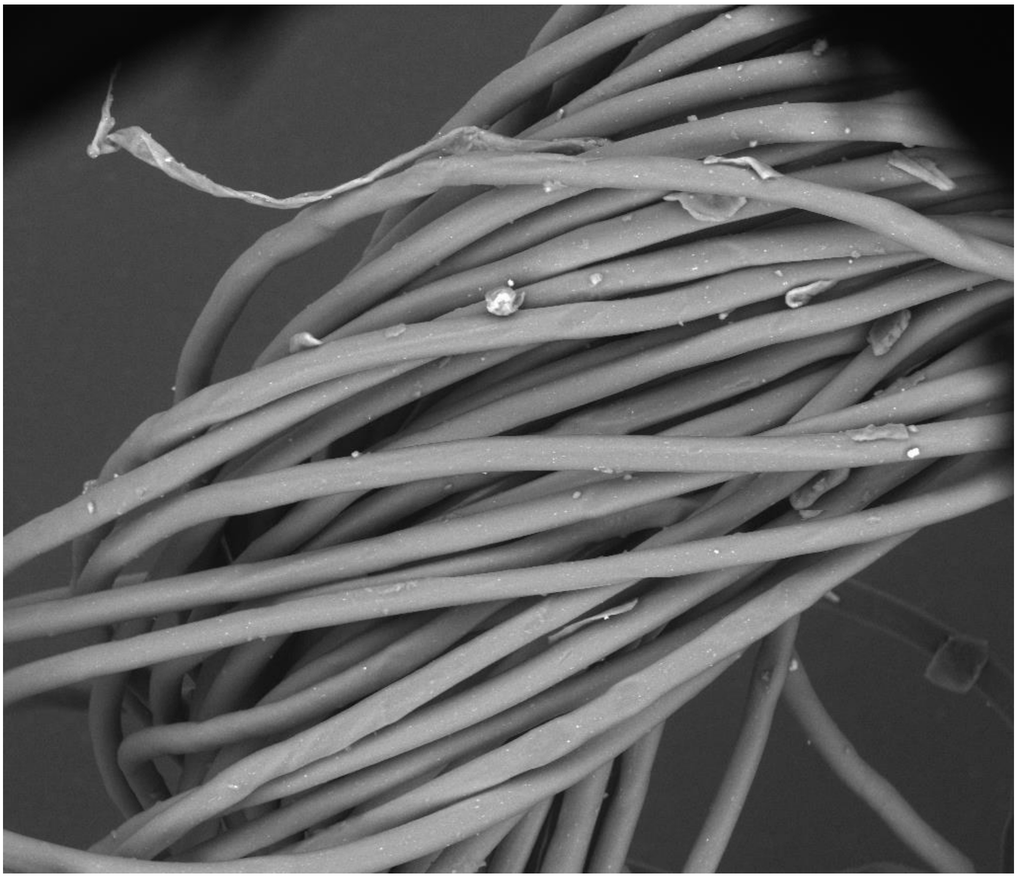
Microplastics2018

28-31 October, 2018
Congressi Stefano Franscini, Monte Verità, Ascona, Switzerland



Program and Abstracts

Sponsors

The Organizing Committee gratefully acknowledges the financial support of:

Congressi
Stefano Franscini

www.csf.ethz.ch

ETH zürich

www.ethz.ch

FNSNF
FONDS NATIONAL SUISSE
SCHWEIZERISCHER NATIONALFONDS
FONDO NAZIONALE SVIZZERO
SWISS NATIONAL SCIENCE FOUNDATION

www.snf.ch

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Office for the Environment FOEN

www.bafu.admin.ch

Agilent

www.agilent.com

PerkinElmer®
For the Better

www.perkinelmer.com

Conference Organizers and Speakers

Scientific Committee

Bernhard Wehrli, Eawag / ETH Zurich, Switzerland
Denise Mitrano, Eawag, Switzerland
Ralf Kaegi, Eawag, Switzerland
Thilo Hofmann, University of Vienna, Austria

Conference Secretariat

Paolo Demaria, Demaria Event Management, Zurich, Switzerland

Invited Speakers

Tamara Galloway, University of Exeter, UK
Gunnar Gerdts, Alfred Wegner Institute, Germany
Thorsten Hüffer, University of Vienna, Austria
Natalia Ivleva, TUM, Germany
Rainer Lohman, University of Rhode Island, USA
Denise Mitrano, Eawag, Switzerland
Chelsea Rochman, University of Toronto, Canada
Michael Sander, ETH Zurich, Switzerland
Richard Thompson, University of Plymouth, UK
Martin Wagner, NTNU, Norway

General Information

The conference takes place at the Congressi Stefano Franscini (CSF), the conference center of ETH Zurich, located at Monte Verità, Ascona, Switzerland. The conference facilities, the restaurant and the bar are located in the main building called Bauhaus Building.

For further information on Monte Verità and on connections to Ascona, please refer to the white CSF folder included in your conference bag.

Conference rooms

All lectures will take place in the Auditorium on the ground floor of the Bauhaus Building. All posters will be displayed from Monday to Tuesday evening in the Balint Room, on the first floor of the Bauhaus Building. We kindly ask you to take your poster with you when you leave. Posters left at the venue after departure of the group will be discarded.

Oral Presentations

Lectures are presented as as power point or pdf slideshow on either a Windows or a Mac computer. The beamer has an additional third channel, so the use of own computers is possible, but compatibility with the video system should be tested ahead of time. Members of the organizing committee will be available to assist you in uploading and testing your presentation.

Chairpersons will control that speakers keep their time.

Poster Presentations

Poster boards are 180 cm (width) x 120 cm (height) and can fit A0-sized posters printed in both portrait or landscape format. The posters can stay on display until Tuesday evening, after the poster session. Please refer to the numbered posters list in this book to find the assigned board for your poster.

A 2 hours poster session is scheduled on Tuesday from 17.00 to 19.00. Authors are kindly requested to stay by their poster during this time.

Spontaneous discussions in the poster room are welcome at any time (in breaks, after lunch, in the evening). Please remove your poster on Tuesday evening after dinner.

“CSF Award”

The *CSF Award* has been established in 2009 by the director and the scientific board of the Congressi Stefano Franscini. The Award will be conferred to the best presentation given by a young scientist during the conference, after review by a jury formed by the conference organizers and invited speakers. The CSF Award ceremony is scheduled at the end of the program on Wednesday morning.

Wireless and computer room

There is a free wireless network in the Bauhaus Building and in the Semiramis Building. Please refer to the CSF folder you have received at registration for further information on the use of the wireless (password, settings, etc.).

A computer room (equipped with Windows and Mac computers and one printer) is available for you 24 hours a day. The room is located at the ground floor of the main building, few steps after the Monte Verità hotel front desk.

Meals and refreshments

Lunches and dinners (from Sunday evening reception till Wednesday lunch) will be served at the Monte Verità Restaurant, on the first floor of the Bauhaus building. Please refer at the timing indicated in the program for meals and arrive on time at the dining room.

All coffee breaks will be served at the Bar Roccia, on the first floor of the Bauhaus Building. The Bar Roccia will also be open for you every evening from 21.00 to midnight.

Disclaimer

The conference organizers cannot accept any liability for personal injuries sustained, or for loss or damage to property belonging to congress participants (or their accompanying persons), either during, or as a result of, the congress.

Registration fees do not include insurance.

Program

Sunday, 28. October, 2018

From 16.00	Arrival, registration
17.30-17.45	Introduction by the Organizing Committee
17.45 – 18.15	**Chelsea Rochmann,** University of Toronto, Canada *The fate and effects of microplastic in aquatic ecosystems*
18.15 – 19.15	*Welcome drink*
19.15	*Dinner*

Monday, 29. October, 2018 - Morning

8.15 – 8.30	CSF and Monte Verità Welcome Address
8.30 – 9.00	**Richard Thompson,** University of Plymouth, UK *How concerned should we be about microplastics?*
9.00 – 9.30	**Gunnar Gerdts,** Alfred Wegner Institute, Germany *Defining the baselines and standards for microplastics analyses in European waters!? Highlights and pitfalls of JPI-O BASEMAN*
9.30 – 9.45	**Joana MacLean,** GFZ German Research Centre for Geosciences *Microbiology of the terrestrial 'plastisphere' - enrichment and characterization of plastic- associated microbial communities*
9.45 – 10.00	**Delphine Kawecki-Wenger,** Empa, Switzerland *Environmental flows of macro- and microplastics for seven different polymers using Material Flow Analysis*
10.00 – 10.45	*Coffee break*
10.45 – 11.00	**Philipp Hopp,** BASF, Germany *Development of a prototype environmental risk assessment framework for microplastics*
11.00 – 11.15	**Brett Roblin,** Trent University, Canada *Atmospheric deposition of microplastics into remote lake catchments*
11.15 – 11.45	**Denise Mitrano,** Eawag, Switzerland *The path of microplastics to the environment: fate and transport in wastewater treatment systems*
11.45 – 12.00	**Allan Gross,** Aarhus University, Denmark *A critical view of wastewater treatment plants ability to clean for microplastics*
12.00 – 12.15	**Christian Laforsch,** University of Bayreuth, Germany *Microplastic in the environment - organic fertilizer as an entry vehicle*
12.30	*Lunch*

Monday, 29. October, 2018 – Afternoon

14.00 – 14.30	**Martin Wagner,** NTNU, Norway *Risk to all or none? On the toxicity of microplastics to animals, scientists and societies*
14.30 – 15.00	**Michael Sander**, ETH Zurich, Switzerland *Going beyond microplastics: biodegradation of synthetic polyesters in soils*
15.00 – 15.15	**Gabor Bordos,** WESSLING Hungary Ltd., Hungary *Microplastics in riverine systems of Hungary*
15.15 – 15.30	**Nathalie Vallotton,** Dow Europe GmbH, Switzerland *Risk based approach to assess solid cross-linked styrene/acrylate copolymers in the environment*
15.30 – 15.45	**Joana Sipe,** Duke University, USA *Quantifying and scaling rates of microplastic generation from various plastic sources during use from mechanical stress*
15.45 – 16.30	*Coffee break*
16.30 – 16.45	**Nathan Bossa,** Duke University, USA *Effect of Nanomaterials on microplastics exposure, behavior, fate and toxicity*
16.45 – 17.00	**Francesca De Falco**, National Research Council, Italy *Quantitative approaches to investigate the release of microfibres from washing processes of synthetic clothes*
17.00 – 17.15	**Yaping Cai**, Empa, Switzerland *The origin of fiber micro-fragments in polyester textiles: does the production process matter?*
19.00	*Dinner*

Tuesday, 30. October, 2018 - Morning

8.30 – 9.00	**Rainer Lohmann,** University of Rhode Island, USA *Sorption of organic pollutants to Microplastics in fresh (and saltier) water systems*
9.00 – 9.15	**Todd Gouin,** TG Environmental Research, UK *Challenges and limitations associated with aquatic toxicity and bioaccumulation studies for sparingly soluble and particulate substances*
9.15 – 9.30	**Scott Coffin,** University of California, Riverside, USA *Analytical and in vitro estimates of estrogenicity from simulated digests of plastic items*
9.30 – 9.45	**Andrew Reynolds,** Dublin Institute of Technology, Ireland *Standardizing in-vivo analysis methods for toxicological effects within freshwater organisms from nano-polystyrene exposure*
9.45 – 10.00	**Veronique Adam,** Empa, Switzerland *Towards ecotoxicological Risk Assessment of Microplastics: A comparative Analysis of Hazard and Exposure Data in Freshwater*
10.00 – 10.45	*Coffee break*
10.45 – 11.15	**Thorsten Hüffer,** University of Vienna, Austria *Microplastic aging and its impact on leaching of polymer additives*
11.15 – 11.30	**Sven Seidensticker**, Eberhard Karls Univ. Tübingen, Germany *Microplastic as pollutant vector: Influence of non-linear sorption and coupled mass transfer*
11.30 – 11.45	**Robin Treilles,** University of Paris-Est, France *Impacts of digestion protocols on man-made and natural fibers*
11.45 – 12.00	**Patricia Burkhardt-Holm**, University of Basel, Switzerland *MOSeS - Microplastics Oil Separation Standard for Surface, Soil and Sediment Samples*
12.00 – 12.15	**Heejun Kang,** University of Science and Technology, Republic of Korea *Microplastics in fat, oil and grease (FOG) in sewage*
12.15 – 13.45	*Lunch*

Tuesday, 30. October, 2018 - Afternoon

14.00 – 15.00	**Panel discussion**: Industry point of view
15.00 – 15.30	**Natalia Ivleva,** TUM, Germany *Microplastic in environmental samples: Identification and quantification by Raman microspectroscopy*
15.30 – 16.15	*Coffee break*
16.15 – 16.30	**Florian Meier,** Postnova Analytics GmbH, Germany *Hyphenation of Asymmetrical Flow Field-Flow Fractionation and Raman Spectroscopy for the simultaneous fractionation and identification of submicroplastic particles*
16.30 – 16.45	**Andreas Kerstan,** Agilent Technologies, Germany *FTIR imaging as a new method in microplastics and microparticle analysis*
16.45 – 17.00	**Andreas Huber,** neaspec GmbH, Germany *nano-FTIR nanoscopy based identification of polymers on sub-100nm length scales*
17.00 – 19.00	Poster session
19.00	*Dinner*

Wednesday, 31. October, 2018 - Morning

8.30 – 9.00	**Tamara Galloway,** University of Exeter, UK *Bioaccumulation and biological effects of micro and nano plastics*
9.00 – 9.15	**Boris Eyheraguibel,** CNRS, France *From macro to nano : analytical tools to follow plastic fragmentation and biodegradation*
9.15 – 9.30	**Dieter Fischer,** Leibniz-Institut f. Polymerforschung Dresden, Germany *Analytical approach for the identification and quantification of microplastic particles in environment samples by a combination of particle analysis with FTIR and Raman microscopy*
9.30 – 9.45	**Kathrin Oelschlaegel,** Fraunhofer Institute of Ceramic Technologies and Systems, Dresden, Germany *Surface charge – An important parameter to evaluate the interactions of microplastics with environmental substances*
9.45 – 10.00	**Julia Reichel**, TU München, Germany *Application of thermal extraction/desorption-pyrolyse-GC/MS to investigate sorption of contaminants on and the identity of (sub)microplastic*
10.00 – 10.45	*Coffee break*
10.45 – 11.00	**Friederike Stock,** Federal Institute of Hydrology, Germany *A new approach to separate (micro)plastics from environmental samples*
11.00 – 11.15	**Rune Aardal Hansen**, Aarhus University, Denmark *Sampling design and instrument development for investigation of microplastics in coastal sediments*
11.15 – 11.30	**Shaun Forrest**, Carleton University, Canada *Citizen science sampling programs as a technique for monitoring microplastic pollution. Lessons learned and recommendations for working with volunteers to expand spatial coverage for monitoring plastic pollution in freshwater ecosystems*
11.30 – 11.40	CSF Award ceremony
11.40 – 12.00	Closing remarks
12.00	*Lunch and departure*

Posters list

Posters are sorted alphabetically according to the presenting author.

1. Size fractionation of plastic nanoparticles via crossflow filtration
André Marcel Bienfait

2. A comprehensive investigation of microplastic contamination in Lake Mjøsa, Norway's largest lake
Nina Buenaventura

3. Preparation and characterization of nano-sized polyethylene particles
Jessica Caldwell

4. Interactions of dissolved organic matter with microplastics
Stephanie Castan

5. Optimizing the workflow for microplastic analysis by FT-IR microscopy
Annamaria Cavalleri

6. Microplastics a macro-disaster: a threat to the largest fish of our seas?
Giulia F. A. Donati

7. Ingestion of microplastics in the monogonont rotifer *Brachionus calyciflorus*
Claudia Drago

8. Characterization of exo-metabolism involved in plastic biodegradation
Boris Eyheraguibel

9. Fate and transport of particulate plastics in a pilot scale wastewater treatment plant (WWTP)
Stefan Frehland

10. Detecting microplastics via photoluminescence: first experiments
Sebastian Gies

11. Investigation of the biodegradability of powdered plastics by strains isolated from the surfaces of composted films
Judit Háhn

12. Microplastics in coastal North Sea sediments – Analyzed using Fourier Transform Infrared Spectroscopy
Lars Michael Hildebrandt

13. Development of a prototype environmental risk assessment framework for microplastics
Philipp Hopp

14. Determination of tire wear particles in road runoff based on elemental composition
Philipp Klöckner

15. Microplastic as an emerging contaminant of water – a state of knowledge in Poland
Ewa Kmiecik

16. Assessment of microplastic concentrations in human stool – Final results of a prospective study
Bettina Liebmann

17. Freshwater microplastic input from Pearl River Estuary is contaminating Hong Kong waters
Hoi-Shing Lo

18. The challenge of detecting submicro- and nanoplastics in environmental and biological matrices – From sample preparation to characterization via Field-Flow Fractionation
Florian Meier

19. Trace nanoplastic and microplastic fiber analysis in wastewater and activated sludge: synthesis and utility of metal doped plastics
Denise M. Mitrano

20. Molecular interactions of organic compounds with tire crumb rubber
Ruoting Peng

21. Characterisation of microplastics in Hong Kong waters: An unexplored type of fragment may reveal a new cause of formation
Beverly Hoi Ki Po

22. Inter-study comparison of Nile Red-based staining protocols for the detection of microplastics in environmental samples
Julia A. Prume

23. The use of moss (*Hylocomium splendens*) as a biomonitor for microplastics
Brett Roblin

24. Survey on occurrence of microplastics in an urban river watershed of Da Nang city in Vietnam
Taishi Ushijima

25. Microplastics in surface waters at Lake Kallavesi, Finland – Analysis of size distribution and their possible sources
Emilia Uurasjärvi

26. The effects of additives and microplastics on freshwater organisms
Jana Vašíčková

27. Tire wear particles in the aquatic environment
Stephan Wagner

28. Influence of environmental factors on the leaching of polymer additives from carbon nanotube (CNT) polymer composites in water
Imari Walker Karega

Abstracts

Abstracts of the oral presentations are sorted chronologically according to the program

Poster abstracts are sorted according to the numbered posters list in this book.

Presenting authors are written in bold font.

Abstracts have been edited in style and formatting, but not in their contents, which remain responsibility of the authors.

The fate and effects of microplastic in aquatic ecosystems

Chelsea M. Rochman

Department of Ecology and Evolutionary Biology, University of Toronto, Canada

chelsea.rochman@utoronto.ca

Discarded plastics are now globally ubiquitous across freshwater and marine habitats. Much of this material is smaller than 5 mm in size, and is referred to as microplastics. As a consequence of widespread contamination, and long-range transport, microplastics have been reported in a great diversity of habitats and animals globally. This includes remote regions, such as the Arctic and the deep sea, as well as freshwater and marine resources, such as our drinking water and seafood. Microplastic pollution is diverse, including a diversity of shapes, sizes and polymers. They are also associated with a diverse cocktail of chemicals, including those that are added during manufacturing (i.e. BPA, PBDEs, phthalates, lead, UV-stabilizers) and that sorb to the material from ambient seawater (e.g., DDT, PCBs, PAHs, copper). It is now understood that microplastics and their associated chemicals can have adverse impacts to organisms at several levels of biological organization – from suborganismal to population and assemblage levels. As such, there is concern regarding whether and how microplastic pollution poses a threat to the marine environment, wildlife and humans. Using recent insights from my own work, this presentation will briefly review the contamination of plastic debris in marine and freshwater ecosystems and discuss the physical and chemical impacts of microplastic to aquatic organisms.

How concerned should we be about microplastics?

