Comments on the ECHA Proposal Concerning the Biodegradation of Microplastics

By Microplastics Solutions Participants

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1 Background and Context

These comments reflect the concerns on the state of the global environment, more specifically the worldwide aquatic system, from SMEs and organisations throughout Europe and beyond, from scientific advisors from different disciplines, and from informed citizens. They take in account the latest scientifically supported findings and reports about the actual predicament into which the global environment shifted in a rapid pace during the last decades.

In our view, human society can not by any means further accept the continuous release of “intentionally added” microparticles in the global environment, be it in the water system, as solid waste or in any other form, when these microparticles do not respond to strict criteria. The actual predicament of seas and oceans dictates drastic measures in the choices of ALL materials intentionally introduced in the planet's metabolism, more specifically in the aquatic system. Not having taken this in consideration in the past lead to the actual unacceptable situation. The worldwide level of pollution through microparticles is so massive and omnipresent that neither abiotic, nor biotic processes, nor the combination of both are able to make this pollution stagnate, let be to reverse it, in the short term.

However, ECHA edited a proposal which is very lenient towards the sourcing and the production technologies of soluble and insoluble solid particles for cosmetics and detergents, as well as on the transition time towards better solutions. Our conviction is that this will only slow down changes as much as possible to protect financial investments by a concept of “acceptable risk”. This is not what is necessary to neutralise and upgrade the environmental predicament and it will not be accepted by the public.

The authors of this comments are not against the use of “intentionally added”, soluble or insoluble solid microparticles in cosmetics and detergents, as far as such microparticles offer functionality and/or convenience. They are convinced that it is definitely possible to replace existing materials which are a burden to the environment with such ones that easily slip into the logics of the ecosystems. However, to come with real solutions to the actual predicament, the ailing metabolism of living nature should be taken as a starting point and from there should be deduced which kind of materials, in which form and how much of them we can afford to introduce in the biotic and abiotic processes of the planet.

2 Definitions

In the absence of a definition of “plastic” in the REACH regulation, it is suggested to take the REACH definition of “polymer” as a starting point. The following regulatory definition is proposed by ECHA:

> *(...) ‘microplastic’ means a material consisting of solid polymer-containing particles, to which additives or other substances may have been added, and where ≥ 1% w/w of particles have (i) all dimensions 1nm ≤ x ≤ 5mm, or (ii), for fibres, a length of 3nm ≤ x ≤ 15mm and length to diameter ratio of >3. Polymers that occur in nature that have not been chemically modified (other than by hydrolysis) are excluded, as are polymers that are (bio)degradable.*

REACH gives as a definition of “polymer”:

> *(a) Over 50 percent of the weight for that substance consists of polymer molecules (see definition below); and,*
> *(b) The amount of polymer molecules presenting the same molecular weight must be less than 50 weight percent of the substance.*
> *In the context of this definition a ‘polymer molecule’ is a molecule that contains a sequence of at least 3 monomer units, which are covalently bound to at least one other monomer unit or other reactant.*

The EU Ecolabel for dishwashing detergents gives a somewhat different definition of “microplastic”. However, the EU Ecolabel regulation is only valid for products submitted voluntarily to its criteria, not for each and every product on the market:

> *(...) 'microplastic' means particles with a size of below 5 mm of insoluble macromolecular plastic, obtained through one of the following processes:*
> *(a) a polymerisation process such as polyaddition or polycondensation or a similar process using monomers or other starting substances;*
> *(b) chemical modification of natural or synthetic macromolecules;*
> *(c) microbial fermentation.*

In the ECHA proposal, polymers that occur in nature but are not chemically modified, other than by hydrolysis, and polymers that are (bio)degradable, are not considered to be “microplastics”. From the above REACH definition of “polymer” it is not unambiguously clear if polymers which are biodegradable may be chemically modified or not, and if so, which technologies would be accepted or rejected; this point has to be clarified.
Further definitions as suggested by ECHA are to be found in Annex A of this document.

3 Basic Principles

The basic principle which could be put forward to deal with waste from all man-made materials should still be the Reduce-Reuse-Recycle waste hierarchy[1]. However, for many commodity products these

1 First introduced in the Waste Framework Directive (1975/442/EEC). The EU Commission in its most recent proposals

principles can't possibly be followed: the leftovers of cosmetics and detergents end in the waste water and in solid waste, without the possibility of reusing or recycling them. Only measures of strict selection of ingredients and raw materials in the development and production phases of the commodities, and of generating awareness with the consumer can improve the predicament[2].

