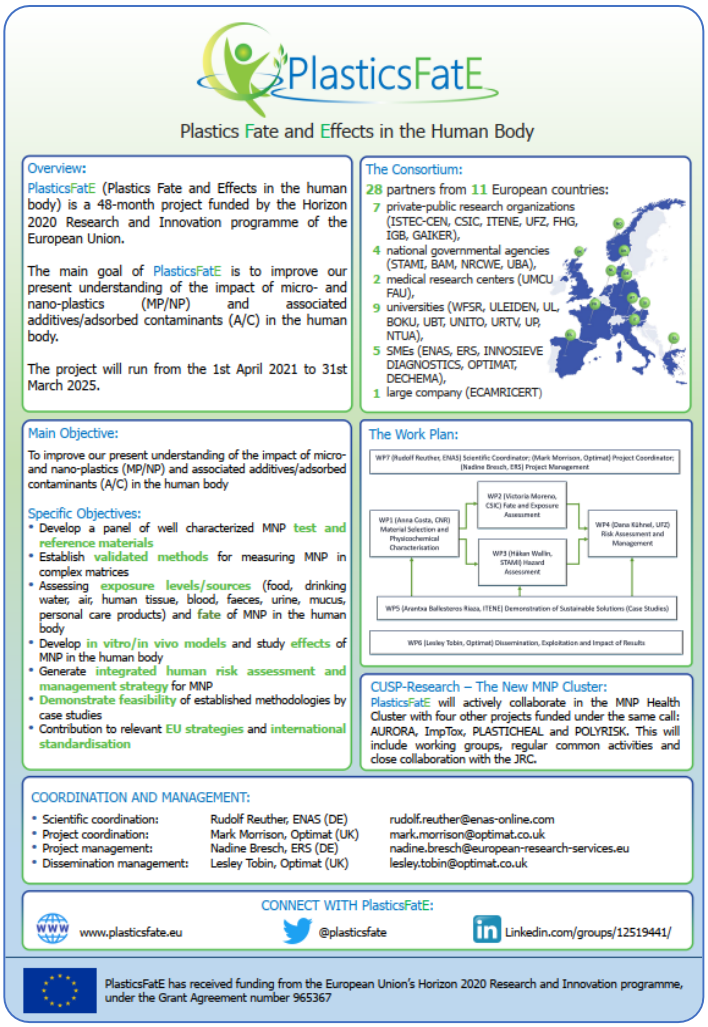
Update from Lesley Tobin, Optimat Ltd

Main goal: WP6 aims to engage with all relevant stakeholders to shape input to policy-makers that takes account of scientific and socio-economic evidence.

Key outcome: Through this engagement, we will formulate coordinated recommendations to the health-relevant aims of the European Strategy for Plastics in a Circular Economy and the European Bioeconomy Strategy.

Achievements so far: WP6 has completed the Plan for Exploitation and Dissemination of Results (D6.1), which will serve as a guide for all partners. We have also established our website and social media presence on LinkedIn and twitter (D6.2), and conducted a Review of current regulations, and policy and market (D6.3). Our website has been deployed at www.plasticsfate.eu, where you can register for updates, and subscribe to our newsletter and event notifications, etc. It is also making our scientific output accessible to you, as well as dissemination material such as our brochure and introductory poster. Meanwhile, the PlasticsFatE social media accounts have now gained traction with increasing numbers of followers on both Twitter (265) and LinkedIn (127).

Plans: We're now in the process of planning training workshops based on new knowledge generated within the project, as well as having regular events to present and discuss project out put and help shape future activities with external stakeholders. These entities include the Momentum cluster based in the Netherlands, the ILSI Europe Microplastics Initiative, the Papillons project, Ocean Diagnostics and the Austrian MNP Network, as well as developing existing collaborations with the University of British Columbia , PlasticsEurope and the EC NanoSafety Cluster.



Images: Left: Dissemination poster; Above: Brochure

PET microplastics affect human gut microbiota communities during simulated gastrointestinal digestion, first evidence of plausible polymer biodegradation during human digestion

Tamargo, A.; Molinero, N.; Reinosa, J.; Alcolea-Rodriguez, V.; Portela, R.; Bañares, MA.; Fernández JF; Moreno-Arribas, M.V.

A recent study carried out at CSIC and published in the journal Scientific Reports has evaluated for the first time the impact of microplastics ingestion on the digestive tract and the human intestinal microbiota. The study focuses on micrometric polyethylene terephthalate (PET), a widespread plastic, but the protocol will be extrapolated soon to study other types of plastic and particle sizes, with the overall goal of contributing to our current understanding of the impact of micro- and nanoplastics and associated additives on the human body.

Access the paper here: https://doi.org/10.1038/s41598-021-04489-w

Quantitative tracing of uptake and transport of submicrometre plastics in crop plants using lanthanide chelates as a dual-functional tracer

Yongming Luo; Lianzhen Li; Yudong Feng; Ruijie Li; Jie Yang; Willie J. G. M. Peijnenburg and Chen Tu

The uptake pathways of nanoplastics by edible plants have recently been qualitatively investigated. There is an urgent need to accurately quantify nanoplastics accumulation in plants. Polystyrene (PS) particles with a diameter of 200 nm were doped with the europium chelate Eu–β-diketonate (PS-Eu), which was used to quantify PS-Eu particles uptake by wheat (Triticum aesti-vum) and lettuce (Lactuca sativa), grown hydroponically and in sandy soil using inductively coupled plasma mass spectrometry. PS-Eu particles accumulated mainly in the roots, while transport to the shoots was limited (for example, <3% for 5,000 µg PS particles per litre exposure). Visualisation of PS-Eu particles in the roots and shoots was performed with time-gated lumi-nescence through the time-resolved fluorescence of the Eu chelate. The presence of PS-Eu particles in the plant was further confirmed by scanning electron microscopy. Doping with lanthanide chelates provides a versatile strategy for elucidating the interactions between nanoplastics and plants.