Richard C. Thompson, S. Pahl and M. Al-Sid-Cheikh

University of Plymouth, Drake Circus Plymouth, UK

rcthompson@plymouth.ac.uk

Microplastics are small fragments of plastic debris. Defined in policy documents as being less then 5mm in diameter with the smallest fragments to be isolated from the natural environment being just a few microns in diameter. Microplastics have been reported on shorelines and in the water column on a global scale, their abundance appears to be increasing and there are concerns that microplastics may present hazards to wildlife and to human health.

Plastic products bring many societal benefits and as a consequence, annual global production has increased from 5 million tonnes in the 1950s to over 250 million tonnes today. However, because of their disposable nature substantial quantities of plastic items are discarded to the natural environment and to landfill every year. This material will not readily biodegrade, however it will fragment and so even if the quantity of large plastic items entering the environment as litter were to cease, the abundance of microplastic would still be likely to increase.

Laboratory experiments have shown that microplastics are ingested by filter feeders, deposit feeders and detritivores and there is concern that ingestion of this material could present a physical hazard to wildlife, for example by compromising the ability to feed. In addition, there is evidence, that small fragments of plastic could facilitate the transfer of toxic substances to wildlife. Two routes have been suggested: (1) the release of chemicals incorporated during manufacture as plasticisers, flame retardants and antimicrobials, and (2) the release of persistent organic pollutants (POPs) that have arisen in the environment from other sources and have sorbed to plastic debris in seawater.

This presentation will summarise scientific understanding about the accumulation and potential environmental consequences of microplastic debris.

Defining the baselines and standards for microplastics analyses in European waters!? Highlights and pitfalls of JPI-O BASEMAN

Gunnar Gerdts

Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI),
Helgoland, Germany

gunnar.gerdts@awi.de

Since the middle of last century rapidly increasing global production of plastics has been accompanied by an accumulation of plastic litter in the marine environment. Dispersal by currents and winds does not diminish the persistence of plastic items which degrade and become fragmented over time. Together with micro-sized primary plastic litter from consumer products these degraded secondary micro-fragments lead to an increasing amount of small plastic particles (smaller than 5 mm), so called “microplastics”. The ubiquitous presence and massive accumulation of microplastics in marine habitats and the uptake of microplastics by various marine biota is now well recognized by scientists and authorities worldwide. A fundamental issue precluding assessment of the environmental risks arising from microplastics is the lack of standard operation protocols (SOP) for microplastics sampling and detection. Comparability of data on microplastics concentrations was (and still is) hampered by the huge variety of different methods applied, generating data of extremely different quality and resolution. JPI-O BASEMAN as one of four projects funded in the framework of the JPI-O pilot action “Ecological Aspects of Microplastics” aimed to overcome this problem by profound and detailed comparison and evaluation of all approaches from sampling to identification of microplastics in the marine environment. Due to the increasing perception of microplastics as emerging pollutant(s) in the environment (not only marine), these approaches now need to be harmonized with those developed (and applied) in freshwater and terrestrial sytems for a holistic understanding of the MP-pollution in interconnected ecosystems.

Microbiology of the terrestrial ‘plastisphere’ - enrichment and characterization of plastic-associated microbial communities

Joana MacLean[a,d], S. Mayanna[b], D. Wagner[a,c] and S. Liebner[a,d]

[a]*GFZ German Research Centre for Geosciences, Section 5.3 Geomicrobiology, Germany*
[b]*GFZ German Research Centre for Geosciences, Section 4.4 Interface Geochemistry, Germany*
[c]*University of Potsdam, Institute of Earth and Environmental Science, Germany*
[d]*University of Potsdam, Institute for Biochemistry and Biology, University of Potsdam, Germany*

jmaclean@gfz-potsdam.de

In soils, microorganisms are involved in degradation processes of both natural and synthesized material. The overabundance of plastic debris and its accumulation in land and waters creates new geological properties where soil profiles contain layers of fragmented plastics of various types and origins. Still in its early stage of research, the *plastisphere* was first suggested as a distinct microbial habitat by studies carried out on aquatic plastic debris and very few studies have proposed a similar phenomenon for terrestrial ecosystems. The objective of this study was to characterize the bacterial and archaeal communities in plastic-contaminated soil and to test their biodegrading potential *in vitro*. Plastic debris retrieved from an abandoned landfill was used as a substrate to isolate plastic-associated microbes on medium containing synthetic polymer as only carbon source. The isolated strains were characterized, incubated with four different polymer types, and their biodegrading features explored by SEM imaging, CO_2 production and weight-reduction of the incubated plastic specimen. Furthermore, the structure and diversity of the bacterial and archaeal community was elucidated with Illumina paired-end sequencing (NGS) directly from environmental samples.

The high plastic content of the soil reduced the overall diversity of both bacterial and archaeal communities. An ammonia-oxidizing archaeon *Nitrosocosmicus oleophilus* of the Soil Crenarchaeotic Group accounted for almost all archaeal OTU’s. The predominant bacterial groups were *Pseudomonas* and *Streptomyces*, from which two isolated members *Pseudomonas koreensis* and *Streptomyces sp. 5-22* were also shown to be the most efficiently degrading strains which caused a significant loss in dry-weight of Polyethylene with up to 7.6% within three month. Combining the findings of both NGS analysis and the isolation of microbes on plastic, it can be concluded that the microbial community was formed and associated with plastic as part of their habitat. Moreover, the key players of this community also had a higher plastic-degrading potential which was observed in the in vitro degradation tests. A putative specialized and substrate-dependent microbial community was herewith firstly described as inhabitants of the terrestrial plastisphere.

Environmental flows of macro- and microplastics for seven different polymers using Material Flow Analysis

Delphine Kawecki-Wenger and B. Nowack

Environmental Risk Assessment and Management Group,
Empa Swiss Federal Laboratories for Material Science and Technology, Switzerland

delphine.kawecki@empa.ch

In the context of microplastic research, one burning question relates to the environmental risk and impact linked to plastic pollution. A first step to either assessment is estimating the total load of the pollutants in the environment. With our ongoing study, we aim at providing large scale predictions of macroplastic and microplastic exposure in Europe using Dynamic Probabilistic Material Flow Analysis (DPMFA). The environmental flows of seven different commodity thermoplastics are estimated based on societal data. In order to provide support for a solid risk and impact assessment, it is our goal to assess the environmental burdens of individual polymers separately. Since these materials have varying densities and physical properties, this may affect their fate and toxicity, which makes a polymer-specific risk assessment necessary. The polymers are chosen for their popularity of use and the frequency at which they are reported in freshwaters: low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), polystyrene (PS), expanded polystyrene (EPS), polyvinyl chloride (PVC) and polyethylene terephthalate (PET). The probabilistic aspect of the DPMFA framework permits one to account for the various uncertainty sources and give a quantitative estimate of the final confidence in the results. The dynamic aspect provides a glimpse of how these flows have changed over time and the possible accumulation of plastic in the environment.

The first step of this project investigates the anthropogenic life cycle of these seven polymers, from production to end of life of a total of 35 product categories, including textile applications. In a second step, every stage of the life cycle is analyzed and the voluntary or inadvertent emissions are assessed. The emission-specific pathways between the anthroposphere and the environment are described, and the resulting environmental flows are compared. Modelling the emission pathways between prime release and final discharge enables to pin-point the principal plastic pollutions sources and the possibilities for pollution mitigation.

Development of a prototype environmental risk assessment framework for microplastics

Philipp Hopp[a], J. Davis[b], A. Burr[c], J. West[c], R. Becker[c], B. Howard[c], S. Harris[c], J. Shi[d], R. Bartolo[d], B. Serrano[e], A.G. Collot[f], M. Lampi[g], C. Mann[h], J. Soto[i], Y. Kabe[i], Y. Harada[j], S. Kimura[k], Y. Nakamura[l], M. Ono[m], S. Sakata[m], K. Inawaka[m], M. Kishimura[n], T Gouin[o] and M. Kayser[a]

[a]BASF, Germany; [b]DOW, U.S.; [c] ACC, U.S.; [d]P&G, U.S.; [e]Cefic, Belgium; [f]Plastics Europe, Belgium; [g]ExxonMobil Biomedical Sciences, Inc., U.S.; [h]ExxonMobil Chemical Company, U.S.; [i]Braskem, Brazil; [j]Mitsubishi, Japan; [k]Mitsui Chemicals Inc., Japan; [l]Sumitomo, Japan; [m]JCIA, Japan; [n]JPIF, Japan; [o]TG Environmental Consultancy, UK

philipp.hopp@basf.com

There continues to be increasing concern among the scientific community, policy makers, and the public regarding the environmental presence of macro and microplastic on land, in sediments, air, biota, and water. Images of floating garbage in both fresh and marine waters, accumulation of plastic on shores, and entangled and injured wildlife ingesting plastic have elicited an appropriate emotional response from the public and policy makers, who are demanding that the issue of plastic pollution must be addressed promptly. At the same time, scientific understanding of the impacts of microplastic pollutants on aquatic and terrestrial populations and ecosystems remains slow to emerge. We argue that to best address current scientific data gaps requires co-operation among all stakeholders engaged in advancing our mechanistic understanding of the environmental effects, fate, and exposure of microplastic. This would require the development of initiatives aimed at bringing together academic, government and industry scientists to identify and prioritize the key science needs, with an emphasis towards the development of a framework that could be used to characterize and quantify the environmental risks of microplastic. Most recently, the International Council of Chemical Associations (ICCA), which represents chemical manufacturers and producers around the world and supports various industry research initiatives (e.g., LRI programmes), has formed a microplastic task force. The main objectives of the task force are to enable opportunities for multi-stakeholder discussions and to provide strategic leadership through the coordination of industry research activities that could help address those knowledge gaps for which all stakeholders agree need to be addressed if we are to strengthen our overall understanding of associated risks. Consistent with the main objectives of the ICCA microplastic task force, a 1-day symposium to discuss a prototype for an environmental risk assessment framework is to be held on 3 November 2018, in Sacramento, California. The primary purpose of this presentation is to thus provide an opportunity for those not able to participate in the forthcoming symposium to input to the discussions. Consequently, we will briefly summarize some of the key challenges associated with assessing the environmental risks of microplastic and present a strawman of an environmental risk assessment framework, which we would encourage participants at the Microplastic 2018 workshop to provide constructive critical feedback (www.surveymonkey.com/r/H2LLGZC).

Atmospheric deposition of microplastics into remote lake catchments

Brett Roblin[a] and J. Aherne[b]

[a] *Environmental and Life Science Graduate Program, Trent University, Canada*
[b]*The School of the Environment, Trent University, Canada*

brettroblin@trentu.ca

This study evaluated the presence of microplastics in three remote lake catchments located in coastal regions of Ireland. At each of these lakes two different water samples (bulk and surface tow net) and sediment samples (lake center and nearshore) were collected. More than 4 L of lake water were collected at ~ 1 m depth for bulk water samples, while surface net samples were trawled with a 100 µm mesh for approximately 1 km. Sediment samples were composited by type and stored in a 500 ml glass jars. The water samples were brought back to the lab and vacuum filtered onto GF/C (1.2 µm pore size) Whatman filters. The sediment samples were dried at 50°C for 72 hrs before 20 g subsamples were density separated in a zinc chloride solution (1.5 g/ml density). Once separated the solution was then filtered following the same procedure for water samples. Filter papers were then dyed using Rose-Bengal and microplastics were counted and measured using a stereomicroscope. A subsample of the microplastics were further analyzed using Raman spectroscopy to identify the type of plastics. The number of plastics per litre of water, and per gram of sediment were estimated for each sample. The results indicate microplastics are present in remote lake catchments suggesting that microplastics can be transported long-ranges through the atmosphere into remote areas.

Trace nanoplastic and microplastic fiber analysis in wastewaters and activated sludge: synthesis and utility of metal doped plastics

Denise M. Mitrano

Eawag – Swiss Federal Institute of Aquatic Science and Technology, Switzerland

Denise.Mitrano@eawag.ch

Reports on the occurrence of particulate plastics (nano- and microplastic particles and fibers) in the environment emerge on a weekly basis, but quantitative data are still limited due to analytical difficulties and inconsistencies of the methods applied to detect particulate plastics in complex environmental matrices. Investigation of transport processes is therefore key to understand environmental fate scenarios and material flows from e.g. urban areas into the environment. In particular, waste water treatment plants (WWTPs) are considered hubs for particulate plastics, but the factors controlling particle fate have not been described in detail. Synthesizing plastic materials with a metallic, chemically entrapped tracer can provide a robust way to more easily, accurately and quantitatively detect particulate plastic in complex environmental and biological media. In this work, we synthesized a variety of particulate plastics (nanoplastic particles, fibers) which encompass a suite of various sizes and dimensions, surface morphologies (smooth, rough) and polymers (polystyrene, polyester). Each variant has an embedded metallic fingerprint (Pd or In; approx. 0.5% metal/wt) which can be used to detect plastic by common analytical techniques for metals analysis, such as ICP-MS and TEM/EDX. This allows us to more quantitatively and quickly assess plastic in complex matrices at particle number concentrations orders of magnitude lower and (much) smaller particle sizes than is currently possible with other analytical techniques measuring the polymer alone. To highlight the utility of this approach, we investigated the attachment efficiency of particulate plastic to sludge flocs (which occurs in < 30min) and determined plastic removal in batch experiments representing the activated sludge process in a municipal wastewater treatment plant (WWTP). With an analytical recovery rate of plastics over 95% in all experimental sets, we found that over 98% of plastics (both nanoplastic particles and microplastic fibers) were found in the sludge, with a high correlation between TSS concentration and plastic concentration. While the processes controlling retention of particles has been demonstrated before (e.g. engineered nanoparticles, etc.) and surveys of municipal treatment plants have shown similar trends in the magnitude of microplastics removed, we can now validate the retention of nanoplastics and microplastic fibers with a more complete mass balance study. Furthermore, this is the first study of its kind using microplastic fibers. With a better understanding of emissions from WWTP, one could suggest estimated annual load of particulate plastics released into the surface waters which could, by extension, be used as a starting point for fate modelling. Beyond the case study specifically highlighted here, these metal laden particulate plastics are suitable to study fate, transport, eco-toxicity and interactions with organisms at trace concentrations. By using these materials, bench scale and pilot scale studies can be used as a bridge to understand the environmental processes that dominate (particulate) plastic fate, transport and interactions with biota until analytical techniques to measure native particulate plastics of small sizes and in trace concentrations have matured.

A critical view of wastewater treatment plants ability to clean for microplastics

Allan Gross and R.A. Hansen

Institute of Business and Technology/Department of Business and Social Sciences,
Aarhus University, Denmark

agr@btech.au.dk

The degenerative nature of most MicroPlastic [MP] prohibits identification of potential point sources. However, it is increasingly accepted that MP could have serious implications for humans and other species. Focus on hubs for translocation of MP between compartments are increasing. Some research indicates that Waste Water Treatment Plants [WWTPs] acts as such a hub, both between terrestrial-marine and terrestrial-terrestrial. This paper focuses on (1) presentation of a new state-of-the-art large-volume MP sampling device, (2) test of the device at a Danish WWTP and (3) a comparison of ten studies on WWTPs' ability to clean for MP.

The developed device was inspired by Ziajahromi et al. and Talvitie et al., and partly consist of an outer casing lined with an steel filter basket (mesh sizes down to 25µm can be mounted), and an in-/output control unit for regulating the flow of water filtered. The uniqueness of the device is the capacity to filtrate large volumes in a continuous flow. A series of tests of was conducted at a WWTP in Herning, Denmark. The samples were taken prior to and after the sand filter (last process prior to entering the natural waterways). During one test, 1000 litres of water was filtered in approx. 1.3 hours.

Even though some research show that retention rates of MP in WWTP to the marine environment is relative high (95.63-96.57 %) these particles still potentially enter the environment as they reside in the sludge sediment for later distribution to agricultural soils. Recently, a large Danish study funded by the Danish EPA estimated, that the average emission of MP (size range 20-500 um) from a Danish WWTP to the marine environment to be 0.3% of the MP mass entering a plant. However, the quantifying numbers were 5800 particles per litre. The study concluded that current practise is sufficient in preventing MP entering marine environment from WWTPs.

Finally, a comparison of our study, together with Danish EPA and eight other European studies will be presented. The main conclusion from the comparison study is, that there is no a clear answer on whether WWTP can clean adequately for MP. Therefore, a critical view on (1) the experimental procedures necessary to determine retention efficiency of a WWTP (2) description of the fundamental parameters which must be measured for evaluating a WWTPs' ability to clean for MP and (3) an overview of these parameters are available in existing treatment systems is also included.

Microplastic in the environment - organic fertilizer as an entry vehicle

Christian Laforsch, N. Weithmann, J. N. Möller, M. G. J. Löder, S. Piehl and R. Freitag

University of Bayreuth, Animal Ecology I, Germany

Christian.laforsch@uni-bayreuth.de

The contamination of the environment with microplastic, defined as particles smaller than 5 mm, has emerged as a global challenge because it may pose risks to biota and public health. Current research focuses predominantly on aquatic systems, whereas comparatively little is known regarding the sources, pathways, and possible accumulation of plastic particles in terrestrial ecosystems. We investigated the potential of organic fertilizers from biowaste fermentation and composting as an entry path for microplastic particles into the environment. Particles were classified by size and identified by attenuated total reflection-Fourier transform infrared spectroscopy. All fertilizer samples from plants converting biowaste contained plastic particles, but amounts differed significantly with substrate pretreatment, plant, and waste (for example, household versus commerce) type. In contrast, digestates from agricultural energy crop digesters tested for comparison contained only isolated particles, if any. Among the most abundant synthetic polymers observed were those used for common consumer products. Our results indicate that depending on pretreatment, organic fertilizers from biowaste fermentation and composting, as applied in agriculture and gardening worldwide, are a neglected source of microplastic in the environment.

Risk to all or none?
On the toxicity of microplastics to animals, scientists and societies

Martin Wagner

Department of Biology, Norwegian University of Science and Technology Trondheim, Norway

martin.wagner@ntnu.no

Microplastics are the pollutants *du jour* attracting massive academic, public and political attention. While it is important to understand that a major part of this "attractiveness" of microplastics is routed in our attention economy it does not imply that they do not pose a real risk to environments *per se*. Thus, I will take a look at the state-of-the-science with regard to the abundance and the toxicity of microplastics, using freshwater bodies and biota as a case study. I will use the available data to approach the key questions of whether microplastics represent an environmental risk or not. As the answer will not be clear-cut, I will also highlight the limitations of our current risk assessment framework.

Microplastics may not only represent a risk to natural environments. In addition, they may have negative impacts on scientists and societies. To explore this, I will take a critical look at the question why we (as researchers) are so obsessed with microplastics and inevitably touch on perverse incentives in academia. Finally, I will place the microplastics debate in the larger context of the Anthropocene to discuss potential impacts on societies.

Going beyond microplastics: biodegradation of synthetic polyesters in soils

Michael Sander

Department of Environmental Systems Science, Environmental Chemistry, ETH Zurich, Switzerland

michael.sander@env.ethz.ch

Conventional, non-degradable plastics accumulate not only in aquatic but also in terrestrial systems. The latter include agricultural soils that receive significant inputs from plastics used in agricultural applications, a practice coined plasticulture. A promising strategy to overcome plastic accumulation in agricultural soils is to replace non-degradable with biodegradable polymer materials in plasticulture. These biodegradable polymers include aliphatic and aliphatic-aromatic co-polyesters designed to be degraded by soil microorganisms under formation of carbon dioxide (CO_2) and microbial biomass. Yet, the process of polyester biodegradation in soils remains poorly studied and understood on a mechanistic level, reflecting a lack of analytical approaches that allow tracking polyester-derived carbon during polyester biodegradation in soils.

This contribution introduces a novel analytical workflow to track carbon from polyesters during their biodegradation in soils. The approach relies on incubating ^{13}C-labeled polyesters in soils. Soil incubations are carried out in flow-through bottles. The gas effluent from these bottles is analyzed by isotope-sensitive $^{13}CO_2$ cavity ring down spectroscopy, allowing for continuous quantification of microbial mineralization of polyester carbon to $^{13}CO2$. When incubations are terminated, the amount of ^{13}C remaining in soils is quantified by combusting soil aliquots coupled to analysis of the formed $^{13}CO2$ using isotope ratio mass spectrometry. When combining the combustion and mineralization data, it is possible to close mass balances on polyester carbon over the course of the incubations. Finally, the amount of ^{13}C that remains in the soil as bulk polyester can be determined by Soxhlet extraction of the soil, followed by nuclear magnetic resonance spectroscopy on the soil extract to quantify extracted polyester.

The analytical workflow is validated using incubation experiments of selected, ^{13}C-labeled polyesters in agricultural soils. This contribution highlights how this workflow serves to advance a more fundamental understanding of the biodegradation of polyesters in agricultural soils and how it may help to isolate soil and polymer factors that are critical for biodegradation.

Microplastics in riverine systems of Hungary

Gábor Bordós[a,b], B. Urbányi[b], A. Micsinai[a], B. Kriszt[b], Z. Palotai[a],
I. Szabó[b], Zs. Hantosi[a] and S. Szoboszlay[b]

[a] *WESSLING Hungary Ltd., Hungary*
[b] *Institute of Aquaculture and Environmental Safety,*
Faculty of Agriculture and Environmental Science, Szent István University, Hungary

bordos.gabor@wessling.hu

Microplastics have been detected globally in a wide range of environmental elements, but the focus on freshwater areas is moderate compared to oceans and seas. Regarding European rivers and lakes, there are a few studies available from the western region, but results from the Central and Eastern Europe region are lacking. In 2017 our research team started the first samplings in the Carpathian basin.

The Tisza is Hungary's second biggest riverine system with its 597 km length. Samples were collected on the upper, the middle and the lover part as well. Further to the river sample, on the middle part a reservoir collecting Tisza river's water and a side stream were also investigated. On the lower section samples were taken from a canal directly originating from Tisza.

Manta net based sampling systems can be complicated to apply on smaller freshwater bodies and the filtered water volume is not obviously defined (due to clogging) even if a flow meter is used. To avoid these difficulties and uncertainties, we developed a mobile sampling system using a pump and a set of stainless steel filters. To prevent clogging of the fine mesh size filter (100 µm), we coupled two cartridges and put in a 300 µm pre-filter. This system enables sampling of more than 1.500 L water even if the Secchi depth is no more than 10 cm (e.g. due to flood or plankton). Sediment samples were collected using a van-Veen grab or a stainless steel beaker with a telescopic rod.

Microplastic concentration in river samples were between 3.13-9.51 particles/m^3 and in the Tisza-tó reservoir 23.12 particles/m^3. Dominant polymer types are polyethylene (PE), polypropylene (PP), but polystyrene (PS) and poly(tetrafluoroethylene) were also indicated. Sediment samples contained 0.77-1.76 particles/kg usually PP and PS, that is less than that of presented in other studies.

Project no. NVKP_16-1-2016-0144 has been implemented with the support provided by the National Research, Development and Innovation Fund of Hungary, financed under the NVKP_16 funding scheme.

Risk based approach to assess solid cross-linked styrene/acrylate copolymers in the environment

Nathalie Vallotton[a], J. W. Davis[b] and J. Hu[b]

[a] *Dow Europe GmbH, Horgen, Toxicology and Environmental Research and Consulting, Switzerland*
[b] *The Dow Chemical Company, Toxicology and Environmental Research and Consulting, USA*

navallotton@dow.com

Over the last several years there has been a range of articles reporting the presence of microplastics in rivers, lakes, and oceans. Although the major sources for input of these particles into waterways are the breakdown of larger plastic objects and dust from tires, it has been suggested that micron and sub-micron particles emitted from down the drain applications would pass through wastewater treatment plants (WWTPs), and thus contribute towards microplastic’s input into the aquatic environment. However, recent publications have reported removal efficiencies of these particles routinely range from 90-99% in properly operating WWTPs. The aim of this presentation is to present the outcome of the risk based assessment of two solid cross linked styrene acrylate copolymers used in down the drain applications. The fate and hazard evaluations will be detailed to illustrate specific challenges encountered during method development and testing. Experimental studies confirm the high potential of the two materials for removal in WWTPs primarily through sorption to sludge and subsequent settling. After treatment, biosolids may be treated, disposed, or reapplied to farm land as fertilizer, which may lead to indirect exposure in soils. Therefore, following the principles of an exposure driven hazard testing paradigm, the hazard assessment was extended from aquatic to soil environments, thus providing comprehensive hazard characterization in all relevant environmental compartments. The materials consistently did not affect the tested species, as demonstrated by the lack of effects observed on acute and chronic endpoints at the highest doses tested and independently of the environmental matrix and route of exposure. The assessment suggests a low potential for exposure in the aquatic compartment as well as low hazard to both aquatic and sediment species. While the soil compartment was identified as a potential receptor in the case of application of sludge to land, the hazard assessment confirmed low hazards for soil species thus support a low risk of these materials for all relevant environmental compartments.

Quantifying and scaling rates of microplastic generation from various plastic sources during use from mechanical stress

Joana Sipe, N. Bossa, W. M. Berger and M. R. Wiesner

Department of Civil and Environmental Engineering, Duke University, USA

joana.sipe@duke.edu

Microplastics have become an emerging new pollutant of rising concern due to the exponential growth of plastic use in consumer products. Most microplastic pollution comes from the fragmentation of plastic products through mechanical stress, chemical reactions and biological degradation that occur during use and after disposal. Models predicting the generation and behavior of microplastic in the environment are growing, however there is lack of data to predict the rates of microplastic generation during product use as a function of abrasive forces to which they may be subjected. A method to deliver scalable, quantitative release rates of microplastics during mechanical stress throughout the plastics life cycle (e.g., drilling, sawing, sanding, wearing, kids chewing) is described. A custom abrasion machine has been built with novel features, such as an added torque meter above the motor, that provide data to calculate both generation rate and power input. The generation rate of microplastics through abrasion across a variety of plastics ranging from biodegradable plastics such as polylacticacid (PLA) to more persistent plastics such as polycarbonate (PC) in the environment were tested. A wide range of plastics, all 3D printed, were chosen to simulate environmental use effects. Thermoplastic rubber (TPR) and thermoplastic polyurethane (TPU) were tested to simulate conditions such as car tire wear and plastics experiencing wave action when used for shoreline stabilization. Polyvinylchloride (PVC) was tested due to its use in child teething toys and water pipes while Nylon was tested due to its use in clothing and interest of microfibers. Polyethylene terephthalate glycol (PETG), polycarbonate (PC) and were tested for their use in plastic containers that are often discarded while PLA was tested for being biodegradable. Each plastic underwent abrasion tests to determine the generation rate of microplastics from each type using a constant power input and to identify plastic properties that drive their abrasion rate. It is predicted that the plastics that have a lower young's modulus and ultimate tensile strength shown using tensile tests will produce more microplastics during mechanical abrasion. Preliminary results indicate that an application of 500 Joules of power applied while abrading with 100-c grit gold aluminum-oxide sandpaper, yields a generation rates of microplastics of 0.992 g/s*m^2 for PETG, 1.078 g/s*m^2 for PLA and 1.145 g/s*m^2 for PC. The ranking of these generation rates follows a ranking of PC having a higher ultimate tensile strength in comparison to PLA and PETG. Overall, this project will help comprehend and provide data to understand generation rates of microplastics from larger- scale consumer plastic products and macro-plastic debris. This will be instrumental to help better understand the release of microplastics into the environment and provide data for microplastic fate and transport models. Microplastic generation rates and power inputs can be correlated with each plastic's use and mechanical strength properties to inform which plastic uses release the most microplastics and how to better change these plastics in order to reduce microplastic pollution in water sources.

Quantifying and scaling rates of microplastic generation from various plastic sources during use from mechanical stress

Nathan Bossa, J. Sipe, C. Hendren and M. R. Wiesner

Department of Civil and Environmental Engineering, Duke University, USA

bossanathan@gmail.com

Microplastics have become an emerging new pollutant of rising concern due to the exponential growth of plastic use in consumer products. Most microplastics pollution comes from the fragmentation of plastic products through mechanical stress, chemical reactions and biological degradation that occur during use and disposal. Recently, nanomaterials (NMs) are incorporated in the plastic product such as Ag-NMs and MWCNT to improve/add new properties. When release, the NMs are completely embedded in the polymer or protuberant at the microplastic surface, NMs are expected to influence change the surface property of microplastic and so their behavior and toxicity in the environment.

The effect of NMs on microplastics generation rate, fate, behavior, and toxicity are investigated.

Exposure was assessed using a team developed method able to deliver scalable, quantitative release rates of microplastics during mechanical stress throughout the plastics life cycle (e.g., drilling, sawing, sanding, wearing, kids chewing). The generation rate of microplastics through abrasion of 3D printed PETG containing different loading (0, 0.5 and 2 w.%) of nano-Ag and MWCNT was investigated. The fate of generated microplastic and NMs speciation was investigated with a full characterization (DLS, SEM, FTIR). The behavior of microplastic in various aquatic media (milliQ, wetland and ocean water) was assessed and finally, the toxicity toward fish model and human lung and intestinal cells was assessed.

It is predicted that the plastics that have a lower Young's modulus and ultimate tensile strength shown using tensile tests will produce more microplastics during mechanical abrasion. MWCNT increase the mechanical property of plastic with for consequence a significant decrease of measured microplastic generation rate in comparison to pristine plastic. However, the size of generated microplastic appears to decrease when adding NMs. Interestingly the shape of microplastic was also modified by NMs. MWCNT-microplastic appears to show a tubular pattern with the polymer embedding MWCNT. The behavior of microplastics in aquatic media was also influenced by NMs. Indeed, the NMs change the surface charge of microplastics as well as their hydrophilicity. Unfortunately, at this time the toxicity data are yet available. Overall, this project will help comprehend and provide data on the exposure, behavior and potential toxicity of microplastic from consumer plastic products with highlight to the influence of embedded NMs.

Quantitative approaches to investigate the release of microfibres from washing processes of synthetic clothes

Francesca De Falco[a,b], G. Gentile [a], E. Di Pace[a], M. Avella[a] and M. Cocca[a]

[a] *Institute for Polymers, Composites and Biomaterials, National Research Council, Italy*
[b] *Department of Chemical, Materials and Production Engineering,*
University of Naples Federico II, Italy

francesca.defalco@ipcb.cnr.it

Microplastic presence in marine ecosystems represent one of the latest and most difficult challenges of the global plastic pollution issue. In fact, the small dimensions of microplastic particles (less than 5 mm) require dedicated strategies to understand and mitigate their environmental impact. Particular worrisome is one of the latest source of microplastics identified: the washing process of synthetic clothes. Synthetic fibres like polyester, nylon and acrylic represent almost the 60% of the global consumption of fibres in the apparel industry and their market is increasing significantly over the years. The release of microplastics from synthetic clothes during washing depends on several factors, such as the fabric type (i.e. woven or knitted), the polymer that constitutes the fibres and on whether the yarn is made of staple fibres or filaments. It also depends on the detergent used in the washing and on washing conditions like temperature, mechanical action, water hardness, etc. Due to their small dimensions, the released microfibres cannot be completely blocked by wastewater treatment plants, thus reaching marine environment. In fact, microfibres of synthetic nature have been found in marine sediments, on shorelines, in marine organisms and even in seafood sold for human consumption. Several approaches have already been developed to evaluate the amount of microfibres shed during washing of synthetic clothes, using real washing machines or lab scale equipment and applying different quantification methods. Nevertheless, due to the difficulties in comparing different experimental and analytical approaches, the release of microfibres from the washing of synthetic clothes is still a debated topic. In such scenario, the present work aims at quantifying such source of microplastic pollution, performing and confronting two diverse types of experiments: washing tests in a real washing machine and lab-scale simulations of real washing processes. The experiments were performed on commercial clothes and using a commercial detergent in the dose recommended by the manufacturer. The microfibres extracted from the water effluents recovered from both tests were examined to determine their dimensions and to quantify the overall fibre shedding effect, identifying specific trends in the release of microfibres.

The origin of fiber micro-fragments in polyester textiles: does the production process matter?

Yaping Cai and B. Nowack

Technology and Society Laboratory, Swiss Federal Laboratories for Materials Science and Technology (Empa), Switzerland

Yaping.Cai@empa.ch

Microplastics can be released to the environment as primary microplastics (directly used in products) and secondary microplastics (from physical or chemical degradation of larger plastic items). Since several legislative efforts have been made to control primary source(s), the emission of microplastics from secondary sources remains a unique challenge to curb plastic input into the environment. As an important secondary source, the release of fiber micro-fragments (FMFs) from synthetic textiles has received growing attention in the last years. However, the mechanisms of FMF release from textiles are still unclear.

FMFs can be formed during production, wearing, washing and drying. This work investigates the formation of FMFs during fiber and fabric manufacturing. Since mechanical stress is required throughout several steps during the manufacturing of textiles, there are a number of possible stages where FMFs already form during manufacturing and thus are embedded in the finished textile. To investigate the occurrence of FMFs in different textile products before use, several representative polyester products along the production line including a sliver, three kinds of yarns and eight kinds of fabrics were collected. The extraction of FMFs embedded in the sample was performed by sequential ultra-sonication. The solution was filtered through a vacuum filtration system. The sonication was performed until the FMF release dropped to a few % of the initial release. The filters were analyzed with ImageJ to obtain the length and the number of released FMFs.

First results show that sonication is able to release FMFs from the fabric and that after three to nine 10-minute sonication steps, the release has dropped to almost zero, indicating that sonication did not produce FMFs but is rather releasing what is already present inside the fiber or fabric. Release is affected by the type of fiber, fabric structure and cutting method.

The results from this work will establish the origins of FMFs and mechanisms of their release from textiles. Furthermore, the results form the basis for engineering options to reduce FMFs in new fabrics being produced.

Sorption of organic pollutants to Microplastics in fresh (and saltier) water systems

Rainer Lohmann

Graduate School of Oceanography, University of Rhode Island, USA

rlohmann@uri.edu

The role of microplastic particles in the cycling and bioaccumulation of persistent organic pollutants (POPs) in water is discussed. Five common concepts, sometimes misconceptions, about the role of microplastics are presented. 1. There is ample evidence that microplastics accumulate high concentrations of various POPs, depending on the polymer type, its shape and residence time in the water. 2. The presence of microplastics loaded with POPs in water systems does not mean that microplastics are important for the global dispersion of POPs. 3. Similarly, there is scant evidence that microplastics are an important transfer vector of POPs into animals, though many studies imply such a transfer. 4. In contrast, though, plastics are more efficient in transferring additives (such as flame retardants) into biota. 5. Last, listing microplastics as POPs could help reduce their environmental impact. The current focus on microplastics is useful to highlight the lack of sustainability in our current economic paradigms and life-styles.

Challenges and limitations associated with aquatic toxicity and bioaccumulation studies for sparingly soluble and particulate substances

Todd Gouin[a], K. Coady[b], P. Hopp[c], M. Leonard[d], D. Lyon[e], E. Salinas[c], and J.A. Sergent[f]

[a] *TG Environmental Research, UK*
[b] *DOW, USA*
[c] *BASF, Germany*
[d] *L'Oreal, France*
[e] *Shell, USA*
[f] *Solvay, Belgium*

todd.gouin@environresearch.com

The observations of physical effects in a variety of standardized and non-standardized ecotoxicological aquatic test systems in relation to exposure to nano-materials and microplastics challenges our interpretation of the potential risks associated with the use of such materials. There are a large number of stakeholders that have an interest in the results produced from toxicity tests. This results in a highly dynamic scenario which might limit the positioning and development of scientific test systems aimed at quantifying the differences between the intrinsic chemical toxicity mediated by molecular interaction between dissolved substances and biological receptors and physical effects associated with what is often mistermed 'particle-toxicity'. The example of microplastics is characteristic of a fast-moving issue that is likely to be regulated using hazard-based or precautionary approaches. The adoption of hazard-based regulatory instruments, however, should act as a warning, in that they impede the development of scientific tools aimed at assessing toxicity and risk for a wide range of both naturally and synthetically derived particulate materials. In this presentation, we demonstrate the importance of applying mechanistic understanding of the processes that influence exposure and effects of particles, differentiating between intrinsic chemical toxicity and physical effects. A key component in the development of mechanistic understanding is an appreciation of accurately defining the material under investigation, including the physical characteristics of size, shape, density, surface charge, as well as an understanding of its chemical nature. Based on an appreciation of the complex relationship between intrinsic and extrinsic properties that can occur within a test system, standardized approaches for creating and maintaining dispersions of particles and poorly soluble materials are urgently needed. In an effort to stimulate constructive dialogue between key stakeholders, a list of recommendations are reported for developing/interpreting aquatic toxicity tests with particles or poorly soluble substances that cause physical effects in test systems. These recommendations are meant for use beyond addressing nanomaterial or microplastic toxicity and should be considered when encountering any material or chemical for which a physical effect is relevant.

Analytical and *in vitro* estimates of estrogenicity from simulated digests of plastic items

Scott Coffin[a], G. Huang[b] and D. Schlenk[a]

[a]*Environmental Toxicology Program, University of California, Riverside, USA*
[b]*Guangzhou Institute of Geochemistry, Guangzhou, China*

scoff003@ucr.edu

Since their mass production in the 1940's, plastic has become an indispensable part of modern life. Poor management of plastic waste results in the leaking of approximately 8.0 million metric tons of plastic into the world's oceans every year. Over 206 species, including 119 bird species and 41 fish species have been documented to ingest plastic, likely confusing it for prey. Once ingested, plastic may release endocrine-disrupting compounds which may impact development, reproduction and success at the individual level and declining trajectory at the population level.

We selected 16 plastic items that are most commonly ingested by marine animals. We then "digested" these plastic items in fish and seabird laboratory gut mimic models using the digestive enzyme pepsin at pH 2 and shook them for 16 hours at either 28° C (in saltwater) for fish or 40° C (in freshwater) for seabirds. Plasticizer content desorbed into the gut mimic liquid was quantified using solid-phase extraction followed by ultra-high-performance liquid chromatography/tandem mass spectrometry. Polymer types were identified using Fourier-transform infrared spectroscopy. *In vitro* estrogenicity was assessed using a recombinant cell line.

Out of 12 plasticizers analyzed, 4-*tert*-octylphenol (OP), bisphenol A (BPA), bisphenol S, butylbenzyl phthalate and bis(2-ethylhexyl) phthalate (DEHP) concentrations were desorbed significantly faster due to digestive gut conditions. Desorption of estrogenic plasticizers from plastic items was significantly higher in the seabird gut mimic than the fish gut mimic. Only micro-sized plastic items (<5mm) had higher *in vitro* estrogenicity due to gut mimic conditions. Of the plastic items tested, expanded polystyrene, shopping bag fragments and polypropylene string had both the highest analytically- and *in vitro* -determined estradiol equivalency values (EEQ) in both seabird and fish gut mimic conditions (range: 2.8-9.6 ng/g). Enhanced desorption of OP, BPA and DEHP accounted for the higher *in vitro* estrogenicity. Predictions of estrogenicity based on chemistry ranged from very poor (R^2=0.004, p=0.87) for the micro-plastic water-control group to very good (R^2=0.85, p=0.003) for the macro-plastic fish digest group, as determined by Pearson correlation analysis. These results demonstrate the need for further biological assays in assessing the transfer of estrogenic compounds to biota through ingestion, as well as the need for non-targeted analytical chemistry to determine estrogenic agents.

Standardizing in-vivo analysis methods for toxicological effects within freshwater organisms from nano-polystyrene exposure

Andrew Reynolds[a], G. Chambers[b] and M. Giltrap[c]

[a]*FOCAS Institute, Dublin Institute of Technology, Ireland*
[b]*School of Physics & Clinical & Optometric Sciences, Dublin Institute of Technology, Ireland*
[c]*School of Food Science and Environmental Health, Dublin Institute of Technology, Ireland*

453613@dit.ie

Modern industry is moving into the use of various new technological and chemical techniques, amongst which is a growing interest in developing the application of “nano-plastics”. These are nanoparticles made primarily of polymer chains in a variety of forms to fulfil novel purposes. They can store certain chemicals in a manner that reduces the overall concentration of the various chemicals used, along with using specialised compounds and capsules for controlled chemical release to ensure optimal application of the active ingredients. However, despite the peaking interest on these products, there is a noted lack of research in the potential toxicological effects related to the nano-plastics. The current testing will be pre-dominantly focused on nano-polystyrene, a substance already found in residual effluence & waste water due to their use in “dissolvable plastics” such as dissolving dishwasher tablets. The purpose of this research is to determine if a consistent and non-invasive testing method of analysis can be produced for determining morphologic complications and toxicity/mortality effects of specific nano-polystyrene spheres. The tests are based on freshwater organisms to act as a realistic but controlled in-vivo comparative assessment to the potential results from nano-carriers present in effluent wastewater products. Initially use of specialised fluorescent nano-polystyrene (NPS) would be used in combination with fluorescence and light microscopy to analyse uptake locations within samples. Later, non-fluorescent compounds were utilized for detection analysis would be conducted by a combination of compound-detecting spectral techniques such as Raman and UV-Vis spectroscopy.

Four test organisms were chosen to provide numerous possible non-invasive analytical techniques to be conducted, along with representing the lowest level of the freshwater food chain. Micro-algae (*Pseudokirchneriella subcapitata*) represented a freshwater producer, the plant life that all species are dependent on (directly or indirectly). The focus would be on detrimental changes to growth rate from NPS exposure, and fluorescent imaging to determine where the NPS interacted with the algae. Water-fleas (*Daphnia magna*) represented primary mobile filter-feeders, dependant on the algae. They were producible on mass and so provided general statistical data on morphology & toxicological impacts from nano-polystyrene. Zebra-mussels (*Dreissena polymorpha*) represented static filter-feeders, providing information on the environmental impact of NPS aggregating into sediment. Bioassays run on the mussel homogenate was used to detect what specific organs the NPS was negatively impacting. Finally, Zebrafish (*Danio rerio*) represented secondary consumers and were used for visual testing due to their relative and transparency well-documented growth pattern from conception. This permits easy identification of morphological malformations during embryotic or early stages development from NPS exposure. The combined information should determine whether these nano-plastics are inherently toxic or incur toxicological effects following alterations from the surrounding freshwater environment.

Towards ecotoxicological Risk Assessment of Microplastics: A comparative Analysis of Hazard and Exposure Data in Freshwater

Véronique Adam, T. Yang and B. Nowack

Empa, Technology and Society Laboratory, Swiss Federal Laboratories for Materials Science and Technology, Switzerland

veronique.adam@empa.ch

Microplastics have been found in freshwaters all around the world. Several studies have also shown that freshwater organisms can be adversely affected by these materials. However, to the best of our knowledge, no complete environmental risk assessment has been performed so far for the freshwater compartment. The aim of this study is therefore to perform an environmental risk assessment of microplastics in freshwaters. Because ecotoxicity data on microplastics in freshwater is scarce and exposure data highly variable, we argue that it is necessary to account for the variability and uncertainty of the results by performing a probabilistic assessment.

Exposure and toxicity data were collected from the scientific literature for 11 different polymers. A probabilistic species sensitivity distribution (pSSD) was compiled based on ecotoxicity data, from which the probability distribution of the predicted no effect concentration (PNEC, hazardous concentration affecting 5% of species) was derived. Both mass- and particle number-based assessments were performed. An exposure probability distribution was obtained based on measured concentrations retrieved from the scientific literature. Exposure and ecotoxicity data were then compared to characterise the risk that microplastics might pose to freshwater organisms.

No observed effect concentrations for different species ranged from 1.60 to 8.10^{7} µg/L, or 6.10^{5} to 5.10^{18} part/m^3. No influence of the particle shape (sphere, fibre or fragment) or composition (e.g. polyethylene or polystyrene) was observed on the toxicity of microplastics towards freshwater organisms. Freshwater concentrations of microplastics could be obtained in four different regions (Canada, China, Europe, USA). These data showed lowest exposure in the USA (3.10^{-3} to 32 part/m^3) and highest exposure in China (0.11 to 29’933 part/m^3). When the exposure probability distribution and the PNEC probability distribution were compared, no overlap was observed. The risk quotient distribution (PEC/PNEC) was always smaller than 1, indicating no immediate risk of microplastics towards freshwater ecosystems given the current state of knowledge.

Microplastic aging in the environment and its impact on leaching of polymer additives

Thorsten Hüffer

Department of Environmental Geosciences; Environmental Sciences Research Network (ESRN); and Research Platform "Plastic in the Environment and Society" (PLENTY), University of Vienna, Austria

thorsten.hueffer@univie.ac.at

The pervasive use of plastics together with inadequate waste management has led to a global contamination of ecosystems with end-of-life plastic products. Global plastic pollution has been shown to pose a planetary threat because it is causing planetary-scale exposure that is not readily reversible. Plastic particles released in the environment are subjected to various aging process including biotic (biofilm formation) and abiotic aging (UV radiation, oxidation, and physical stress). These processes lead to an alteration in the physical and chemical properties of the polymeric particle and may ultimately result in an embrittlement and fragmentation. The additive release in turn depends on the chemical compatibility of the additive with the polymer, the exposure and aging of the plastic in the environment, and the type of bonding between the additive and the polymer (chemical or physical). Bearing in mind that sampling of microplastics in the water column is most commonly performed using nets with mesh sizes around 300 µm, the indication of recent reports towards a significant microplastic fraction in the size range down to 1 µm, and the relevance of nanoplastics, their role for contaminant release may be drastically underestimated. The aging of plastic particles under environmental conditions, the leaching of plasticizers, and the fragmentation of are some of the most pressing research priorities in microplastic exposure and risk assessment.

In this contribution, the current understanding of abiotic polymer aging and its role in the release of polymer plasticizers will be addressed for the examples of polyvinyl chloride (PVC) and tire materials. While the release for example of bis(2-ethylhexyl) phthalate (DEHP) from PVC used as medical devices (e.g. blood bags) or children articles has been studied quite intensively there is very little information on the release of plasticizers from PVC plastics into aquatic environmental systems, and how aging influences polymer properties and additive release. Tire materials are a significant share of (micro-) plastics in the environment that until today have been clearly overlooked. They are unintentionally released to the environment as tire wear, an abrasion product that reaches the environment via road runoff, or intentionally, e.g. as shredded tire crumble as filling material for playgrounds. Their main composite components, polymeric rubber and carbon black, make the aging of the polymer and the release of additives of these materials complex to assess.

Microplastic as pollutant vector: Influence of non-linear sorption and coupled mass transfer

Sven Seidensticker, C. Zarfl and P. Grathwohl

Center for Applied Geoscience, Tuebingen University, Germany

sven.seidensticker@uni-tuebingen.de

As microplastic particles are ubiquitously detected in the environment and increasingly discussed in science and media, a realistic assessment of their potential to transport contaminants is needed. For that purpose we performed batch experiments with typical hydrophobic wastewater contaminants and different types of particles, varying in size, shape, and material in order measure equilibrium sorption isotherms and sorption kinetic parameters. While for polyethylene linear sorption isotherms, clearly indicating partitioning, were observed, polyamide and polystyrene showed nonlinear sorption isotherms which were fitted by the Freundlich and Polanyi-Dubinin-Manes isotherms, respectively. Kinetic models, however, are usually based on linear isotherms without taking non-linear patterns into account. Sorption kinetics was described as a combination of two different diffusive fluxes: external mass transfer governed by diffusion through an aqueous boundary layer (ABL) on the one hand and internal mass transfer limited by intraparticle diffusion on the other hand. Which of these mechanisms controls the kinetics depends on various factors, such as sorption coefficients, particle size, diffusion coefficients, and time. For linear sorption isotherms we use a coupled mass-transfer model to consider both, external and internal mass transfer based on an analytical solution via Laplace transformation. For nonlinear sorption a numerical model was developed which allow to use Freundlich or Polanyi-Manes sorption isotherms. To properly describe the transport process within the plastic particle, the particle needs to be spatially discretized which can be achieved by subdividing the particles into different cells. Every cell has the same radius hence the volume is different. The diffusive fluxes within the plastic particle are specified as fluxes over the diffusion effective surface areas of the different cells. Furthermore, an additional cell representing the flux in the plastic/water interface is introduced to represent the ABL. The numerical code was successfully verified by comparison with the analytical solution for PE. Applying the model to other types of particles such as PA and PS allowed to successfully describe the measured kinetics and reasonable values for mass transfer coefficients and intraparticle diffusion coefficients were obtained. Subsequently, this coefficients were used to estimate transport distances of particle-bound contaminants for the plastics investigated. For PA and PS nonlinear sorption leads to significantly different transport ranges and a numerical model is necessary to properly assess the vector function of microplastic particles.

Impacts of digestion protocols on man-made and natural fibers

Robin Treilles[a], A. Cayla[b,c], J. Gasperi[a], B. Strich[c], and B. Tassin[a]

[a] *University of Paris-Est, France*
[b] *University of Lille Nord de France, Lille, France*
[c] *ENSAIT, GEMTEX, Roubaix, France*

robin.treilles@enpc.fr

Microplastics are an emerging environmental issue. It has been shown that two principle types of microplastics exist: fibers and fragments. Fibers have been encountered in the air, in rivers and oceans, in sediments, in fish and even in several food products (such as honey, beer and bottled water). Organic matter removal is needed to quantify microplastics in environmental samples. Different digestion protocols are used for extraction of microplastics. However, there is a gap in data regarding the impacts of those protocols on fiber integrity. Indeed those impacts are generally estimated for fragments and not for fibers. This work focuses on the impact of four different digestion protocols on seven different fiber types. The effects of those protocols on fiber integrity have been characterized. The protocols to be tested were selected based on their frequency in the literature : KOH 10 % at 40°C for 24 hours; KOH 10% at 60°C for 24 hours ; NaClO 9% at room temperature for 12 hours ; H_2O_2 30% at 40°C for 48 hours. We decided to test the KOH protocol with two different temperatures (40°C and 60°C) to assess temperature impact on fibers. Other protocols such as Fenton reagent and enzymatic digestion could also be tested. Each protocol is tested on the 7 most used fibers in the world in textile apparel: three synthetic (polyamide 6.6 (PA 6.6), polyethylene terephthalate (PET) and Acrylic), one artificial (viscose), two vegetal (cotton and flax) and one animal (wool). Those fibers are characterized before and after the digestion and several of their properties are assessed: their weight, their linear mass density, their mechanical properties (tenacity, elongation) and their zeta potential. Their cross-sectional and longitudinal degradations are characterized using optical microscope. For the synthetic fibers, their crystallinity content is evaluated by Differential Scanning Calorimetry (DSC). Finally, all the fibers are characterized using an infrared spectroscope and a scanning electron microscope (SEM). The fibers are currently being analyzed. A comparison between the four digestion protocols will be made in order to conclude which one should be the most appropriate for fiber analysis.

MOSeS – Microplastics oil separation standard for surface, soil and sediment samples

T. Mani[a], S. Frehland[a,b], A. Kalberer[a], and **Patricia Burkhardt-Holm[a],**

[a] [1]The Man-Society-Environment Programme, Department of Environmental Sciences,
University of Basel, Switzerland
[b] Dept. Process Engineering, Eawag, Dübendorf, Switzerland

[*]patricia.holm@unibas.ch

Reports on the occurrence of microplastics in almost any global region and environmental compartment emerge on a weekly basis. However, methodological consistency and the accuracy of polymer particle identification and quantification are still in dispute. This is mainly due to the great challenge of rigorous polymer separation from their surrounding matrix which is necessary before most chemical polymer analysis techniques (e.g. vibrational spectroscopy). Here we present the Microplastic Oil Separation Standard (MOSeS). This protocol demonstrates for the first time that the use of castor oil enables an effective separation of four distinct polymer spike microplastics (PET-G, PS, PP and PMMA, size range: 0.3–1 mm) from four different environmental matrices (fluvial (i) and marine (ii) suspended solids, agricultural soil (iii) and marine beach sand (iv)). Mean (± SD) matrix reduction (dw) was 94.7 ± 3.5% with an average microplastics spike recovery rate of 98.6 ± 3.5% ($n = 16$). This is the first report of a castor oil lipophilicity-based protocol which i) demonstrates an environmentally friendly, non-hazardous and resource efficient microplastics separation from four different, typically investigated, environmental compartments using the same method and ii) shows a very high microplastics recovery rate as a function of a powerful environmental matrix reduction. The utilised castor oil consists of 88.3% 18-carbon ricinoleic acid. The natural plant oil's molecular weight of 933.45 g mol^{-1} causes a high viscosity of >650 cP enabling a strong retention of even large and high-density polymer particles in the oil phase after separation.

Microplastics in fat, oil and grease (FOG) in sewage

Heejun Kang[a, b], B. Lee[a,b], J. Ahn[a], Y. Kim[a] , H. Oh[a] and S. Kim[a,b]

[a] *Institute/Department, Korea Institute of Civil Engineering and building Technology, Republic of Korea*
[b] *Smart City and Building Technology, University of Science and Technology, Republic of Korea*

Heejunkang@kict.re.kr

Fat, oil and grease (FOG) is waste oil, fat is converted into solid by effect of temperature and hydrolysis in sewage. Since feature of FOG is highly viscous, it causes clogging of the sewage pipe and sewer overflows. Density of the FOG is lower than water, so it is floating in top of the water. Microplastics also primarily present in the upper layers of water, so when FOG was formed in the sewage, it could affect the microplastic. In this study, to confirm number of microplastics in the FOG and to check whether microplastics are collected during FOG formation process.

In this experiment, FOG was sampled in vial from the sewage treatment plant influent. In order to homogenision, it mixed with lab spoon. 100mg of FOG into a beaker and potassium hydroxide to heat it to 60℃. The reason for use Potassium hydroxide was FOG was not degraded fat and oil when hydrogen peroxide used. Decomposed FOG was filted, using a 0.45㎛ cellulose filter and then observed with a microscope(S-545,macrotech). After microscopic observe, the number of microplastic was confirmed and the suspected substance were identified by FT-IR analysis(FT-IR Microscope Spotlight 400, PerkinElmer).

The result of microscopic observation was about 11,000 of microplatics in 100 mg of fog. This amount of microplatics in FOG 1 g is almost 13times larger than the amount of microplatic contained in the sewage influent 1 L. Fiber, flake form was usually discovered. The FT-IR analysis resulted in a large proportion flake was michemlube 170 substance, Michemlube 170 is kind of coating agent and it usually used cars and furniture and fiber was polyethylene.

It is confirmed that there was a large amount of microplastic in FOG. microplastic could be captured, when FOG is formed . It is expected that the microplastic will be collected when the oil, fat, and grease contained in sewage are solidificated. So it could possible to remove microplastic using FOG.

Microplastic in environmental samples: Identification and quantification by Raman microspectroscopy

Natalia P. Ivleva

Chair of Analytical Chemistry and Water Chemistry / Institute of Hydrochemistry,
Technical University of Munich, Germany

natalia.ivleva@ch.tum.de

Synthetic polymer (or plastic) materials are ubiquitous in our daily life. Being lightweight, durable and corrosion-resistant, they offer remarkable technological and medical benefits. On the other hand, plastic waste enters the environment from year to year. Despite the general durability of synthetic polymers, a combination of mechanical abrasion, UV radiation, and (micro)biological degradation of plastic debris in the environment causes the formation of tiny plastic fragments – secondary microplastic (MP, particles in the size range of 1 µm – 5 mm). Furthermore, the so-called primary MP particles (designed and produced on purpose, e.g., virgin plastic pellets or MP for industrial cleaners and personal care products) can also enter the environment by different pathways. Therefore, the contamination of aquatic environment with plastic and, especially, with microplastic is of increasing scientific and public concern. Recently, it has been proposed that also smaller plastic particles, so called submicro- (100 nm – 1 µm) and nanoplastic (<100 nm) are discharged into the environment or/and are formed from larger (micro)plastic debris.

Undoubtedly, (micro)plastic as global anthropogenic contaminant represents a big aesthetic problem. However, the degree of contamination remains uncertain – reported values range from less than 1 to more than 10^5 items/m^3. Therefore, it is essential to develop, improve and harmonize methods for representative sampling and sample preparation, identification and quantification of microplastic as well as submicro- and nanoplastic in different environmental matrices. The identification represents the crucial step in MP analysis. The commonly applied visual sorting can lead to a high level of false (positive and/or negative) results, especially for particles <500 µm. The information on the polymer types can be obtained by thermoanalytical methods; e.g., thermoextraction and desorption coupled with gas chromatography mass spectrometry (TED-GC-MS) provides data on the mass fractions of polymers in environmental samples. In contrast, spectroscopic methods – Fourier-transform infrared (FTIR) spectroscopy and Raman microspectroscopy (RM) are appropriate for the analysis of single MP particles. While micro-FTIR spectroscopy allows for an automated detection of MP down to about 20 µm, RM is the only method that enables the 2D & 3D analysis of MP with a spatial resolution down to 1 µm and even below. This nondestructive analytical technique is based on the inelastic light scattering by molecules. Similar to IR spectroscopy, RM provides vibrational fingerprint spectra, but has no interference from water. A problem of the fluorescence background, caused by (in)organic contaminations (e.g., clay minerals and humic substances), can be tackled by sample preparation (matrix removal) and various technical measures (appropriate laser wavelength, photobleaching, confocal mode, etc.).

In this talk, the feasibility of RM for the identification and quantification of (pigmented) microplastic as well as paint particles in the environmental samples will be discussed. The focus will be made on (further) development of the technique for (semi-)automated analysis of plastic in the lower micro-, submicro- and nano-range, as these particles assumed to pose the highest risks for aquatic ecosystems.

Hyphenation of Asymmetrical Flow Field-Flow Fractionation and Raman Spectroscopy for the simultaneous fractionation and identification of submicroplastic particles

Florian Meier[a], R. Drexel[a], V. Sogne[a], C. Schwaferts[b], R. Niessner[b],
M. Elsner[b], N. P. Ivleva[b] and T. Klein[a]

[a] *Postnova Analytics GmbH, Germany*
[b] *Institute of Hydrochemistry, Chair of Analytical Chemistry and Water Chemistry,*
Technical University of Munich, Germany

florian.meier@postnova.com

Today, gaining unambiguous information about the size as well as the chemical identity of submicro- (100 nm – 1 µm) and nanoplastic (< 100 nm) particles particularly in complex matrices is still very time-consuming as it usually involves laborious sample preparation such as for example multiple centrifugation steps followed by further offline analysis using electron microscopy techniques and Raman spectroscopy.

We present here a novel analytical approach for the comprehensive characterization of submicro- and nanoplastic particles using Asymmetrical Flow Field-Flow Fractionation (AF4) hyphenated with Raman spectroscopy. While AF4 enables the fractionation of submicro- and nanoplastic particles according to their hydrodynamic properties, the hyphenation with Raman spectroscopy allows for their simultaneous and non-destructive chemical identification.

The hyphenation of AF4 with Raman spectroscopy has the potential to significantly accelerate submicro- and nanoplastic particles analysis thus becoming a valuable tool for researchers working in this field.

Acknowledgements: Financial support by the BMBF (project SubµTrack (BMBF Grant No. 02WPL1443F)) is gratefully acknowledged.

FTIR imaging as a new method in microplastics and microparticle analysis

Andreas Kerstan[a], Marion Börger[a], Mustafa Kansiz[a]

[a] *Agilent Technologies, Sales and Service GmbH & Co KG, Germany*
[b] *Agilent Technologies, Mulgrave, Australia*

andreas.kerstan@agilent.com

The pollution of the oceans and waterways by plastics has been a very big issue for many years. Investigations are being carried out to determine the type and sizes of microplastics in oceans, fresh water, wastewater and also in animal organs. However, until recently, analytical tools for accurate and rapid characterisation have been lacking, with many studies up until now only considering a manual approach to investigate the larger particles and fibres (>100-200um). However, it is known that the smaller particles (<<100um) have particular biological relevance and implications (being able to be ingested by organisms) as well as their ability to transport adsorbed organic pollutants. Analogously, similar efforts are underway in looking at a range of particles in air, , such as the determination of asbestos is in the room air.

FTIR spectroscopic imaging provides simultaneous information on the molecular composition of the samples and their spatial distribution with resolution to a few microns.. With the development of new optics, objectives and Large Area micro ATR accessories, there has been a drastic improvement in the spatial resolution, sensitivity and overall speed of analysis for a range of new and existing applications. This contribution presents the latest developments in FTIR imaging, providing examples in the analysis of of very small particles, such as microplastics,microparticles, powders and thin layer structures.

nano-FTIR nanoscopy based identification of polymers on sub-100nm length scales

Andreas J. Huber

neaspec GmbH, Germany

andreas.huber@neaspec.com

Scattering-type Scanning Near-field Optical Microscopy (s-SNOM) is a scanning probe approach to optical microscopy and spectroscopy bypassing the ubiquitous diffraction limit of light to achieve a spatial resolution below 20 nanometers. s-SNOM employs the strong confinement of light at the apex of a sharp metallic AFM tip to create a nanoscale optical hot-spot. Analyzing the scattered light from the tip enables the extraction of the optical properties (dielectric function) of the sample directly below the tip and yields nanoscale resolved images simultaneous to topography [1]. In addition, the technology has been advanced to enable Fourier-Transform Infrared Spectroscopy on the nanoscale (nano-FTIR) [2] using broadband radiation (i.e. a mid-IR supercontinuum fs-laser) in the mid-IR spectral range.

Applying nano-FITR near-field spectroscopy to measure the spectroscopic signature enables identification of i.e. polymers at a spatial resolution given only by the size of the AFM tip at unprecedented sensitivity [3]. For example, nano-FTIR spectra of a phase-separated PS/LDPE polymer blend of only 50nm thickness enable to identify the samples polymer materials. Further, measuring a line profile across a ca. 500nm sized LDPE island verifies a sharp material interface with a spatial extension <30nm. Near-field reflection/absorption imaging at 1500cm^{-1} allows to selectively highlight the distribution of PS in the blend and simultaneously map the mechanical properties like adhesion of the different materials.

Results presented demonstrate that nano-FTIR can be an ideal analysis method to characterize complex material systems and to identify polymer materials at the nanoscale spatial resolution and unmatched sensitivity.

[1] F. Keilmann, R. Hillenbrand, Phil. Trans. R. Soc. Lond. A 362, 787 (2004).
[2] F. Huth, et al., Nano Lett. 12, 3973 (2012).
[3] I. Amenabar, et al., Nature Commun. 8, 14402 (2017).

Bioaccumulation and biological effects of micro and nano plastics

Tamara Galloway

College of Life and Environmental Sciences
University of Exeter, UK

t.s.galloway@exeter.ac.uk

Contamination of the aquatic environment with microplastics is a conversation issue of high concern. This presentation provides an overview of our recent research into the ecotoxicology of micro- and nano- plastics, and their surface interactions in natural waters, and how we have used state of the art bio-imaging approaches to understand more about what drives these interactions. This kind of information is critically important for understanding the environmental fate and behaviour of microplastics; including how they become biofouled, how they aggregate and how this influences their movement through organisms following ingestion, all of which can influence the toxicity of microplastics to cells and tissues. The importance of understanding particle surface interactions as a basis for toxicological risk assessment will be discussed, along with the exciting potential for positive intervention e.g. through manipulating the aggregation of particles via selective biomolecule binding, or through improved design of biodegradable or recyclable plastic.

From macro to nano : analytical tools to follow plastic fragmentation and biodegradation

Boris Eyheraguibel, M. Leremboure, M. Traikia and A-M. Delort

Institute of chemistry /CNRS, University Clermont Auvergne, France

boris.eyheraguibel@uca.fr

Environmental concerns about the source and fate of microplastics lead the scientists to develop a wide range of analytical methods to monitor this specific pollution. The methods of sampling, extracting or identifying microplastics debris are of major importance to detect, characterize and quantify their occurrence in the environment. On the other end, a little knowledge is available on their ultimate fate and their biodegradation. The biodegradation of polymers is commonly assessed through indirect measurement of bacterial activity or the loss of polymer properties, giving few information on the size and chemical structure of molecules than can be biodegraded. It is though well accepted that a fragmentation step, transforming microparticles to nanoparticles, is required to provide low molecular weight compounds that can be assimilated by microorganisms. In order to understand the specificity and efficiency of biodegradation processes, we have used Orbitrap mass spectrometry and NMR spectroscopy to characterize, at nanometric scale level, the fragmentation products (oligomers) of various polymers (Polyolefins, Polystyren) artificially aged in laboratory conditions. The results provide qualitative and quantitative data allowing to identify and sort complex mixtures of low molecular weight oligomers. This analytical approach can be used to assess the changes in the composition of oligomers before and after incubation with microorganisms and thus establish a relationship between the chemical properties of oligomers and their biodegradation.

Analytical approach for the identification and quantification of microplastic particles in environment samples by a combination of particle analysis with FTIR and Raman microscopy

Dieter Fischer[a]**,** A. Kaeppler[a], F. Fischer[a], J. Brandt[a], J. Muche[a], K.-J. Eichhorn[a],
S. Oberbeckmann[b] and M. Labrenz[b]

[a] *Leibniz-Institut f. Polymerforschung Dresden, Germany*
[b] *Leibniz-Institut f. Ostseeforschung Warnemuende, Germany*

fisch@ipfdd.de

The detection of microplastic particles (MP) in an environment sample in the wide range from 1 µm to 5 mm nearly quantitatively in a reasonable time is a challenging mission. This task should start with well-defined sampling procedures and sampling locations. Next task is the sample preparation procedure to remove organic and inorganic parts in such a manner, that the MP will not be destroyed. A further important point is the subsequent loss free transport to an analytical lab and the use of blind samples from the sampling location through all steps until the lab.

The lecture will describe the following procedures to identify and quantify the MP in environment samples. Important points are the working in MP-free rooms, use of MP-free equipment and clothes and use of blind samples in all steps until the lab and in the lab. First procedure is a three-step vacuum filtration to divide the particles in four fractions, above 500 µm, from 500 to 50 µm, from 50 to 10 µm and below 10 µm. After filtration the particles of the different fractions are on silicon filters made from wafers which are IR transparent. An optical particle identification program determines all particles in shape and dimension and store there coordinates for the subsequent measurements with FTIR and Raman microscopy. Both methods identify the MP on the filter by their chemical structure using spectral databases automatically. The databases include polymers, copolymers, fillers, inorganic and organic substances, paints and lacquers. The IR libraries use transmission, ATR and reflection spectra and the Raman libraries use spectra measured with 532, 633 and 785 nm lasers. Every particle is assigned about the spectrum to a substance. This can be a polymer or in case of a mixed spectrum a polymer with paint/filler or also not a polymer. The fractions above 500 µm and from 500 to 50 µm are measured mainly by FTIR and the fraction from 50 to 10 µm and some selected samples below 10 µm mainly by Raman. However, several samples of the fractions above 10 µm are measured also with both methods since only a combination of both spectroscopic methods delivers a complete MP analysis. Advantage of the FTIR is a faster measurement time and often a better identification of the polymer matrix in coloured samples; disadvantage is the limit of particle detection at 15 µm. Advantage of the Raman is the better detection of additives and paints and the identification of particles up to 1 µm particle size; disadvantage is the longer measurement time and the appearance of fluorescence in case of not sufficient cleaned samples. Parameters, like the integration time, the number of accumulations and the magnification of the objectives, influence the quality of the spectra and can cause an increasing measurement time. Important is also the size of investigated filter and the lateral resolution (measuring point distance) which influence also significant the measurement time. All this points and parameters and a comparison between FTIR and Raman will be discussed.

Surface charge – An important parameter to evaluate the interactions of microplastics with environmental substances

Kathrin Oelschlägel and A. Potthoff

Process and Materials Characterization,
Fraunhofer Institute for Ceramic Technologies and Systems IKTS, Germany

Kathrin.oelschlaegel@ikts.fraunhofer.de

Microplastics (MP) – plastic fragments that are smaller than 5 mm – are omnipresent in the environment. Such particles were detected in all vertical compartments of the marine environment: surface water, water column and sediment. The prevailing weather conditions in the aquatic environment including sun light (UV radiation), wind, currents, wave action and temperature fluctuations lead to the degradation of polymers and consequently to a change of their behavior. Properties such as chemical composition, density, particle size, surface characteristics, shape and crystallinity affect their fate and transport in the sea water. Understanding the interaction mechanisms of microplastics with organisms and environmental substances like marine snow (natural agglomerates present in the sea water) and their transport behavior helps to assess the risk of particles towards the nature.

While pristine polymers show a hydrophobic behavior, weathered plastics seem to be hydrophilic. We expect that both, weathering and adsorption of organic macromolecules, bacteria and algae alter the type and amount of functional surface groups of a polymer causing the transition from a hydrophobic to a hydrophilic behavior. The adsorption process is probably driven by the surface charge of the polymer in its present state. Therefore, our attempt is to compare pristine, lab-weathered and natural weathered polymer surfaces with respect to their surface charge.

Natural weathered MP vary significantly in their shape and size. Hence, using complementing techniques, which cover a broad size and shape distribution in zeta potential analysis, is reasonable. Two different measuring techniques are applicable: microelectrophoresis (MEP) for small particles (few nanometers – 3 µm) and streaming potential measurements (SPM) for larger plastic fragments (50 µm – 2 mm), fibers and sheets. For SPM the samples are fixed in a streaming channel and an appropriate fluid like sea water is forced to flow through or over the sample. In contrast, MEP is needed for fine dispersed particles in a fluid.

With SPM we analyzed the surface charge of PET (polyethylene terephthalate) sheets with different amounts of biofilm attached to the surface. For each sample a pH titration from the starting point towards the isoelectric point (IEP) was performed. The measurements indicate a shift of the titration curve towards lower pH values. The magnitude of the shift seems to be related to the amount of biofilm attached to the PET surface. The shift of the curve results in a shift of the IEP (from pH 3,8 of the pure to pH 3,2 with biofilm), indicating a change in the surface properties due to the attached biofilm. Consequently materials with or without biofilm will interact differently with their surroundings. By covering the plastic surface the biofilm may relieve the uptake of MP by organisms by different mechanisms. Combining the knowledge of experts in material science and biology could help to understand the colonization mechanisms on MP surface and to predict interactions between MP and their surroundings.

Application of thermal extraction/desorption-pyrolyse-GC/MS to investigate sorption of contaminants on and the identity of (sub)microplastic

Julia Reichel, J.E. Drewes, J. Graßmann

Chair of Urban Water Systems Engineering/TUM Department of Civil, Geo and Environmental Engineering, Technical University of Munich, Germany

Julia.reichel@tum.de

The methods available for the analysis of microplastic in environmental matrices are currently mainly designed for particles in the size range of 1 µm to 5 mm. Smaller particles below 1 µm (i.e. submicroplastic) have hardly been investigated so far. However, due to their small size, these particles can act as a potential vector, sorbent or source of metabolic inhibitors and toxins. In addition, as a result of the higher surface to volume ratio, there is probably a higher adsorption capacity for chemical substances, e.g. pollutants like pesticides and thus a higher ecotoxicological relevance. In order to address these shortcomings, the interdisciplinary research project 'SubµTrack' focuses on microplastic in the range between 50 nm and 100 µm (submicroplastic). Especially for this size range there is still a lack of standardized and established detection methods as well as toxicological evaluation.

The objective of this study is to investigate sorption processes of various pollutants, e.g. pesticides, on (sub)microparticles. For doing so, thermal extraction/desorption-pyrolyse-GC/MS (TED-Pyr-GC/MS) is employed. Ad- and Desorption experiments are carried out with selected contaminants and (sub)microparticles of various types and sizes of plastic. An innovative development of the TED-Pyr-GC/MS enables identification of the adsorbed pollutants and the type of plastic in one single analysis. Initially, the pollutants are desorbed from the particles by thermodesorption and analyzed using GC/MS. Subsequently, the polymers are decomposed by pyrolysis and the decomposition products and by this the type of plastic is identified via GC/MS analysis. First results will be presented regarding optimization of the method initially by use of stir bar sorptive extraction (SBSE) and subsequently with defined reference (sub)microparticles with selected trace substances. The results should enable the assessment of different sorption behaviors of micro- and submicroparticles regarding the respective contaminants. Additionally, the application of TED-Pyr-GC/MS to analyze contaminants in samples from toxicological assays with and without particles will be shown. Perspectives for future research will also be given, e.g. investigation of the fate of particles during (laboratory-scale) wastewater treatment.

A new approach to separate (micro)plastics from environmental samples

Friederike Stock[a], S. Felsing[b], C. Kochleus[a], B. Bänsch-Baltruschat[a],
N. Brennholt[a] andG. Reifferscheid[a]

[a] *Federal Institute of Hydrology, Am Mainzer Tor 1, Koblenz, Germany*
[b] *Leibniz Institute for Baltic Sea Research Warnemünde, Rostock, Germany*

Stock@bafg.de

Plastics in rivers and lakes are an emerging issue for science and regulation. So far there is little knowledge about the pollution of freshwater environments with micro-, meso-, and macroplastics, whereas the occurrence of plastics in the marine environment has already been identified as a critical environmental concern. In addition, riverine inputs are regarded as a significant source for plastics in the marine compartment.

To date, there is no standardized methodology to sample the entire water column, to separate microplastics from environmental samples and to determine the size classes or distribution of the particles. Therefore, in 2015, the German Federal Institute of Hydrology initiated the research project “Microplastics in inland waterways and coastal waters – origin, fate, impact”. During this project, a method has successfully been developed for separating microplastics (< 5 mm) from environmental samples without much effort, using a modified Korona–Walzen–Scheider (KWS) device originally used in recycling management. This method makes use of the electrostatic behavior of plastic particles to facilitate their separation from sample matter, with up to 99% of the original sample mass removed without any loss of MPs. Different materials (quartz sand, freshwater suspended particulate matter, freshwater sediment, and beach sand) were spiked with different types of microplastics from the seven most common types of plastics, one bioplastic type, polyethylene fibers, and tire wear. A modified electrostatic metal/plastic separator was used to reduce the sample mass and concentrate the plastics based on their physical separation. The recovery achieved with this method was as high as nearly 100% for each type of material. The method was then tested on plastic particles of different shapes and types isolated from the Rhine River. These were successfully electroseparated from the four materials, which demonstrated the utility of this method. Its advantages include the simplified handling and preparation of different field samples as well as a much shorter processing time.

Sampling design and instrument development for investigation of microplastics in coastal sediments

Rune Aardal Hansen and A. Gross

[a] *Institute of Business and Technology/Department of Business and Social Sciences, Aarhus University, Denmark*

rah@btech.au.dk

More than five trillion pieces of plastic already exist in the oceans, and it is estimated that between 4.8 and 12.1 million tonnes of plastics entered the marine environment from land sources in 2010. Research shows that weathering makes plastics degrade into tiny particles, which we refer to as MicroPlastic (MP). The questions are: which impact does MP have on our environment? Where and how is MP transported in our food chains? Before these questions can be answered, it is necessary to identify the sources of MP's into nature. The majority of research focusing on source determination of MP has focused on sampling in oceans and larger seas – less attention has been on MP in coastal beach sediment. Furthermore, despite the increasing interest in MP, no acknowledged Standard Operation Procedure (SOP) exists. National Oceanic and Atmospheric Administration has proposed a procedure, including using small shovels for sample excavation. A considerable part of research still utilise such excavation tools e.g. metal spoons or even handpicked. This study proposes an approach with rigorous focus on a set of easy repetitive steps using a new excavation device in order to ensure a uniform sampling profile across (sub) sites. The amount of available data continues to grow rapidly, thus establishing common procedures are very important since it provides the ability to benchmark across studies.

Therefore, the purpose of this study is (1) building a multi-seasonal sampling design and (2) development and testing of appropriate instruments. Nine sampling sites in Denmark and Sweden were selected to provide a sampling pattern covering the coastal areas surrounding the inner Danish waters (Kattegat). On sampling sites, two transects were measured (45 metres in total, three stations with 15 metres apart) – one at the lowest tidal line (X) on the beach section and one parallel 15 meters inland (Y) from the first line.

Tests using the new sampling methodology were conducted covering five Danish sites. The identified MP were sphere, fragments and fibres. We observe that only ≈22m^{-3} fragments and ≈11m^{-3} fibres were identified at one sites, while 11 to 18 times more MP particles were identified at the other four sites. This large difference of identified MP can be explained by the five sites location in relation to the water in-/outflow to Kattegat. Furthermore, two samples (one X- and Y-sample) showed less MP particles in the Y-sample compared with the X-sample, but the difference were not significant. Furthermore, in the four sites located directly to Kattegat, almost the same number of MP's was identified using X-samples. This indicates that the MP observed in the coastal marine environment originates from the sea. The dominant particles were black fragments and blue fibrous particles. Limited quantities of spherical particles indicates presence of microbeads. All these results are supported by other regional studies.

In conclusion, we have presented a new SOP involving a new developed sampling device to insure a uniform sampling methodology. Such an approach is needed if research studies from different research groups should be able to be compared, and this will give the scientific community a better understanding of the impact MP's have on our environment.

Citizen science sampling programs as a technique for monitoring microplastic pollution. Lessons learned and recommendations for working with volunteers to expand spatial coverage for monitoring plastic pollution in freshwater ecosystems

Shaun A. Forrest[a], M. Murphy[b] and J.C. Vermaire[a,c]

[a] *Department of Geography and Environmental Studies, Carleton University, Canada*
[b] *Ottawa Riverkeeper, Canada*
[c] *Institute of Environmental Science, Carleton University, Canada*

shaunforrest@cmail.carleton.ca

Citizen scientists provided samples for quantification of microplastic contamination from various sites along an approximate 600-kilometre length of the Ottawa River in Canada from Lake Temiskaming to Hawkesbury. The volunteers filtered 100 litres of river water through a 100 µm mesh at their desired location on the Ottawa River. All but 1 of the river samples (n=43) contained microplastics, with the vast majority of microplastics identified as microfibres. Microplastic concentration ranged from 0.02 to 0.41 microplastics per litre, with 8 out of 9 the control samples also containing microplastics. Microplastic concentrations were higher in more urban areas of the Ottawa River watershed, particularly downstream of identified wastewater treatment plants, suggesting wastewater is a pathway for microplastics into the Ottawa River. The samples obtained away from the shoreline of the river had an average microplastic concentration of 0.15 microplastics per litre, with shoreline samples at 0.03 microplastics per litre. The overall sampling average was 0.09 microplastics per litre. This result suggests river dynamics and flow could potentially influence the Ottawa River's cross-sectional microplastic concentration. The advantages of utilising citizen scientists in freshwater microplastic research, includes actively engaging citizens interested in microplastic research, especially true with the Ottawa Riverkeeper network, wherein the citizen scientists sampled the Ottawa River where they use and care about the river. Furthermore, engaging the Ottawa Riverkeeper volunteers is a relatively inexpensive technique, especially when considering the spatial coverage the volunteers provided. Disadvantages include incomplete sample sheets and incorrect sampling or sample labelling by the citizen scientists. Furthermore, potential contamination of samples is an issue, however, this extends from the citizen scientists through to the researchers and laboratory analysis. Recommendations for future citizen science projects for freshwater ecosystems include utilising an established and engaged network (for example the Ottawa Riverkeeper network), as attempting to create and establish a new network could be difficult to implement. Secondly, higher volume samples would be advantageous to help negate field and laboratory contamination. However, imposing a high water volume for sampling could deter citizen scientists. Lastly, control samples are very important, especially for establishing the detection limit of microplastics for the research. These criteria need to be conveyed to the citizen scientist, in addition to the importance of completing the sample template sheets correctly, to maintain sample consistency and integrity. If the integrity of the samples can be preserved, citizen science collaboration can provide an invaluable spatial analysis tool for freshwater microplastic research.

Posters

Size fractionation of plastic nanoparticles via crossflow filtration

André Marcel Bienfait, T. Kögel and M. Sanden

Institute of Marine Research, Norway

andre.marcel.bienfait@hi.no

The omnipresence of microplastics in the world’s oceans is well established.

Advancing detection and analysis techniques make the size-dependent quantification of microplastics possible. A growing number of publications show a strongly increasing number of microplastic particles with decreasing particle size.

Even though detection and analysis of small microplastics with only a few micrometers in diameter has been achieved, sub-micrometer-scale nanoplastics remained undetected/unquantified, thus far.

We at the Institute of Marine Research (Bergen/Norway) attempt to approach the problem of nanoplastics analysis by the combination of fractionized crossflow filtration followed by pyrolysis/gas chromatography/mass-spectrometry (py/GC/MS).

Crossflow filtration is a process of high importance for a large spectrum of industrial users, from the food and beverages industry to wastewater treatment in the oil and gas industry. However, crossflow filtration also showed its versatility in a fair number of laboratory applications. Membranes featuring a wide range of pore sizes (from micro- via ultra- to nanofiltration) are available, simultaneously exhibiting narrow pore size distributions.

Since our focus lies on seafood safety, our approach will have its starting point at enzymatically digested seafood samples, which will be coarsely (pre-)filtered over a 10 µm mesh. The filtrate will be subjected to several stages of crossflow filtration. The separation procedure will include a final (re-)concentration step, in which the amount of dissolved molecular matter will be reduced. Thereafter, the resulting sample fractions will be analyzed for nanoplastics employing py/GC/MS.

A comprehensive investigation of microplastic contamination in Lake Mjøsa, Norway's largest lake

Nina Buenaventura, A.L. Lusher, D. Eidsvoll and M. Jartun

Norwegian Institute for Water Research (NIVA), Norway

nib@niva.no

Plastic is a ubiquitous contaminant in the environment, this includes microplastics (< 1 mm) which have been found globally. Some microplastics are released directly into the environment whereas others break down from larger plastic items because of environmental processes. The widespread presence of microplastics in the environment highlights the need to understand the sources for microplastics and the consequences of this contamination. In this current project, our aim was to contribute to knowledge concerning microplastic contamination in freshwater environments. To do so, an assessment of microplastic contamination in Lake Mjøsa was carried out, looking at sediments, biota, and water samples. The results from this study will form the basis for a recommendation for further monitoring of microplastics in Lake Mjøsa, and in freshwater in general. This study will also be essential for sealing the knowledge gaps in microplastic studies, which will enable this field to be further developed and provide a better understanding of the effects and impacts of microplastics in the environment.

Preparation and characterization of nano-sized polyethylene particles

Jessica Caldwell[a], R. Lehner[a], C. Rhême[b] and B. Rothen-Rutishauser[a]

[a] *Adolphe Merkle Institute, University of Fribourg, Switzerland*
[b] *Frewitt fabrique de machines SA, Switzerland*

jessica.caldwell@unifr.ch

Most studies focus on micro-sized plastic particles, but recent studies have indicated the potential for fragmentation of these particles into nanoplastic particles, which can show markedly different chemical and physical properties than larger particles. Up to now, the knowledge of possible adverse effects in the environment from these nanoplastic particles is very sparse also because their detection by analytical methods is challenging and has only rarely being described.

Studies involving nano-sized plastic particles focus primarily on polystyrene, but many other types of plastic materials, such as polypropylene, polystyrene, and polyethylene therephthalate are used for products and thus found in the environment. Therefore, more work is needed to use representative plastic types and to study the possible impact on aquatic and mammalian organisms depending on the size.

This study acts as a feasibility study with the aims to (i) produce nano-polyethylene particles by applying a nanomilling method, to (ii) characterize those particles by dynamic light scattering (DLS), atomic force microscopy (AFM) and scanning electron microscopy (SEM) and to (iii) explore the potential of hyperspectral imaging to detect these (nano) particles in microscopy images.

Interactions of dissolved organic matter with microplastics

Stephanie Castan, T. Hüffer and T. Hofmann

Department of Environmental Geosciences, Environmental Science Research Network, and Research Platform Plastics in the Environment and Society, University of Vienna, Austria

stephanie.castan@univie.ac.at

The constantly increasing production of plastic products worldwide and deficient waste management has led to an accumulation of primary and especially secondary MPs (MPs) resulting from breakdown of larger plastic pieces in surface freshwater systems. While a majority of studies has focused on MPs in marine systems less attention has been paid to the processes MPs undergo in freshwater and technical systems. As dissolved organic matter (DOM) is ubiquitous in freshwaters the DOM will inevitably come into contact with the MPs once they are released into these systems. However, a mechanistic understanding of how DOM interacts with MPs remains poorly understood. Since DOM is a heterogeneous mixture of different fractions of organic polymers, the characterization of interactions between DOM and MPs is not straight forward. Studies on carbonaceous nanomaterials (CNMs) have shown that upon sorption the DOM exhibits a fractionation according to molecular weight and aromaticity. Further, first studies have shown that DOM has an impact on aggregation of MPs but to date the extent and nature of their interactions have not been analyzed. A systematic study of DOM sorption to different kinds of MPs is therefore necessary to identify and characterize dominating sorption mechanisms as well as physical and chemical DOM fractionation.

For the investigation of our hypothesis different polymeric particles are selected as model sorbents to allow a detailed analysis of the effects of sorbent properties on DOM sorption. Furthermore, a range of CNMs with different surface properties and porosities such as graphite, carbon nanotubes and biochar are used to allow comparisons between both kinds of environmentally relevant particulate sorbents. DOM of different origins and compositions are selected in order to evaluate the effect of DOM properties on sorption. Suwannee River natural organic matter (NOM), Sigma Aldrich Humic acid (HA) and Pahokee Peat NOM are used as model sorbates to systematically analyze the effect of sorbate aromaticity and molecular weight. Comprehensive characterization of the sorbents and DOM, including elemental analysis, specific surface area and pore size distribution derived from N_2 and CO_2 physisorption isotherms as well as size exclusion chromatography, fluorescence emission excitation matrices and UV–visible spectroscopy will be connected with sorption batch experiments at different DOC concentrations to allow for an in-depth discussion of sorption and fractionation of DOM by microplastics.

Optimizing the workflow for microplastic analysis by FT-IR microscopy

Annamaria Cavalleri and I. Robertson

PerkinElmer, Italy and UK

annamaria.cavalleri@perkinelmer.com

Analysis of environmental samples containing microplastics is essential to determine their prevalence and their impact. A range of analytical techniques have been applied to the analysis of microplastics. Of the techniques adopted, infrared (IR) spectroscopy, and more specifically IR microscopy, has established itself as a primary analytical technique for the detection and identification of microplastics. The microplastics analysis workflow for IR microscopy consists of several steps involved in getting from the raw sample to answers, including the initial sampling through to data analysis. The steps involved may be different depending on the type of initial sample and the amount of sample cleanup required to prepare the sample for infrared (IR) analysis. This paper describes the different types of environmental samples, the sample collection methods, the range of different sample cleanup methods, and then deals more specifically with the best ways to optimise sample filtration for measurement by IR microscopy. The principles of IR microscopy and the different sample measurement modes will be described, comparing and contrasting each type. IR microscopy and imaging experiments can generate significant quantities of data that need to be analysed to get the required information. The different methods for extracting data and information will be explained and suggestions made for best practice.

Microplastics a macro-disaster: a threat to the largest fish of our seas?

Giulia F. A. Donati[a,b], I. Zazeer[c], I. Shameel[c] and A.M. Wieczorek[d]

[a] *Landscape Ecology, Department of Environmental Systems Science, ETH Zurich, Switzerland*
[b] *Landscape Ecology, Swiss Federal Research Institute WSL, Birmensdorf, Switzerland*
[c] *Maldives Whale Shark Research Programme, Maldives*
[d] *Ryan Institute, School of Natural Sciences, National University of Ireland Galway, Ireland*

giulia.donati@usys.ethz.ch

Microplastics have emerged as one of the major environmental threats to our seas (Galloway et al. 2017, Worm et al. 2017). In fish, such pollutants have been shown to cause reductions in food uptake and predatory performance, and to act as a vector of toxins, which can bioaccumulate and lead to endocrine disruption as well as hepatic stress (De Sá et al. 2015, Rochman et al. 2013, Rochman et al. 2014). The largest fish of our planet, the whale shark (Rhincodon typus), is particularly prone to the ingestion of microplastics, filtering up to 614 m3/h of sea water to obtain its planktonic preys (Motta et al. 2010). An area of particular concern are the Maldives, where whale sharks occur all year round and microplastics have been found to be particularly abundant (Riley et al. 2010, Imhof et al. 2017). As a consequence, microplastics may add another stressor onto this endangered species, who in this region has long suffered from hunting for its meat and oil-filled liver (Rowat 2007; Jackson et al 2001), some remaining illegal finning (Riley et al. 2009), and nowadays a lack of management of the tourism industry. While there has been an initial effort to investigate microplastic interactions with filter-feeding marine megafauna, up to date, such research has been based on strandings of carcasses and presence of plasticisers in their tissues (Besseling et al., 2015; Fossi et al., 2017). Through the analysis of faecal matter, we identified a non-invasive method to provide evidence of microplastic ingestion by whale sharks and address further questions such as routes of exposure and potential links to behavioural residency patterns. At present time, nine faecal samples were successfully collected and we proceeded to the analysis of one initial sample from which ten microplastics were extracted. Beyond the scientific advances, this project entails an extensive outreach programme involving local communities, major stakeholders and decision makers. Through a series of specifically designed environmental problem-solving workshops, we aim to create a shared problem framing and to use insight- driven science communication to develop collaborative solutions. In partnership with a long- established local NGO (Maldives Whale Shark Research Programme), we also aim to contribute to their efforts as evidence shows that research is a fundamental part in establishing trust when introducing new regulations for the protection of our seas (Cvitanovic et al. 2018). Finally, this ambitious but necessary project provides a timely opportunity to address a concrete and urgent environmental issue involving an emblematic umbrella species in a regional context to enhance a global action movement.

Ingestion of microplastics in the monogonont rotifer *Brachionus calyciflorus*

Claudia Drago[a], J. Pawlak[a], K. Wendt-Potthoff[b] and G. Weithoff[a]

[a] *Department of Ecology and Ecosystem modelling, Potsdam University, Germany*
[b] *Helmholtz Centres for Environmental Research – UFZ, Department of Lake Research, Germany*

drago@uni-potsdam.de

Microplastic is a ubiquitous problem all over the world from marine to freshwater and terrestrial environment. The knowledge about the effect and the behaviour of microplastic in marine environment is building up during the last decade, on the other hand, investigations of microplastic in freshwater systems are scarce. Dams and reservoir as part of freshwater systems are important for the understanding of sedimentation of microplastic due to reduced flow velocity. Microplastic in aquatic environment may interact with freshwater biota affecting the feeding, reproduction, growth rate and the survival of aquatic invertebrates. The MikroPlaTaS project (funded by the German Ministry of Science and Education) will investigate the abundance, sedimentation and impact of microplastic in dams and reservoirs.

One of the goals of the project is recording how microplastics affect and interact with individual organisms as well as with the entire communities in model ecosystems.

The risks for the pelagic and benthic fauna is assessed using common model organisms. A harmful effect in the organism requires an uptake into the body, either by the ingestion of the particles themselves or by transmission in the food web (biomagnification).

To determine the uptake of microplastic in freshwater organisms, we perform a series of ingestion experiments with rotifers. The aim of these experiments is assessing the variation of microplastics ingestion in culture medium and in association with algae and bacteria and with natural water. In this pilot experiment, we use the monogonont rotifer *Brachionus calyciflorus* as model species. We test different sizes of fluorescent polystyrene microsphere (1, 3, 6 µm) at different concentrations. We also want to compare the ingestion rate when the microspheres are associated with algae of the same size and when the microspheres are incubated with bacteria, so called “aged particles”. Further experiments may concern how the presence of algae of the same size range of microspheres and bacteria in aged microspheres can influence the ingestion rate.

Characterization of exo-metabolism involved in plastic biodegradation

Boris Eyheraguibel[a], M. Brissy[a], B. Diem[b] M. Leremboure[a] and A-M. Delort[a]

[a] *Institute of chemistry /CNRS, University Clermont Auvergne, France*
[b] *Plateforme d'exploration du métabolisme/ University Clermont Auvergne, France*

boris.eyheraguibel@uca.fr

Plastic pollution is a major ecological problem concerning all the ecosystems of the planet. The environmental diagnosis, carried out so far, provides information on the sources, the abundance, the distribution of plastic debris and their biotic or abiotic interactions with the environment. The interactions of polymers with microorganisms result in the formation of biofilms with complex communities and a wide range of metabolic activities. Among these microorganisms, some have the ability to degrade and metabolize synthetic polymers, through the production of enzymes or the establishment of co-metabolism. While an increasing number of studies has identified microbial ability to degrade synthetic plastics, the metabolic pathways involved in the biodegradation and the ultimate fate of polymers are still poorly understood.

This biodegradation is usually expressed in the presence of polymers already oxidized by environmental conditions. Although the majority of isolated strains come from terrestrial environments, the potential of microorganisms in the marine environment has paradoxically been poorly studied. Similarly, the metabolic pathways involved in biodegradation, the ultimate fate of polymers and their importance in biogeochemical cycles are still unknown. To meet these challenges, current research must integrate multidisciplinary, adapted and optimized approaches for each ecosystem and considering the nature of polymers, biological, chemical and physical factors influencing their degradation. The development of methods for the characterization of polymer degradation products and the use of molecular biology tools will help to better understand the biodegradation pathways of polymers in the environment.

Fate and transport of particulate plastics in a pilot scale wastewater treatment plant (WWTP)

Stefan Frehland, M. Schmiedgruber, R. Kägi and D. M. Mitrano

Eawag – Swiss Federal Institute of Aquatic Science and Technology Dübendorf, Switzerland

stefan.frehland@eawag.ch

Reports on the occurrence of particulate plastics (nano- and microplastic particles and fibers) in the environment emerge on a weekly basis, but quantitative data are still limited due to analytical difficulties and inconsistencies of the methods applied to detect particulate plastics in complex environmental matrices. Investigation of transport processes is therefore key to understand environmental fate scenarios and material flows from e.g. urban areas into the environment. While wastewater treatment plants (WWTPs) are considered hubs for particulate plastics between consumers and the environment, the fate of particulate plastics in the system is still highly uncertain and needs an accurate and truly quantitative assessment. In previous work, we synthesized nanoplastic particles and microplastic fibers, with a chemically entrapped metal tracer (Pd, In respectively), which enabled tracing plastic particles through well-established total elemental analyses. Here we used these materials to investigate the fate and transport of particulate plastic in a pilot WWTP representing the activated sludge process. Our findings show that >95 % of the nanoplastic particles and microplastic fibers are associated with the sludge flocs and therefore removed from the wastewater stream by the activated sludge process. While the processes controlling retention of particles has been demonstrated before (e.g. engineered nanoparticles, etc.) and surveys of municipal treatment plants have shown similar trends in the magnitude of microplastics removed, we can now validate the retention of nanoplastics and microplastic fibers with a more complete mass balance study. With a better understanding of emissions from WWTP, one could suggest estimated annual load of particulate plastics released into the surface waters which could, by extension, be used as a starting point for fate modelling.

Detecting microplastics via photoluminescence: first experiments

J. Ornik[a], S. Sommer[a], M. Weber[b], C. Lott[b], J.C. Balzer[a], **Sebastian Gies[a]** and M. Koch[a]

[a] Physics Department, Philipps-Universität Marburg, Germany
[b] HYDRA Marine Sciences GmbH, Sinzheim, Germany and Field Station Elba, Italy

Sebastian.gies@physik.uni-marburg.de

Typical spectroscopic methods for the identification of microplastics are Raman and FTIR spectroscopy. Raman spectroscopy provides a better spatial resolution due to the shorter wavelengths of the excitation laser. Yet, it often requires rather long integration times and several co-scans for sample identification. Hence, an automated recognition of microplastics by mapping the sample would be time consuming. FTIR imaging was employed for microplastics detection. Yet, this approach has a few drawbacks: the sample needs to be completely dry and irregularly shaped particles could cause problems.

We report on first experiments to explore the potential of photoluminescence spectroscopy for the detection of microplastics. The first question to be answered in this regard is whether the photoluminescence spectra of plastics differ from that of other materials which are found in the marine environment.

We measured the photoluminescence spectra of nine different polymer materials and nine other non-plastic materials typically found in the sea, including sand, wood, and shell fragments. We focussed on the question whether plastics can be reliably distinguished from non-plastics based on the shape of their PL spectra. We achieved an accuracy of 99.3 % when categorizing samples into plastic and non-plastic materials. Our results showed that the photoluminescence spectroscopy could hold the potential for reliable characterization of samples from the environment regarding the microplastics content.

Although our first results are promising we would like to point out that microparticles incrusted by organic materials as well as particles of plastic which have been dyed will most likely have spectra which differ from the unaltered base polymers studied here. Yet, other spectroscopic methods will be affected by these effects as well. Hence, this study should only be seen as a promising starting point towards our long-term vision of an automated luminescence method for the detection of microplastics.

Investigation of the biodegradability of powdered plastics by strains isolated from the surfaces of composted films

G. Bordós[a], **Judit Háhn[b]**, B. Kriszt[c] and S. Szoboszlay[c]

[a] *WESSLING Hungary Ltd., Hungary*
[b]*Regional University Center of Excellence, Szent István University, Hungary*
[c]*Institute of Aquaculture and Environmental Safety, Department of Environmental Safety and Ecotoxicology, Szent István University, Hungary*

hahn.judit@mkk.szie.hu

In recent studies degradation of plastics was tested after significant abiotic treatment (i.e. accelerated photooxidation and thermooxidation). None of these pre-treating conditions (simulating month, years of aging, etc.) stands at any kind of waste management system (composting, landfills) although the aim of these packages is to be able to utilize as biowaste. Moreover, migrating into the environment, they are often breaking down into small pieces and persisting under adverse conditions.

The aim of this study was to investigate the real biodegradation of oxo-biodegradable films and bioplastics in industrial composting and laboratory environment and to isolate bacterial strains capable of plastic degradation.

Different kinds of films from renewable and non-renewable materials were buried in an aerated composting pile in duplicate. After six weeks bioplastics were mostly disintegrated. Observable visual changes did not occur on oxo-biodegradable and control PE films, also measurable weight loss was not detected.

Microbiological availability of plastics was tested in laboratory conditions by aerobic respiration test (BOD measurement). Bacterial strains applied in these experiments were isolated from plastic films' surface stored in compost and soil. 31 isolated strains were identified on basis of 16S rRNA gene sequence analysis and one of them proved to be potentially new species *(Microbacterium sp. nov*., species description is in progress). Bioplastics (disintegrated in compost), oxo-biodegradable PE and PE films were tested based on the production of CO_2 in OxiTop® flasks. Powdered films and liquid mineral salt media were used; experiments ran for 60 days in duplicate. Result verifies the composting experiences; due to microbiological activity, the bioplastics showed better transformation than the oxo-biodegradable and commercial PE films.

Based on our results, PE films with oxo-biodegradable additives are not suitable for biological waste treatment processes, because of the absence of the main aging/weathering condition, the UV irradiation. Further experiments are needed for appropriate comparison and definition of biodegradation levels, and to select bacterial strains with plastic-degrading ability for bioremediation purposes.

This study was supported by the NVKP_16-1-2016-0023 grant.

Microplastics in coastal North Sea sediments – Analyzed using Fourier Transform Infrared Spectroscopy

Lars Michael Hildebrandt[a,b], C. Lorenz[a], S. Primpke[a] and G. Gerdts[a]

[a]*Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research,*
Biological Institute Helgoland, Germany
[b]*Helmholtz Centre for Materials and Coastal Research, Germany*

lars.hildebrandt@hzg.de

Anthropogenic litter, especially highly persistent plastic litter, has become a global problem. It is present in almost all marine habitats and freshwater ecosystems, making its future monitoring and removal one of the greatest challenges for environmental protection. In this context, microplastics (≤ 5 mm) are way more difficult to handle than larger plastic debris. Moreover, microplastic particles pose a threat to a huge spectrum of organisms. Microplastics' potential adverse effects stem from the obstruction of different Lumina and their chemical properties, i.e. due to sorption and transfer of POPs or leaching of toxic additives or residual monomers. According to their formation, microplastics are divided into two categories: primary and secondary microplastics. Primary microplastics are produced in micrometer dimensions for domestic applications, abrasives (e.g. shot blasting) or industrial processing (e.g. virgin pellets for injection molding), whereas secondary microplastics result from the fragmentation of larger items. Regrettably, degradation rates of plastics in general are very slow and depend on the presence of UV radiation, weathering, physical stress and biological factors such as biofilm formation. Once microplastics reach the seafloor, degradation can come to a nearly complete halt which means that marine sediments can become an ultimate repository for microplastics. In the present study, microplastics in 14 sediment samples from locations close to the Frisian Island, from the English Channel and offshore locations were isolated, quantified, measured and assigned to polymer clusters by state-of-the-art methods. In contrast to studies that solely use visual identification, this study employed µ-FTIR imaging to detect microplastics. Density separation with the MicroPlastic Sediment Separator in combination with $ZnCl_2$ solution ($\rho = 1.7$ g mL^{-1}) was used to separate the microplastics from sediment. Subsequently, the samples were subdivided into a fraction ≥ 500 µm and one < 500 µm. Particles ≥ 500 µm were visually sorted and manually analyzed using ATR-FTIR spectroscopy whereas smaller particles were enzymatically and chemically purified using recently developed microplastic-reactors. Afterwards, the samples were enriched on inorganic membrane filters and automatically analyzed using µ-FTIR imaging. The concentrations for the different stations ranged between 34 and 1457 particles per kg dry weight. All particles had a size ≤ 300 µm. Most particles (69%) were between 11 µm and 25 µm in size which indicates a high risk for ingestion, e.g. by filter feeding marine organisms. The study provides a substantial contribution to the assessment of the microplastic contamination status of the North Sea which the Marine Strategy Framework Directive targets. To date, data on microplastic burden of North Sea sediments are very scarce as only three studies exist with inter-study comparability being hampered by the lack of a standard operation procedure.

Determination of tire wear particles in road runoff based on elemental composition

Philipp Klöckner, S. Wagner and T. Reemtsma

Analytical Chemistry, Helmholtz-Centre for Environmental Research, Leipzig, Germany

philipp.kloeckner@ufz.de

Tire wear particles have been recognized as an important particulate environmental pollutant, due to emission rates of up to 133 000 t/a (Germany) and a broad range of toxic constituents that can leave the particles. Several analytical methods for the quantification of tire wear particles in environmental samples have been described, but suffer from deficits such as marker unspecificity or marker instability. In this work, an analytical method allowing to quantify tire wear particles in road runoff and road runoff sediments is presented. Tire wear particle quantification is based on elemental composition. In particular, Zinc (Zn) is present in characteristic concentrations in tires, at a concentration of approximately 1% by weight. Zn can leach from tire wear particles, however, leaching rates are below 1% per week under neutral pH conditions. Since Zn in environmental samples may derive from other sources than tires, it is important to enrich tire wear particles from the matrix, since otherwise tire wear particle concentrations could be overestimated. The analytical method developed by us is based on i) tire wear particle enrichment from sediment samples using density separation followed by ii) microwave assisted acid digestion and iii) elemental detection of Zn in the digested sample. The optimization and validation of the method shall be presented here. We optimized the analytical method regarding sample size (100 mg – 2g), density of the separation medium (1.7 - 2.3 g/cm³), length and energy input by ultrasound treatment (ultrasonic bath vs. direct application to the sample container walls) and the number of repetitions in density separation (1-5 repetitions). Various detergents (Tween 20, Tween 80, detergent mix SF100) were tested to improve dispersion of aggregates. The use of centrifugation to facilitate the separation procedure was examined and compared with gravity based separation. A two-step density separation was tested to increase enrichment specificity. In a first step, particles with a density lower than tire wear particles were removed from the matrix at a density of 1.2 g/cm³. In a second step, the tire wear particles were enriched at density 1.9 g/cm³. Particle sizes and elemental contents were evaluated as parameters for the optimization.

The analytical approach based on elemental content was verified by independent analytical methods targeting organic constituents of tire wear particles Ultimately, we applied the method to road runoff sediments from two sites with different runoff treatment systems.

Microplastic as an emerging contaminant of water – a state of knowledge in Poland

K. Wątor, M. Połeć, U. Aleksander-Kwaterczak and **Ewa Kmiecik**

AGH University of Science and Technology, Poland

ewa.kmiecik@agh.edu.pl

Plastic is a material commonly used in many different areas of our life. Due to the large quantities of plastics produced the risk of their released as a waste to the natural environment increases each year. The UV radiation and mechanical abrasion cause that plastic is transformed into smaller particles called microplastic which then get into environment, in particular water ecosystems. They are dangerous not only because they can directly or indirectly get into the animal and human organism, but also due to the fact that on their surface can be absorbed numerous harmful substances (such as heavy metals, PCBs, PAHs or bisphenol A). The research conducted by scientists around the world indicates that both marine and fresh waters are strongly exposed to pollution with these substances. In Poland, just a few years ago, the knowledge of water contamination with microplastics was negligible. However, recent years show a greater interest in this problem both in questions of water and animal protection. The most widely recognized problem is the presence of microplastics in the Baltic Sea. Microplastic present in the marine ecosystems poses a threat to marine fauna mainly due to the possibility of becoming entangled in plastic packaging (such as plastic bags, links or fishing nets) and, as a result, of mutilation or strangulation. An important danger is also the risk of consuming of microplastic by animals who often confuse it with plankton. Research published in 2017 indicates that the most common plastic occurred in the Baltic marine and beach sediments is polyester and less frequently poly(vinyl)acetate and poly(ethylene-propylene) are found. Still there is a lack of research on the problem of the occurrence of microplastic particles in freshwater – both surface and groundwaters. The low number of research on microplastic pollution in the environment results both from analytical difficulties and lack of appropriate legislation.

The study was partially supported by AGH-UST 11.11.140.797, 11.11.140.017 and 15.11.140.012.

Assessment of microplastic concentrations in human stool – Final results of a prospective study

Bettina Liebmann[a], S. Köppel[a], P. Königshofer[b], T. Bucsics[b], T. Reiberger[b] and P. Schwabl[b]

[a] *Environment Agency Austria (Umweltbundesamt GmbH),*
Testing Laboratory for Environmental Analysis, GMO and Fuel Analysis, Vienna, Austria
[b] *Div. of Gastroenterology & Hepatolology, Dept. of Internal Medicine III,*
Medical University of Vienna, Vienna, Austria

bettina.liebmann@umweltbundesamt.at

For their many practical characteristics, plastics are a pervasive part of everyday life and humans are exposed to plastics in numerous ways. In all probability, microplastics are being present in food items. It has been shown that they can be ingested by aquatic organisms and thus have the potential to accumulate in the food chain. Beyond that it is highly likely that during various steps of food processing or as a result of packaging food is being contaminated with plastics. Following ingestion, microplastic may impact human health via the gastrointestinal tract where it could affect the tolerance and immune response of the gut by bioaccumulation or aiding transmission of toxic chemicals and pathogens. However, the evidence for the unintentional uptake of microplastics through the diet into the human body was missing. Thus, we decided to monitor a small group of participants for the presence of microplastics in human stool.

The pilot study was conducted with eight participants (five females, three males), aged between 33 and 65, from across the globe. Each person kept a food diary in the week leading up to their stool sampling. The diaries logged the consumption of sea-food and whether people were exposed to plastics by consuming plastic wrapped foods or drinking from plastic bottles. The stools were tested at the Environment Agency Austria for 10 types of plastics in the size range above 50 µm. The solids fraction of human stool consists of mainly bacterial biomass, nitrogenous matter, undigested plant matter and fat. The insoluble fibres (carbohydrates) and fat in particular required several steps of sample pretreatment, because they were both masking and swamping potential microplastics.

Subsequent to a newly developed sample pretreatment procedure, however, the plastic types PE, PP, PVC, PA, PC, PET, PS, PU, PMMA, and POM could be reliably identified in the stool samples by FT-IR microspectroscopy and imaging. The final quantitative results of this “first of its kind” study including a small group of participants will be presented.

Freshwater microplastic input from Pearl River Estuary is contaminating Hong Kong waters

Hoi-Shing Lo[a], S. G. Cheung[a, b], C. Y. Wong[a]

[a] *Department of Chemistry, City University of Hong Kong, Tat Chee Avenue, Hong Kong*
[b] *State Key Laboratory in Marine Pollution, City University of Hong Kong, Tat Chee Avenue, Hong Kong*

hoislo2-c@my.cityu.edu.hk

Being located on the eastern side of the Pearl River Delta, the mega-urban region in China, the western waters of Hong Kong is polluted by the river with various pollutants including heavy metals, persistent organic pollutants and microplastic. We investigated the abundances of microplastic on 10 shores that receive discharge from the Pearl River. Highest mean abundance of microplastic was estimated at 2116 items kg^{-1} dry sediment with fibres being the most abundant form that followed by fragment, while foam, pellet and film were rare. Spectroscopic analysis by ATR-FTIR has shown that polyethylene (PE), polypropylene (PP) and polyethylene terephthalate (PET) accounted for $> 70\%$ of total polymer compositions. A substantial reduction in the microplastic input from the river can be achieved through better management of garbage collection and effective waste reduction and recycling in megacities along the river.

The challenge of detecting submicro- and nanoplastics in environmental and biological matrices – From sample preparation to characterization via Field-Flow Fractionation

Florian Meier, R. Drexel, V. Sogne and T. Klein

Postnova Analytics GmbH, Germany

florian.meier@postnova.com

With increasing application of microplastics in various products the release of such materials into the environment rapidly increases with implications difficult to predict. Due to the lack of suitable analytical methodologies, general analytical solutions to study the fate and behavior of submicro- and particularly nanoplastics in the environment as well as their human- and ecotoxicological effects are very challenging.

Asymmetrical Flow Field-Flow Fractionation (AF4) is a powerful technique that separates submicro- and nanoplastics by their hydrodynamic size based on their different different diffusion coefficients without using a stationary phase.

We present here a novel strategy for the comprehensive characterization of submicro- and nanoplastics-containing complex environmental and biological matrices based on matched sample preparation followed by AF4 multidetector analysis.

This procedure was successfully established for polystyrene submicro- and nanoparticles in river water and fish tissues, offering a promising analytical methodology for the investigation of the fate and behavior of such materials in complex environmental and biological matrices.

Acknowledgements: Financial support by the BMBF (project NanoUmwelt (BMBF Grant No. 03X0150)) is gratefully acknowledged.

Molecular interactions of organic compounds with tire crumb rubber

Ruoting Peng, M. Wehrhahn, T. Hüffer and T. Hofmann

Department of Environmental Geosciences and Research Platform Plastics in the Environment and Society, University of Vienna, Austria

Ruoting.peng@univie.ac.at

Concerns over the quantity and impact microplastics in the environment have grown rapidly in recent years. Prior research on microplastic has mainly focused on thermoplastic material like e.g. polyethylene or polystyrene. Besides thermoplastics, elastomers can also be considered as plastics and are often overlooked as a potential source of microplastics. Tire materials are one of the major sources of elastomers being released into the environment. The emission of tire material can be split into two routes. One route is the generation of particles due to mechanical abrasion of the tire against a surface. The other would be the intentional introduction of shredded tire crumb rubber (TCR), for applications such as fill material for playgrounds, turf fields, and artificial reefs. TCR has been shown to have high sorption capacity for organic molecules. This in combination with it being a composite material of carbon black and natural/synthetic rubber, makes the understanding of their molecular interactions with organic compounds important to assess their fate and behavior. Therefore we studied the sorption of TCR by determining experimental sorption data using a multiphase system and a probe sorbate set of a variety of substance classes.

The interpretation and prediction of molecular interactions are key to understanding environmental phase transfer processes, however, distribution coefficients cannot be determined for all compounds due to the large number of compounds and phases involved. The poly-parameter linear free-energy relationship (ppLFER) models have been successfully used to provide both qualitative and quantitative descriptions of the sorption of organic compounds by various sorbents. Fitting the sorption data obtained for TCR into the ppLFER model allows the investigation of individual molecular interactions and their contribution to overall sorption, which could be used to predict sorption of organic molecules to TCR. In this contribution, we present sorption data for a diverse set of molecular probe sorbates and compare it with data obtained for micro-sized plastic particles and aged plastic particles.

Characterisation of microplastics in Hong Kong waters: An unexplored type of fragment may reveal a new cause of formation

Beverly Hoi Ki Po[a], H.-S. Lo[b], K.P. Lai[a] and S.G. Cheung[a,b]

[a] *State Key Laboratory in Marine Pollution, City University of Hong Kong, Hong Kong SAR*
[b] *Department of Chemistry, City University of Hong Kong, Hong Kong SAR*

pobev@connect.hku.hk

Microplastics collected from different environments vary in composition due to the variation in sources and factors that brought the pieces to a particular location. In order to characterise the types of microplastics present in Hong Kong waters, microplastics (size of 1 – 5 mm) were collected from 10 beaches. Out of more than 4000 pieces of microplastics analyzed, 74% (by pieces) were plastic fragments with a predominance of white or transparent (38%) and blue (30%) in colour.

More importantly, a special type of fragment which has not been reported before is revealed from this study. These fragments, composing about 16% of the fragments collected, are interestingly triangular in shape with at least two of the three sides being characteristically straight and resembling a cut made by compression, often coupled with signs of tearing. Objective measurements and observation from some special pieces have made apparent differences between these "trimmed fragments" and those triangular fragments that were fractured randomly as the plastic degraded. Therefore, we proposed that this type of "trimmed fragment" was formed by biological causes, presumably by biting, instead of natural weathering.

A brief review of photographs of microplastics from other parts of the world supported that the "trimmed fragments" discovered in this study could be widely distributed. To date, only certain microbial strains are regarded as the biological cause for plastic degradation. The finding here could therefore have wide implications on current ecotoxicological and modeling studies for microplastics since the active biting of large plastic debris has generally not been considered as a factor.

Inter-study comparison of Nile Red-based staining protocols for the detection of microplastics in environmental samples

S. Konde, **Julia A. Prume**[a], J. Ornik, J. Taiber and M. Koch

Fachbereich Physik/Halbleiterphotonik, Philipps-Universität Marburg, Germany

julia.prume@physik.uni-marburg.de

Since microplastic prevalence in aquatic systems has been investigated in the beginning of this millennium, optical microscopy and spectroscopic FTIR and RAMAN techniques have been established to detect microplastics and – in the latter case – identify their polymeric nature. However, no method can yet meet the claim to be cost-efficient, time-efficient and reliable at the same time. Therefore, and because different sample purification protocols are applied, the scientific community agrees in the need of a standardized purification and analysis protocol to allow for meaningful inter-study comparisons. Recently, several studies arose which proposed the dye Nile Red, common in biosciences, as possibility to detect plastics in an environmental matrix. Nile Red is a fluorophore which binds to organic polymers and fluoresces upon excitation. The emission wavelength and intensity are highly variable and depend on excitation light, solvent, dye concentration and staining conditions. In this work, we present a comparison of five already published staining protocols and a novel one. To this end, we stained and compared fluorescence intensity and wavelength of the different forms pellet, fragment, foil and powder consisting of the common polymer types polypropylene, polyethylene, polyamide and polyethylene terephthalate. We demonstrate that all protocols can stain the investigated forms and types. However, we found partly large inter-protocol differences regarding fluorescence intensity and wavelenght which can mainly be attributed to different solvents and dye concentrations. Based on our comparison, we recommend a simple but functional staining protocol which 1) requires a relatively low Nile Red concentration, 2) provides a high fluorescence intensity and 3) differentiates between polar and non-polar polymers. In future studies, the suitability of this protocol in environmental samples can be investigated.

The use of moss (*Hylocomium splendens*) as a biomonitor for microplastics

Brett Roblin[a] and J. Aherne[b]

[a] *Environmental and Life Science Graduate Program, Trent University, Canada*
[b] *The School of the Environment, Trent University, Canada*

brettroblin@trentu.ca

Moss has been used as a biomonitor of air pollutant deposition, such as trace metals, since the 1970s. This study evaluated the use of mass as a biomonitor for the atmospheric deposition of microplastics. Microplastics are plastic products that are less than 5mm in size. Our understanding of the sources and transport mechanisms of this emerging pollutant has increased during the last decade. However, few studies have focused on the atmospheric transport of microplastics. In this study, moss field samples (~500 mlL were collected from an area covering ~50 m^2 from three remote sites in Ireland. Moss samples were subsequently processed using two different treatments: a digestion using hydrogen peroxide (H_2O_2) compared with aggressively washing in water (H_2O) to assess their difference in microplastic extraction efficiency. The H_2O_2 treatment utilized 100 mL of 30% H_2O_2 to dissolve a range of moss sample masses (0.10 g, 0.50 g and 1 g). Whereas H_2O treatment employed a range of washing times (4 hrs, 8 hrs and 16 hrs) for the moss samples (0.10 g, 0.50 g and 1 g samples). Each treatment (H_2O or H_2O_2) was then vacuum filtered onto GF/C Whatman filters. Microplastics were counted and measured using a steromicroscope. A subsample of the microplastics were further analyzed using raman spectroscopy to identify the type of plastics. The number of plastics per g of moss were calculated. The results indicate that moss has the potential to be utilized as a biomonitor for the atmospheric deposition of microplastics. Each treatment was effective at obtaining microplastics, however, the H_2O_2 treatment took longer but dissolved the entire sample, whereas the washing treatment was quicker but only represents microplastics collected on the moss surface.