3.1 Waste Water Treatment

In the EU a large part of the household waste water is collected and treated in local or regional waste water plants before being released in the aquatic system. However:

1. A large and increasing number of waste water plants operates in *anaerobic* conditions, whereas regulations are still focused on *aerobic* conditions,
2. The retention time of waste water in treatment plants is to be counted in hours rather than days,
3. Many man-made materials, soluble or insoluble, ending in waste water are not readily degradable, especially not in anaerobic and marine conditions,
4. Man-made materials, including soluble and therefore invisible microplastics from petrochemical sources, cannot be retained of filtered out in waste water treatment.

The aquatic pollution caused by microplastics is considerable, although insufficiently monitored and documented:

> *There is an urgent need to promote improved standardized analytical techniques for sampling and quantifying microplastics in the marine environment, in order to build up international monitoring programs that could provide the required baseline data for understanding the spatial and temporal distribution of micro- plastics in open and coastal oceans*[3]

> *Divers have reportedly spotted plastic bags and candy wrappers as deep as the Mariana Trench. Now, a survey of microplastics at various depths off the coast of California suggests that this debris is most common several hundred meters below the surface, scientists report online June 6 in Scientific Reports.*
> *Using remotely operated underwater vehicles, researchers sampled microplastics in Monterey Bay at depths from five to 1,000 meters. The team also measured pollutants in the guts of 24 pelagic red crabs and eight mucus filters from giant larvaceans — both of which eat organic particles about the same size as microplastics (SN Online: 8/16/17).*
> *The concentration of particles 1,000 meters deep was roughly the same as it was five meters deep, averaging about three particles per cubic meter. Plastic in water from 200 to 600 meters deep was more concentrated, with 10 to 15 particles per cubic meter*[4].

In the meantime there is increasing evidence that microplastics worked their way up the food chain:

> *Microplastics are ubiquitous across ecosystems, yet the exposure risk to humans is unresolved. Focusing on the American diet, we evaluated the number of microplastic particles in commonly consumed foods in relation to their recommended daily intake. The potential for microplastic inhalation and how the source of drinking water may affect microplastic consumption were also explored. Our analysis used 402 data points from 26 studies, which represents over 3600 processed samples. Evaluating approximately 15% of Americans' caloric intake, we estimate that annual microplastics consumption ranges from 39000 to 52000 particles depending on age and sex. These estimates increase to 74000 and 121000 when inhalation is considered. Additionally, individuals who meet their*

respects this without naming it

2 Circular Economy: Commission welcomes Council final adoption of new rules on single-use plastics to reduce marine plastic litter, Press Release, 21 May 2019, http://europa.eu/rapid/press-release_IP-19-2631_en.htm

3 *Plastic Debris in the Ocean The Characterization of Marine Plastics and their Environmental Impacts, Situation Analysis Report, Florian Thevenon, Chris Carroll and João Sousa, IUCN 2016 www.iucn.org.*

4 C.A. Choy et al. The vertical distribution and biological transport of marine microplastics across the epipelagic and mesopelagic water column. Scientific Reports. Published online June 6, 2019. doi: 10.1038/s41598-019-44117-2.

recommended water intake through only bottled sources may be ingesting an additional 90000 microplastics annually, compared to 4000 microplastics for those who consume only tap water. These estimates are subject to large amounts of variation; however, given methodological and data limitations, these values are likely underestimates[5].

3.2 Effluent of Waste Water Treatment

As a consequence of point 3.4.1. above, insufficiently degraded waste is reaching seas and oceans in large quantities over the watercourses. This is for the time being difficult to estimate reliably, as the average speed of surface water is largely depending on several external factors such as gradient, width and depth of the river bed etc., and thus will be quite different between rivers. For a large part of Europe it will only take a couple of days before the effluent of waste water treatment is carried to seas and oceans. This can explain why i.e. the Mediterranean shows a documented pollution with several types of microplastics. The following percentages are calculated on sampled particles of >700 µm[6]:

- 0,3% of PET
- 1,2% of PVA
- 16% of PP
- 52% of PE

The detection of PVA particles is alarming, as PVA is considered to be (bio)degradable:

With the advent of new technology surrounding renewable natural polymers, polyvinyl alcohol has become a highly lucrative due to its biodegradable quality, under certain microbial conditions[7].

However, the production and use of PVA are only increasing:

Currently, Asia Pacific, North America, and Europe are the largest players in the polyvinyl alcohol market. Regionally, Asia Pacific reported an estimated 580.3 kilotons of PVA in 2016, projecting a compound annual growth rate (CAGR) of 5.5 percent from 2017 to 2025[8].

PVA particles may partially be originating from wasted fishing gear. However, the study by Suaria et al. in the footnote only searched for *floating particles >700 µm*, not for *dissolved, but undegraded PVA*. The presence of 1,2 % of PVA particles may indicate that it is not readily degradable. We also might assume that PVA particles as well as dissolved, undegraded PVA worked their way up the food chain.