Access the paper here: https://www.nature.com/articles/s41565-021-01063-3

From properties to toxicity: Comparing microplastics to other airborne microparticles

Simon Wieland, Aylin Balmes, Julian Bender, Jonas Kitzinger, Felix Meyer, Anja FRM Ramsperger, Franz Roeder, Caroline Tengelmann, Benedikt H. Wimmer, Christian Laforsch, Holger Kress

Microplastic (MP) debris is considered as a potentially hazardous material. It is omnipresent in our environment, and evidence that MP is also abundant in the atmosphere is increasing. Consequently, the inhalation of these particles is a significant exposure route to humans. Concerns about potential effects of airborne MP on human health are rising. However, currently, there are not enough studies on the putative toxicity of airborne MP to adequately assess its impact on human health. Therefore, we examined potential drivers of airborne MP toxicity

Access the paper here: https://doi.org/10.1016/j.jhazmat.2021.128151

Simgi® as an advanced model for the study of the interaction between food-derived microplastics, the human gastrointestinal tract and gut microbiota

Tamargo, Alba; Cueva, Carolina; Alcolea, Víctor; Portela, Raquel; Bañares, Miguel Ángel; Reinosa, Julián Jiménez; del Campo, Alfonso; Fernández, Jose Francisco; Moreno-Arribas, M. Victoria

The prevalence of plastic particles in the food chain is already evident. Therefore, the scientific community is concerned about the health risks of food-use microplastics; although the risk assessment of microplastics is not possible, it is a current global challenge. This study aims to evaluate the impact of the main stages of the human gastrointestinal tract on different relevant food-use plastic materials, also to ascertain the effect of digested microplastics on gut 10.5281/zenodo.4747440microbiota composition and functionality.

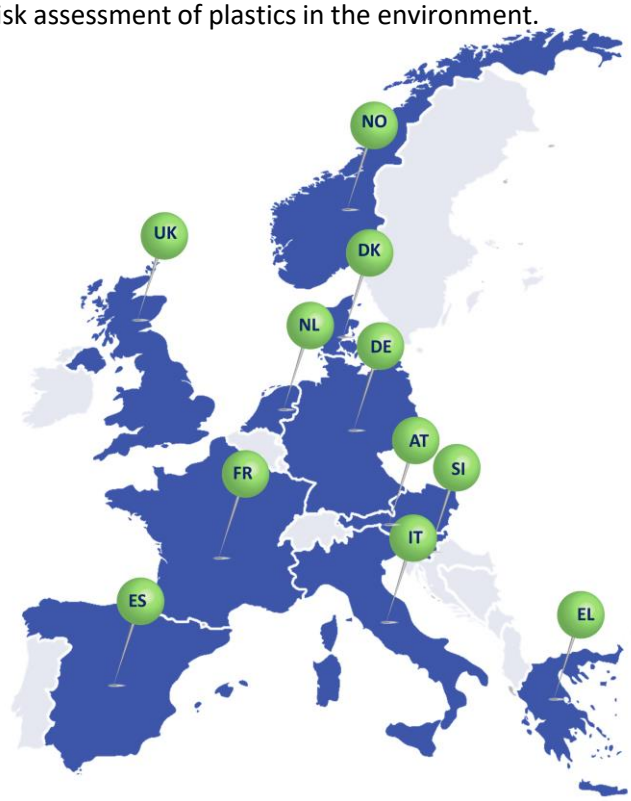
Access the poster here: https://doi.org/10.5281/zenodo.4747440

To keep up to date with our publications, visit: https://zenodo.org/communities/cusp-research

About PlasticsFatE

PlasticsFatE is a 48-month project funded by the Horizon 2020 Research and Innovation programme of the European Union. The project will run from 1st April 2021 to 31st March 2025.

Its main goal is to improve our present understanding of the impact of MNPs and associated additives/adsorbed contaminants (A/Cs) in the human body. To achieve this, a highly interdisciplinary approach is required, and so we have pooled some of Europe's foremost experts in these fields, and laboratories that have the scientific and technical capacities, experience, and resources to jointly develop scientifically sound and innovative procedures, methods and instruments for human hazard, exposure and risk assessment of plastics in the environment.



The partners have been chosen for their competences, strong track-records, synergies, and complementarities, to collectively achieve the critical mass of expertise and infrastructure necessary to meet the project's impact-focused ambitions and goals. This unique partnership will ensure the required innovation of current relevant methodologies and their successful implementation to arrive at a better understanding of the health impacts of exposure to micro- and/or nano-plastics found in the environment.

The Consortium: 28 partners from 11 countries

- 7 private-public research organisations (ISTEC-CNR, CSIC, ITENE, UFZ, FHG, IGB, GAIKER)
- 4 national governmental agencies (STAMI, BAM, NRCWE, UBA)
- 2 medical research centres (UMCU, FAU)
- 9 universities (WFSR, ULEIDEN, UL, BOKU, UBT, UNITO, URTV, UP, NTUA)
- 5 SMEs (ENAS, ERS, INNO, OPTIMAT, DECHEMA)
- 1 large company (ECAMRICERT)