Survey on occurrence of microplastics in an urban river watershed of Da Nang city in Vietnam

Taishi Ushijima[a], S. Tanaka[b], S. Yukioka[b], M. Wang[b], Y. Nabetani[a], M. Kakita[a], A.N. Hoang[c]
Q.V. Trang[c], S. Fuji[b] and H. Takada[d]

[a] *Graduate School of Engineering, Kyoto University, Japan*
[b] *Graduate School of Global Environmental Studies, Kyoto University, Japan*
[c] *Department of Environmental Engineering, Da Nang University of Science and Technology, Vietnam*
[d] *Department of Environmental and Natural Resource Sciences,*
Tokyo University of Agriculture and Technology, Japan

t-shuhei@eden.env.kyoto-u.ac.jp

There are many microplastics in seas and oceans all over the world. Most of them may be released from Asian developing countries (e.g. China, Indonesia and Vietnam). It is important to reveal occurrences, properties and features of microplastics in developing countries. This study shows occurrences of microplastics larger than 100 µm in one of the cities in developing countries, Da Nang city in Vietnam.

Field surveys were conducted in Da Nang city, Vietnam from October to November in 2017. Road dusts (*n*=12) in a watershed of Phu Loc River which flows into Da Nang Bay, surface water (*n*=6) in Phu Loc River and anchovy's digestive tracts (*n*=35) in Da Nang Bay were collected. Microplastics lager than 100 µm were separated from collected samples by some pre-treatments. Microplastics size was measured with a microscope and a digital camera. It was calculated by averaging long axis and short axis of microplastics particles. The components of microplastics were identified with Fourier Transform Infrared Spectrometer (FT-IR).

As a result, the microplastics density of road dusts in the watershed of Phu Loc River and surface water in Phu Loc River were 19.7±14.3 (particles/m^2) and 0.85±0.42 (particles/m^3), respectively. The ratio of microplastics detection was 8.6% in anchovies from Da Nang Bay. The median values of microplastics size of road dusts, surface water in Phu Loc River and anchovies in Da Nang Bay were 605 µm, 465 µm and 681 µm, respectively. Most microplastics particles in each sample were polyethylene or polypropylene.

The microplastics density of road dusts and surface water in Phu Loc River were approximately ten times larger than that in a watershed of Lake Biwa respectively. On the other hand, the ratio of microplastics detection of anchovies in Da Nang Bay was approximately three times smaller than that of pond smelts in Lake Biwa. The median values of microplastics size of road dusts and surface water in Phu Loc River were smaller than that of road dusts and surface water in the watershed of Lake Biwa. It was suspected that microplastics in Da Nang city were fragile and easy to become smaller, and furthermore, the small microplastics were difficult to accumulate in digestive tracts of anchovy in Da Nang Bay.

Microplastics in surface waters at Lake Kallavesi, Finland – Analysis of size distribution and their possible sources

Emilia Uurasjärvi[a], S. Hartikainen[a,c], O. Setälä[b], M. Lehtiniemi[b] and A. Koistinen[a]

[a] *SIB Labs, University of Eastern Finland, Finland*
[b] *Marine Research Centre, Finnish Environment Institute, Finland*
[c] *Department of Environmental and Biological Sciences, University of Eastern Finland, Finland*

emilia.uurasjarvi@uef.fi

Microplastic concentrations in freshwater environments are not yet widely studied. However, the ecosystems of shallow lakes may be particularly vulnerable to the microplastic pollution. In this study, we analyzed microplastic concentrations, size distributions and polymer types in surface waters at Lake Kallavesi. The lake is located in Eastern Finland and it surrounds the city of Kuopio.

Two sampling methods, a pump collecting different size fractions of 20, 100 and 300 µm and a common manta trawl (333 µm), were used to collect surface water microparticles from 12 sampling sites in autumn 2016 and spring 2017 at Lake Kallavesi. The sampling sites represented various potential sources of microplastics, such as the city harbor, a highway, a discharge pipe of a wastewater treatment plant (WWTP) and a snow dumping site. The number of synthetic polymer particles was examined and the polymer types were determined by FTIR microscopy.

The total average concentration of microplastic particles in manta samples was 0.27 particles m^{-3}. This is in agreement with the previous findings of the microplastic concentrations in the Baltic Sea. However, the number of MPs was significantly higher in smaller size fractions obtained with pump collection (averages 155, 12 and 1.8 particles m^{-3} for sizes 20, 100 and 300 µm, respectively). The results indicated that larger (> 300 µm) MPs were abundant in the city harbor, whereas smaller MPs had several sources, such as the snow dumping site and the WWTP. Considering polymer materials and morphology, majority (64 %) of the identified microplastics were fibres. All plastic particles were common polymers used in consumer products, such as polyethylene, polypropylene and polyethylene terephthalate.

The effects of additives and microplastics on freshwater organisms

Jana Vašíčková[a] and T. Hüffer[b]

[a] *RECETOX, Masaryk University, Czech Republic*
[b] *Department of Environmental Geosciences; Environmental Sciences Research Network (ESRN); and Research Platform "Plastic in the Environment and Society" (PLENTY), University of Vienna, Austria*

vasickova@recetox.muni.cz

Global plastics pollution is a consequence of unsustainable use and uncontrolled, inadequate plastic disposal and waste management. Despite their persistence for several decades, larger plastic particles slowly degrade under environmental conditions to so-called microplastics, fragments smaller than 5 mm. Microplastics are of special concern due their ability to be i) ingested by a variety of species at many trophic levels, which can result in direct physical damage, ii) a transfer vector for co-occurring chemical compounds, and iii) a source of additional pollution due to leaching of incorporated additives. While the so-called vector effect of microplastics for persistent organic pollutants seems to be of less relevance at a global scale, more focus should be given to the leaching of additives from microplastics. However, the environmental risks of the additive release in freshwater systems are largely unknown.

A broad range of chemical agents are incorporated into polymers during the manufacturing process to adjust the plastics for their specific application. Most additives are not chemically bound to the polymer and thus, can leach into the surrounding aquatic environment as the plastics undergo weathering. Among the most commonly used additives are phthalates, organotin compounds, brominated flame retardants, bisphenol A and alkylphenols. The uptake, bioactivity and toxicity of these individual chemical compounds are well studied and most of them reveal endocrine disruptive properties. While it has been suggested that chemicals in plastics might be released into the alimentary tract after ingestion, only a limited number of studies measured the chemical release from plastics and linked their effects on aquatic organisms.

In this contribution, we critically evaluate the current literature on how the leaching of additives manifests at the biological level and how aquatic organisms may be affected by additives leaching. To clarify to what extent microplastics represent a risk to aquatic organisms, chemicals incorporated into plastics need to be better characterized. Development of methodologies is required to quantify the amount of chemicals within microplastics and to elucidate their release and effects on aquatic ecosystems. Many features of microplastics are yet to be investigated including the impact of polymer composition on the behavior of plasticizers and its fate and interactions with organisms.

Tire wear particles in the aquatic environment

Stephan Wagner[a], T. Hüffer[b], P. Klöckner[a], M. Wehrhahn[b], T. Hofmann[b] and T. Reemtsma[a]

[a] *Helmholtz Centre for Environmental Research - UFZ, Department of Analytical Chemistry, Germany*
[b] *University of Vienna, Department of Environmental Geosciences, Austria*

stephan.wagner@ufz.de

Tire wear particles (TWP) have gained increasing attention as part of organic particulate contaminants introduced in high amounts in aquatic environments. In this study we reviewed the current knowledge on emissions, and occurrence in surface waters as well as properties and behaviour in the aquatic environment. The current knowledge was evaluated in the light of environmental TWP exposure. Finally we identified knowledge gaps in this field.

The mass of TWP generated is estimated at 1,327,000 t/a for the European Union, 1,120,000 t/a for the United States and 133,000 t/a for Germany. In case TWP are considered as microplastic, TWP emission equal approximately 60% of the total MP emissions in the aquatic environment. However, the mass of TWP ultimately entering the aquatic environment strongly depends on the extent of collection and treatment of road runoff, which is highly variable. We estimated that between 0.1 and 10% of the total TWP emissions reach surface waters. Data on TWP concentrations in the environment, including surface waters are fragmentary, which is also due to the lack of suitable analytical methods for their determination. However, a few studies estimate TWP concentrations in the range from micrograms per litre in surface water to milligrams per kilogram in sediments, suggesting that sediments act as a sink for TWP.

TWP are generated from tire material during use on roads. After release from tire they are most likely subjected to various ageing processes causing strong particle alterations. For example aggregation with mostly inorganic particulate matter of traffic origin is likely to occur. However, information on TWP properties such as morphology, density and size distribution are missing or inconsistent; this hampers assessing the fate of TWP in the aquatic environment and making it difficult to track them in the environment. For example, few data shows that density increases up to 1.9 g/cm³ facilitating sedimentation in surface water. This verifies measurement data showing an accumulation in the sediment.

TWP consist of a multitude of organic (poly-butadiene, styrene-butadiene, plasticizer, anti-oxidants, processing aids e.g. mineral oil, vulcanisation agents e.g. thiazoles) and inorganic (filler like silica, vulcanisation agents like ZnO) compounds. Leaching of these compounds from TWP may affect the surrounding aqueous environment making this process highly relevant with respect to local water quality conditions.

It is concluded that reliable knowledge on transport mechanism to surface waters, concentrations in surface waters and sediments, effects of aging and environmental half-lives of TWP are missing or incomplete. Furthermore, to be able to assess the environmental relevance of TWP it is also necessary to determine mass flows of elements and chemicals related to the TWP fluxes and compare them with inputs from other sources.

Influence of environmental factors on the leaching of polymer additives from carbon nanotube (CNT) polymer composites in water

Imari Walker Karega[a], M. D. Montaño[a,b], P. L. Ferguson[a]

[a] *Department of Civil and Environmental Engineering, Duke University, USA*
[b] *Department of Environmental Geosciences, University of Vienna, Austria*

imari.walker.karega@duke.edu

Engineered nanomaterials and nanoparticles are increasingly used in consumer products due to their properties and ability to be placed into composites. Nanoparticles such as carbon nanotubes are placed into polymer matrices to improve tensile strength, UV inhibition, flame resistance, electrical and thermal conductivity and reduce gas permeability. Many studies have investigated the impact of release of these nanoparticles into the environment and their ecotoxicological effects. However, few studies have investigated how the inclusion of carbon nanotubes in polymer matrices can impact the release of polymer additives. Polymer additives can be released through mechanisms of pH-mediated hydrolysis, oxidation, UV degradation, mechanical abrasions, and thermal degradation. The release of these additives into the environment are of concern due to additives like Bisphenol A and nonylphenol which are known to act as endocrine disruptors. In this study, a 5 day leaching experiments of cryomilled epoxy containing varying concentrations of carbon nanotubes (0, 0.01, 0.05, 0.1%) was completed. The three polymer additives that were studied are Bisphenol A (BPA), Bisphenol A diglycerol ether (BADGE), and Nonylphenol. The epoxy was placed in water under conditions of no light, and a temperature of 65 °C. This experiment was performed with one set of epoxy exposed to 5 days of 500 Watt UV exposure, while a control was run in parallel where epoxy was not exposed to UV. Daily measurements of polymer additive concentrations were taken to investigate how the concentration of carbon nanotubes and UV exposure increase the release of these polymer additives into an aqueous environment.

Véronique Adam
Empa
Switzerland
veronique.adam@empa.ch

Nizar Benismail
Nestle Waters MT
France
nizar.benismail@waters.nestle.com

Katarzyna Bochenek
PerkinElmer
Switzerland
katarzyna.bochenek@perkinelmer.com

Nathan Bossa
Duke university
USA
bossanathan@gmail.com

Giulia Buob
Ufficio Monitoraggio Ambientale
Switzerland
giulia.buob@ti.ch

Yaping Cai
Empa
Switzerland
yaping.cai@empa.ch

Stephanie Castan
University of Vienna
Austria
stephanie.castan@univie.ac.at

Mariacristina Cocca
National Research Council of Italy (CNR)
Italy
mariacristina.cocca@ipcb.cnr.it

Stephanie Andrews
University of Exeter
UK
sa728@exeter.ac.uk

André Marcel Bienfait
Institute of Marine Research
Norway
amb@hi.no

Gabor Bordos
Wessling Hungary
Hungary
bordos.gabor@wessling.hu

Nina Buenaventura
Norwegian Instutute for Water Research
Norway
nina.buenaventura@niva.no

Patricia Burkhardt-Holm
University of Basel
Switzerland
patricia.holm@unibas.ch

Jessica Caldwell
University of Fribourg
Switzerland
jessica.caldwell@unifr.ch

Annamaria Cavalleri
PerkinElmer
Italy
annamaria.cavalleri@perkinelmer.com

Scott Coffin
University of California, Riverside
USA
scoff003@ucr.edu

Francesca De Falco
National Research Council of Italy (CNR)
Italy
francesca.defalco@ipcb.cnr.it

Claudia Drago
University of Potsdam
Germany
drago@uni-potsdam.de

Boris Eyheraguibel
University Clermont Auvergne
France
boris.eyheraguibel@uca.fr

Dieter Fischer
Leibniz-Institute of Polymer Research Dresden
Germany
fisch@ipfdd.de

Stefan Frehland
Eawag
Switzerland
stefan.frehland@eawag.ch

Tamara Galloway
University of Exeter
UK
T.S.Galloway@exeter.ac.uk

Gunnar Gerdts
Alfred Wegner Institute
Germany
gunnar.gerdts@awi.de

Todd Gouin
TG Environmental
UK
todd.gouin@environresearch.com

Giulia Donati
ETH Zurich
Switzerland
giulia.donati@usys.ethz.ch

Edith Durisch
Baudirektion Kanton Zürich, AWEL
Switzerland
edith.durisch@bd.zh.ch

Montserrat Filella
University of Geneva
Switzerland
montserrat.filella@unige.ch

Shaun Forrest
Carleton University
Canada
shaunforrest@cmail.carleton.ca

Nicolas Fuentes Colomer
CEFIC
Belgium
nfc@cefic.be

Giulio Gasparini
Firmenich SA
Switzerland
giulio.gasparini@firmenich.com

Sebastian Gies
Philipps-Universität Marburg
Germany
Sebastian.gies@physik.uni-marburg.de

Ksenia Groh
Food Packaging Forum Foundation
Switzerland
ksenia.groh@fp-forum.org

Allan Gross
Aarhus University
Denmark
agr@btech.au.dk

Judit Hahn
Szent István University
Hungary
hahn.judit@mkk.szie.hu

Rune Aardal Hansen
Aarhus University
Denmark
rah@btech.au.dk

Lars Hildebrandt
Helmoltz Centre Geesthacht
Germany
lars.hildebrandt@hzg.de

Dirk Hoegaerts
Agilent Technologies
Belgium
dirk.hoegaerts@agilent.com

Anke Hofacker
Federal Office for the Environment FOEN
Switzerland
anke.hofacker@bafu.admin.ch

Thilo Hofmann
University of Vienna
Austria
thilo.hofmann@univie.ac.at

Philipp Hopp
BASF PC & N
Germany
philipp.hopp@basf.com

Andreas Huber
neaspec GmbH
Germany
andreas.huber@neaspec.com

Thorsten Hüffer
University of Vienna
Austria
thorsten.hueffer@univie.ac.at

Marco Inglessis
Istituto Superiore di Sanità
Italy
marco.inglessis@iss.it

Natalia Ivleva
TU Munich
Germany
natalia.ivleva@ch.tum.de

Jennifer Jones
University of Exeter
UK
jj407@exeter.ac.uk

Ralf Kaegi
Eawag
Switzerland
Ralf.Kaegi@eawag.ch

Heejun Kang
Korea Institute of Civilin Engineering and Building Technology
Republic of Korea
Heejunkang@kict.re.kr

Delphine Kawecki-Wenger
Empa
Switzerland
delphine.kawecki@empa.ch

Andreas Kerstan
Agilent Technologies
Germany
andreas.kerstan@agilent.com

Philipp Kloeckner
Helmholtz Centre for Environmental Research
Germany
philipp.kloeckner@ufz.de

Ewa Kmiecik
AGH University of Science and Technology
Poland
ewa.kmiecik@agh.edu.pl

Christian Laforsch
University of Bayreuth
Germany
Christian.laforsch@uni-bayreuth.de

Roman Lehner
University of Fribourg
Switzerland
roman.lehner@unifr.ch

Ceri Lewis
University of Exeter
UK
c.n.lewis@exeter.ac.uk

Bettina Liebmann
Environment Agency Austria
Austria
bettina.liebmann@umweltbundesamt.at

Hoi Shing Lo
City University of Hong Kong
Hong Kong
hoislo2-c@my.cityu.edu.hk

Rainer Lohmann
University of Rhode Island
USA
rlohmann@uri.edu

Rachele Longhitano
Ufficio Monitoraggio Ambientale
Switzerland
rachele.longhitano@ti.ch

Joana MacLean
GFZ Potsdam
Germany
jmaclean@gfz-potsdam.de

Cynthia Mann
ExxonMobil
USA
cynthia.l.mann@exxonmobil.com

Michael Mattle
Holinger SA
Switzerland
lausanne@holinger.com

Florian Meier
Postnova Analytics GmbH
Germany
florian.meier@postnova.com

Freija Mendrik
University of Hull
UK
freija.mendrik@hotmail.co.uk

Denise Mitrano
Eawag
Switzerland
Denise.Mitrano@eawag.ch

Daniel Nagy
Wessling Hungary
Hungary
nagy.daniel@wessling.hu

Kathrin Oelschlaegel
Fraunhofer IKTS
Germany
kathrin.oelschlaegel@ikts.fraunhofer.de

Johanna Otto
Envilab AG
Switzerland
johanna.otto@envilab.ch

Lorenzo Palumbo
Istituto Superiore di Sanità
Italy
lorenzo.palumbo@iss.it

Ruoting Peng
University of Vienna
Austria
ruoting.peng@univie.ac.at

Alessandro Piazzoli
Envilab AG
Switzerland
alessandro.piazzoli@envilab.ch

Beverly Hoi Ki Po
City University of Hong Kong
Hong Kong
beverlypo@gmail.com

Julia Prume
Philipps-Universität Marburg
Germany
julia.prume@physik.uni-marburg.de

Julia Reichel
TU Munich
Germany
julia.reichel@tum.de

Andrew Reynolds
Dublin Institute of Technology
Ireland
C11354601@mydit.ie

Brett Roblin
Trent University
Canada
brettroblin@trentu.ca

Chelsea Rochman
University of Toronto
Canada
chelsearochman@gmail.com

Emily Rowlands
University of Exeter
UK
er399@exeter.ac.uk

Michael Sander
ETH Zurich
Switzerland
michael.sander@env.ethz.ch

Sven Seidensticker
University of Tübingen
Germany
sven.seidensticker@uni-tuebingen.de

Joana Sipe
Duke University
USA
jms256@duke.edu

Friederike Stock
Federal Institute of Hydrology
Switzerland
stock@bafg.de

Richard Thompson
University of Plymouth
UK
rcthompson@plymouth.ac.uk

Federica Tommasi
Italian National Institute of Health
Italy
Federica.tommasi@iss.it

Robin Treilles
LEESU/UPEC
France
robin.treilles@enpc.fr

Taishi Ushijima
Kyoto University
Japan
ushizima@eden.env.kyoto-u.ac.jp

Emilia Uurasjärvi
University of Eastern Finland
Finland
emilia.uurasjarvi@uef.fi

Nathalie Vallotton
Dow Europe GmbH
Switzerland
navallotton@dow.com

Jana Vasícková
Masaryk University
Czech Republic
vasickova@recetox.muni.cz

Stephan Wagner
Helmholtz Centre for Environmental Research
Germany
stephan.wagner@ufz.de

Martin Wagner
NTNU
Norway
martin.wagner@ntnu.no

Imari Walker Karega
Duke University
USA
iiw2@duke.edu

Bernhard Wehrli
Eawag / ETH Zurich
Switzerland
Bernhard.Wehrli@eawag.ch