3.3 Plastic Recycling

In the actual societal organisation the collection and recycling of plastics is still quite limited:

In Europe, energy recovery is the most used way to dispose of plastic waste, followed by landfill. Some 30% of all the generated plastic waste is collected for recycling and recycling rates by country vary a lot (...).
Half of the plastic collected for recycling is exported to be treated in countries outside the EU. Reasons for the exportation include the lack of capacity, technology or financial

5 *Human Consumption of Microplastics, Kieran D. Cox, Garth A. Covernton, Hailey L. Davies, John F. Dower, Francis Juanes, Sarah E. Dudas, American Chemical Society, June 2019*
6 Suaria G. et al., The Mediterranean Plastic Soup: synthetic polymers in Mediterranean surface waters, Sci. Rep. 6, 37551; doi 10.1038/srep37551 (2016)
7 https://www.toppr.com/bytes/polyvinyl-alcohol/
8 ibidem

resources to treat the waste locally. Previously, a significant share of the exported plastic waste was shipped to China, but with the country's recent ban on plastic waste imports, it is increasingly urgent to find other solutions.
The low share of plastic recycling in the EU means big losses for the economy as well as for the environment. It is estimated that 95% of the value of plastic packaging material is lost to the economy after a short first-use cycle.
Each year, the production and incineration of plastic emits about 400 million tonnes of CO2 globally, a part of which could be avoided through better recycling[9].

3.4 Biodegradation Tests

ECHA proposes (bio)degradation tests such as OECD 301B, 307, 308, 309 and 310 for the testing of microplastics, but with testing cycles extended to 90 or even 120 days instead of the usual 28 days, and testing temperatures up to 30°C.
However, these tests have been developed for the biodegradation testing of *soluble surfactants*, not for *insoluble* microplastics. With soluble microplastics, their solubility is by no means a sign for readily degradability. Microplastics, both insoluble and soluble, should be tested with appropriate test methods. The average actual microplastic will not be readily degradable in aerobic and anaerobic conditions, in a time frame short enough to keep the environment in a good working condition. It therefore makes no sense to aim at long degradation cycles under unrealistic temperature conditions, documented by inappropriate methods, even not when a certain correlation can be shown. Moreover, the actual waste water treatment – when already present – does not allow the separation of soluble and insoluble microplastics before the release of the effluent in the aquatic system, and the retention times in the waste water plants are too short to allow degradation.

4 Proposal by Microplastics Solutions Participants

4.1 Strict criteria

In view of all the above it should be an obvious choice and a matter of common sense to prohibit the release in the environment of "intentionally added" materials, including microparticles, be it in soluble or insoluble form, when they do not respond to strict criteria. These criteria are inspired by the principles of Green Chemistry as put forward by *Anastas, Warner et al.*[10], see Appendix B:

1. Sourced from renewable resources (Principle 7),
2. Transformed only by physical processes, or by such ones which are in compliance with the principles of Green Chemistry (Principles 3 & 4),
3. Free from unwanted or harmful additives (such as, but not limited to, mutagenic, teratogenic and/or carcinogenic molecules and/or endocrine disruptors) (Principles 4 & 5),
4. Featuring a low aquatic toxicity (Principle 4),
5. Readily (bio)degradable in both aerobic and anaerobic conditions, OR readily 'compostable home' (Principle 10),
6. The (bio)degradation demonstrated by adequate and realistic methodologies (Principles 10 & 11); compostability test methods are to be defined,
7. Leaving no stable metabolites after degradation or composting (Principle 10).

9 News EU Parliament, http://www.europarl.europa.eu/news/en/headlines/society/20181212STO21610/plastic-waste-and-recycling-in-the-eu-facts-and-figures, 12/2018
10 *https://global.oup.com/academic/product/green-chemistry-theory-and-practice-9780198506980?cc=be&lang=en&*

These criteria are focused on prevention and, taken together, respond to the first and most important Principle of the Green Chemistry approach:

> *1. Prevention. Preventing waste is better than treating or cleaning up waste after it is created*[11].

4.2 Compulsory mention

Furthermore, and in compliance with the precautionary principle, we propose that insofar microplastics which do not comply with the above criteria would be allowed to stay in the market, they should bear a compulsory, well readable warning about their non-sustainable nature, so that the informed consumer can avoid buying products which contain them and/or are packed with them.

4.3 Alternatives

There are several molecules in existence which comply with such a profile, which have been checked and tested on these characteristics and which have proven to be applicable for the purposes needed. They will however be more expensive; that will be the price to pay to save and respect our health and the environment. Cheap prices were based on petrochemicals and weak or lacking regulations, they have co-generated the actual predicament.
A non-profit organisation documenting many alternatives for conventional plastics is European Bioplastics https://www.european-bioplastics.org:

> *Today, there is a bioplastic alternative for almost every conventional plastic material and corresponding application. Bioplastics – plastics that are bio-based, biodegradable, or both – have the same properties as conventional plastics and offer additional advantages, such as a reduced carbon footprint or additional waste management options such as composting. Bioplastics are an essential part of the bio-economy and a fast-growing, innovative industry that has the potential to decouple economic growth from resource depletion and environmental impact. Bioplastics are a diverse family of materials with differing properties.*

Some amongst the big detergent producers have publicly announced even more challenging deadlines proposing respectively 2020 and 2022 to phase out the use of microplastics in opacifiers and microencapsulated fragrances, products for which other big producers are opposing their inclusion in the ECHA proposal[12].

Several SMEs have developed alternatives which have a.o. been mentioned in the ECHA Conference Presentation in May 2019[13], also visible in a video format[14].

We take it for granted that a consequent ECHA proposal could act as a general incentive to big producers to speed up developments and implementations.

See Appendices C and D for the Signatories and Sympathisers of this Proposal.

11 *https://en.wikipedia.org/wiki/Green_chemistry*
12 https://www.henkel.com/sustainability/positions/microplastics
13 https://echa.europa.eu/-/safer-chemicals-2019
14 https://www.youtube.com/watch?v=XmDS75a82yg&feature=youtu.be&t=13221

APPENDICES

A Further ECHA Definition Proposals:

- *'microbead' means a microplastic used in a mixture as an abrasive i.e. to exfoliate, polish or clean.*
- *'polymer' means a substance within the meaning of Article 3(5) of Regulation (EC) No 1907/2006 (REACH).*
- *'particle' is a minute piece of matter with defined physical boundaries; a defined physical boundary is an interface.*
- *'polymer-containing particle' means either (i) a particle of any composition with a continuous polymer surface coating of any thickness or (ii) a particle of any composition with a polymer content of ≥ 1% w/w.*
- *'solid' means a substance or a mixture which does not meet the definitions of liquid or gas. 21*
- *'gas' means a substance which (i) at 50°C has a vapour pressure greater than 300 kPa (absolute); or (ii) is completely gaseous at 20°C at a standard pressure of 101.3 kPa.*
- *'liquid' means a substance or mixture which (i) at 50°C has a vapour pressure of not more than 300 kPa (3 bar); (ii) is not completely gaseous at 20°C and at a standard pressure of 101.3 kPa; and (iii) which has a melting point or initial melting point of 20°C or less at a standard pressure of 101.3 kPa.*

B Green Chemistry Principles

1. **Prevention**. Preventing waste is better than treating or cleaning up waste after it is created.
2. **Atom economy**. Synthetic methods should try to maximize the incorporation of all materials used in the process into the final product.This means that less waste will be generated as a result.
3. **Less hazardous chemical syntheses**. Synthetic methods should avoid using or generating substances toxic to humans and/or the environment.
4. **Designing safer chemicals**. Chemical products should be designed to achieve their desired function while being as non-toxic as possible.
5. **Safer solvents and auxiliaries**. Auxiliary substances should be avoided wherever possible, and as non-hazardous as possible when they must be used.
6. **Design for energy efficiency**. Energy requirements should be minimized, and processes should be conducted at ambient temperature and pressure whenever possible.
7. **Use of renewable feedstocks**. Whenever it is practical to do so, renewable feedstocks or raw materials are preferable to non-renewable ones.
8. **Reduce derivatives**. Unnecessary generation of derivatives—such as the use of protecting groups —should be minimized or avoided if possible; such steps require additional reagents and may generate additional waste.
9. **Catalysis**. Catalytic reagents that can be used in small quantities to repeat a reaction are superior to stoichiometric reagents (ones that are consumed in a reaction).
10. **Design for degradation**. Chemical products should be designed so that they do not pollute the environment; when their function is complete, they should break down into non-harmful products.
11. **Real-time analysis for pollution prevention**. Analytical methodologies need to be further developed to permit real-time, in-process monitoring and control before hazardous substances form.
12. **Inherently safer chemistry for accident prevention**. Whenever possible, the substances in a process, and the forms of those substances, should be chosen to minimize risks such as explosions, fires, and accidental releases.

C List of Signatories

The Signatories below, acting on their moral and/or technical authority, underwrite the Microplastics Solutions Participants Proposal as formulated in the above document and urge the ECHA to adapt their proposal concerning the biodegradation of microplastics in this spirit:

D List of Sympathisers

The Sympathisers mentioned below sustain the ideas which are formulated in the Microplastics Solutions Participants Proposal concerning the biodegradation of microplastics as detailed in the above document: