POSITION-PAPER ON MICROPLASTICS

From Polyethylene (PE) and Polypropylene (PP)

Making Plastic Smarter

Symphony environmental

30 YEARS

Plastic pollution and in particular microplastics are seen today as the main problem with plastics. These are being found on land, in the sea, and even in the air we breathe and the water we drink.

Fortunately, a technology is now available to deal with this problem.

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Executive Summary

Plastic pollution and in particular microplastics are seen today as the main problem with plastics. They are being found on land, in the sea, and even in the air we breathe and the water we drink. They are caused by the fragmentation of ordinary plastic when exposed to weathering.

Ordinary plastic products persist in the environment, getting smaller and smaller until they are small enough to get into our bodies. This is because their molecular weight is too high to permit biodegradation. The purpose of d_2w technology is to reduce it.

If the plastic is upgraded with d_2w it will not just break up into smaller pieces. The molecular chains within the polymer will be dismantled, and it will no longer be a plastic. The resulting material **will safely biodegrade, and will not persist in the ecosystem.**

The technology has been extensively studied over many years, including studies by Intertek, the **European Chemicals Agency** (ECHA), the **American National Standards Institute** (ANSI), **Lambton Manufacturing Innovation Centre** in Canada, **Jordi Labs** in the United States **CIQA in Mexico**, and the **Federal Institute of Education, Science and Technology** in Brazil.

The **OXOMAR project**, sponsored by the French government, demonstrates that this type of plastic biodegrades efficiently in seawater.

d_2w products when tested to ASTM D6954 have demonstrated that the molecular weight of the plastic irrevocably reduces as oxygen atoms attach during the degradation process.

This Standard provides a method for exposing and testing plastics that degrade in the environment by a combination of oxidation and biodegradation. The reduction in molecular weight is a critical factor that enables the plastic to become biodegradable.

The Global Issue

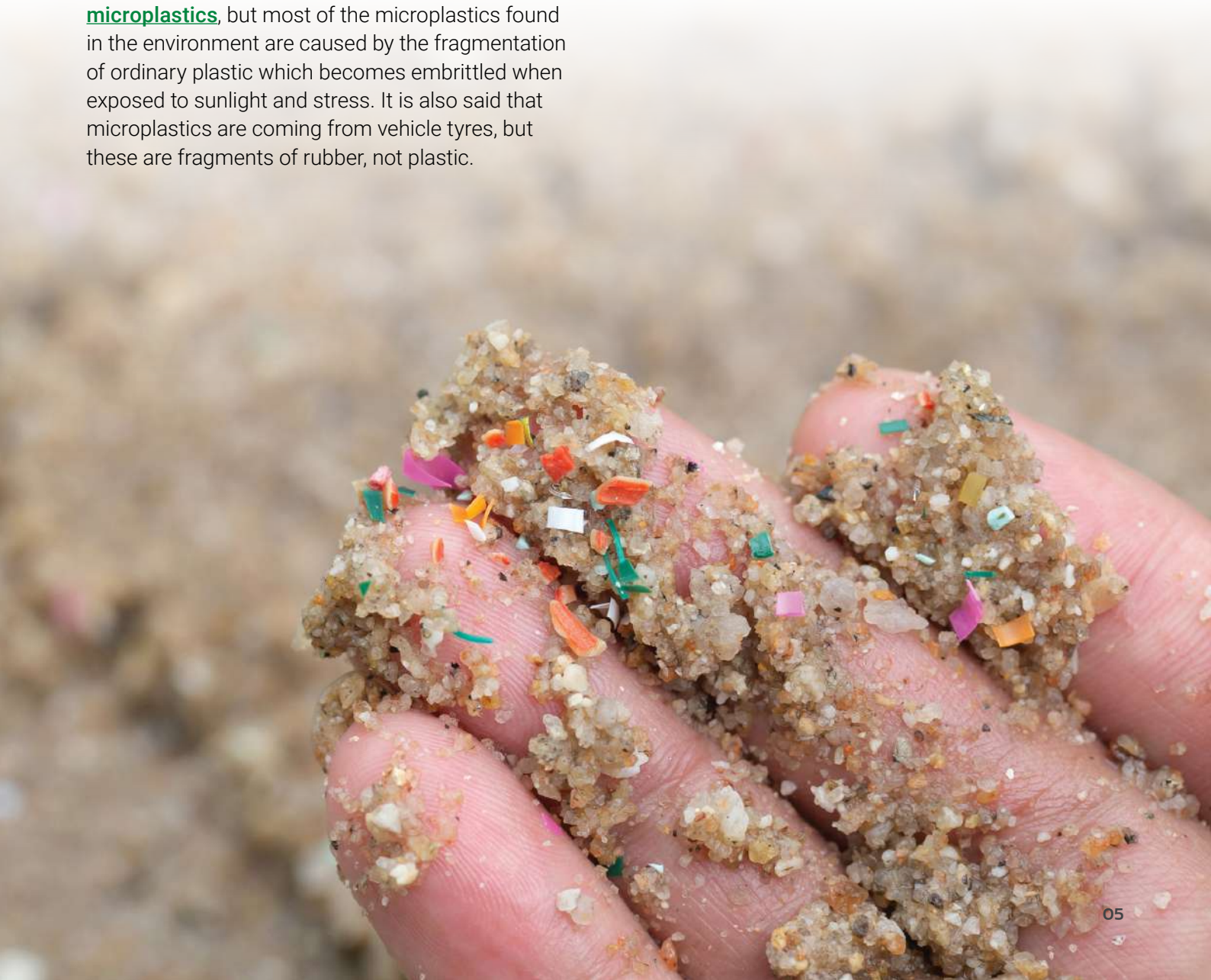
Traditional policies of "Reduce, re-use and recycle" are not sufficient. Waste management in Switzerland is among the most efficient in the world, but the **Swiss Federal Office for the Environment** says:

"Plastics have no place in the environment. Nevertheless, around 14,000 tonnes of plastics end up in Switzerland's soil and waters every year – primarily due to the abrasion and decomposition of plastic products and improper disposal of plastic waste. Plastics then accumulate in the environment because they degrade very slowly."

Some of the microplastics are coming from man-made fibres, and **recycling can be a source of microplastics. Composting can also be a source of microplastics**, but most of the microplastics found in the environment are caused by the fragmentation of ordinary plastic which becomes embrittled when exposed to sunlight and stress. It is also said that microplastics are coming from vehicle tyres, but these are fragments of rubber, not plastic.

Waste-management and education must of course be improved, but for the foreseeable future some way must be found to deal with plastic which has escaped into the environment and cannot realistically be collected for inclusion in a circular economy.

This is the reason why d_2w plastic was invented. It is used in a wide variety of bottles, packaging, and other products made from polyethylene (PE) or polypropylene (PP), which are among the products most likely to be littered. It is **also very useful in agriculture**.



Plastics have no place in the environment

Nevertheless, around 14,000 tonnes of plastics end up in Switzerland's soil and waters every year – primarily due to the abrasion and decomposition of plastic products and improper disposal of plastic waste. Plastics then accumulate in the environment because they degrade very slowly.

The Global Issue (continued)

d_2w plastic is NOT designed to end up in nature, but it is the only way to prevent plastic which gets into the open environment from accumulating there for decades. It is designed to be used and disposed of in the same way as ordinary plastic, so there is no need to label the product as biodegradable. It is designed to biodegrade only if at the end of its useful life it escapes into the open environment deliberately or by accident. **It can however be recycled if collected during its useful life.**

Ordinary plastic and d_2w plastic lose their tensile strength and fall apart at about the same time when exposed to sunlight, depending on their age and degree of stabilisation, but the fragments of ordinary plastic have a molecular weight which is much too high for biodegradation.

d_2w technology was invented fifty years ago, not by marketeers or salesmen, but by the scientists who had themselves created plastics, and who realised that the durability which they had achieved could be a problem.

Foremost among these scientists was Professor Gerald Scott, Professor of Chemistry at Aston University. He was the holder of several patents for the technology and was later the Chief Scientific Adviser to the Biodegradable Plastics Association (BPA) and to Symphony Environmental Technologies Plc. He published the results of his work in many scientific publications including "Polymers & the Environment" (ISBN 9780854045785); "Degradable Polymers; Principles & Applications" (ISBN 1-4020-0790-6); and **"Programmed-Life Plastics from Polyolefins: A New Look at Sustainability"**

Professor Scott and the other polymer scientists made it clear in their published work that PE and PP made with the masterbatch which they had formulated will degrade and then biodegrade in the open environment very much more quickly than ordinary PE or PP, leaving no persistent fragments and no toxicity.

If their invention had been widely adopted there would be no ocean garbage patches today, but instead the plastics industry chose to continue to make conventional plastic products, which started to create microplastics and accumulate in the oceans. This has now become a serious problem. Nevertheless, it is not too late – If d_2w is widely adopted today the accumulation of plastic in the oceans will start to reduce immediately, and will eventually be reversed.

Standards

Polymer scientists were also the authors of ASTM D6954 and BS 8472 the standards for plastics which biodegrade in the open environment by a combination of oxidation and microbial activity. See the **evidence of one of the authors of ASTM D6954** to the UK Government. He explains why it contains a caveat recognising that laboratory environments are isolated, unlike the dynamic natural environment - in which degradation and therefore biodegradation is likely to proceed more quickly.

By contrast, ASTM D6400 and EN13432 are designed for biodegradation in the special conditions found in a composting facility and are not therefore relevant to biodegradation in the open environment. Those Standards do not require testing of compostable plastic in a compost heap and ASTM D6954 does not require testing for biodegradation in a field or in the ocean, which would be impossible because the degraded material would be lost and the carbon-evolution could not be measured.

In both cases the plastics are tested in a laboratory according to standards designed by scientists to replicate the conditions in which they are intended to biodegrade. All of these standards also require eco-toxicity testing to ensure that they will be safe in the environment.

Definitions

What is a microplastic?

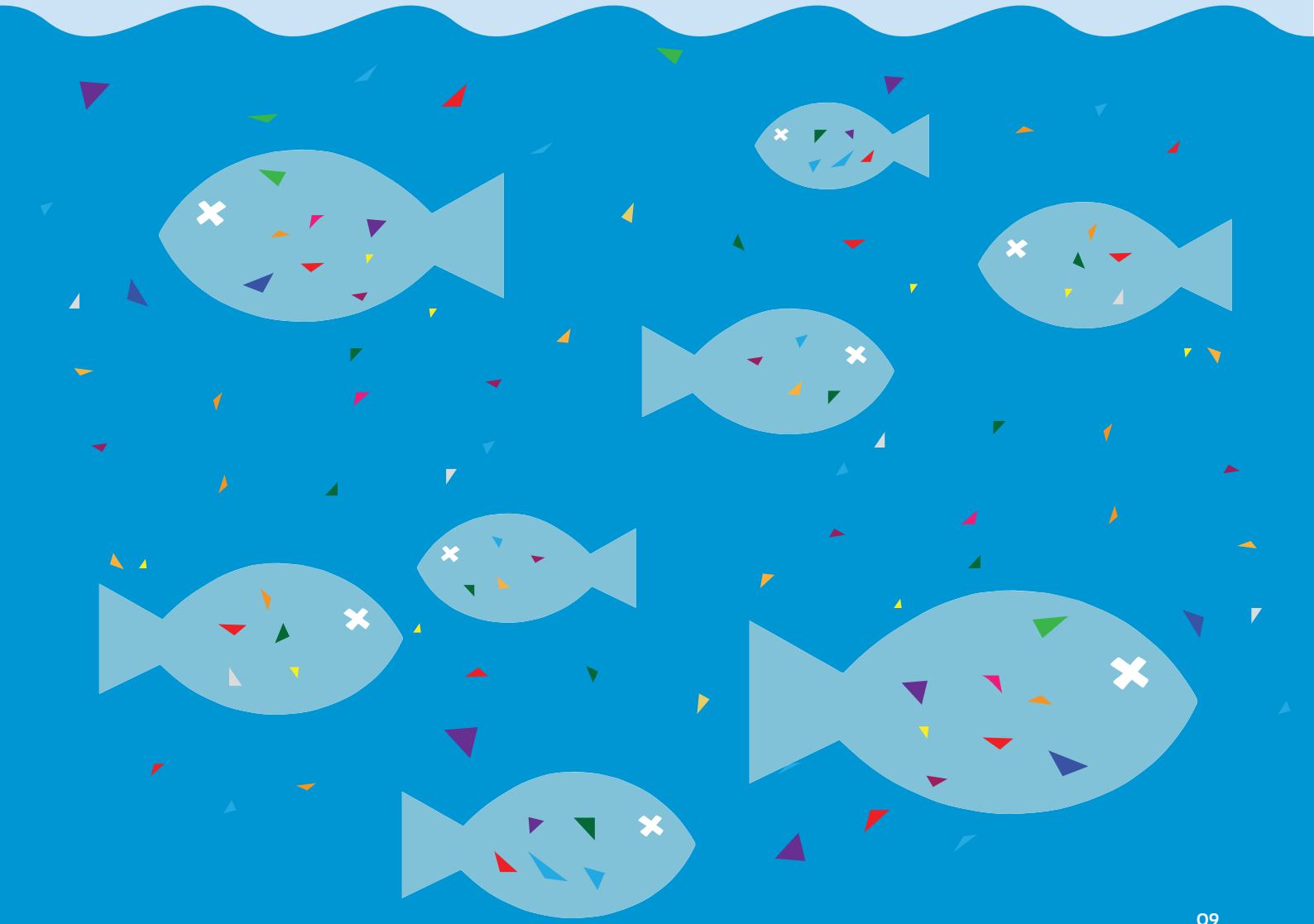
The key point is that a fragment is not a microplastic if it is biodegradable and therefore not persistent.

The **Annex XV restriction report** by the European Chemicals Agency says at page 7 "The term 'microplastic' is not consistency defined, but is typically considered to refer to small, usually microscopic, solid particles made of a synthetic polymer. They are associated with long-term *persistence in the environment,* if released, as they are very resistant to (bio)degradation.

At page 13 "Microplastics are extremely *persistent in the environment*, are difficult to remove once they are there.

This view is supported by the report by the Netherlands National Institute for Public Health and the Environment **"Towards a definition of microplastics** - Considerations for the specification of physico-chemical properties" which says (p11) The presence of plastics in the environment is of great concern because *plastics are persistent*

"From the perspective of the marine environment, microplastics that disappear quickly by natural processes (e.g. biodegradation to harmless degradation products), or microplastics that never reach the aquatic environment *are not of concern.*"



Definitions (continued)

Oxo-biodegradable plastic should **not be confused with the type of** plastic marketed as "compostable," which is tested according to ASTM D6400 and EN13432 to biodegrade in an industrial composting facility.

It is also important **not to confuse oxo-degradation and oxo-biodegradation**. "Oxo-degradation" is defined by CEN (the European Standards authority) in TR15351 as "degradation resulting from oxidative cleavage of macromolecules." This describes ordinary PE and PP (which does not contain an intentionally-added prodegradant catalyst). It will abiotically degrade by oxidation in the open environment and create microplastics but does not become biodegradable except over a very long period of time, because its molecular weight is too high. Nobody puts a prodegradant additive into a polymer and markets it as "oxo-degradable."

By contrast, **"oxo-biodegradation is defined by CEN** (TR15351) as "degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively". This means that PE and PP (which does contain a prodegradant catalyst) degrades rapidly by oxidation until its molecular weight is low enough to be accessible to bacteria and fungi, who then recycle it back into nature.

It is not possible to say exactly how long the plastic will take to degrade and then biodegrade in the open environment, because timescale depends on how much heat and sunlight it receives and, on the formulation used and other components of the plastic such as antioxidants. It is however clear that it will be many times faster than exactly the same type of plastic without a prodegradant masterbatch when exposed under the same conditions in the open environment. Queen Mary University say (at para. 2.3) **up to 90 times faster.**

There is however no need for it to biodegrade within the 180 days required by the industrial composters for plastic intended to biodegrade in composting. In fact, once it has abiotically degraded and is no longer a plastic, the length of time for biodegradation is not important.

Oxo-biodegradable plastics consist of conventional PE or PP with a masterbatch added usually @1%, which itself contains a salt of manganese or iron, antioxidant stabilisers, and a polymer carrier. It does not contain starch, because although the starch would biodegrade, the polymer would simply fragment into microplastics, and it was this which gave early formulations a bad reputation. Today's masterbatches, such as Symphony's d_2w, accelerate oxidation so that the molecular chains within the polymer are rapidly dismantled. The material is then no longer a plastic – it is hydrophilic and biodegradable.

Definitions (continued)

Exposure to weathering in the environment causes the degradation of ordinary PE and PP products, leading to embrittlement and fragmentation in as little as 4-8 weeks particularly when exposed to sunlight. They will float on water because their specific gravity is less than 1.

Although ordinary plastic and oxo-biodegradable plastic lose their strength and fall apart when exposed in the open environment, the fragments of ordinary plastic have a molecular weight which is much too high for biodegradation. In the case of oxo-biodegradable plastics, Professor Ignacy Jakubowicz, one of the world's leading polymer scientists **has explained**: "The degradation process is not only a fragmentation, but is an entire change of the material from a high molecular weight polymer, to monomeric and oligomeric fragments, and from hydrocarbon molecules to oxygen-containing molecules which can be bioassimilated."

The prodegradant catalyst in the d_2w masterbatch not only accelerates oxidative degradation, but also – critically – removes the dependence of this process on sunlight so that, unlike conventional plastics or photo-degradable plastics, degradation will continue in darkness – even if buried - until biodegradability is achieved. Moisture is not necessary for oxidation and does not prevent it.

In summary it is clear that if PE and PP products are made with an oxo-biodegradable masterbatch and get into the open environment intentionally or by accident, the molecular-weight of the plastic will reduce much more quickly and it will become a waxy substance which is no longer a plastic. It will then have become a source of nutrition for naturally occurring micro-organisms.

"The degradation process is not only a fragmentation, but is an entire change of the material from a high molecular weight polymer, to monomeric and oligomeric fragments, and from hydrocarbon molecules to oxygen-containing molecules which can be bioassimilated."

Independent Verification

The **European Chemicals Agency** were asked to study this type of plastic in December 2017. They made a Call for Evidence, and they advised the BPA on 30th October 2018 that they were not convinced that it creates microplastics. There is no report from ECHA because the Commission terminated the study when it became apparent that ECHA were not going to agree with them about microplastics. There is no evidence that microplastics from this type of plastic have ever been found in the environment.

An article published in March 2024 by the American National Standards Institute (ANSI) states: **"Using oxo-biodegradable technology can prevent future contributions to the accumulation of plastic waste that has escaped into the environment. Oxo-biodegradable plastic serves as a solution to littered plastic because it is recyclable and will degrade without releasing methane."**

ANSI continues "It is **important to note that oxo-biodegradable plastic** is not the same as oxo-degradable plastic. Oxo-degradable plastic [i.e. conventional plastic] does not biodegrade but breaks into microplastics which are then released into the environment and cause significant harm, especially to ocean life. They quickly fragment into smaller and smaller pieces (i.e., microplastics) that do not break down at the molecular or polymer level like biodegradable and compostable plastics. The resulting microplastics are left in the environment indefinitely until they fully break down over a very long period of time."

"By contrast, oxo-biodegradation means degradation resulting from oxidative and cell-mediated phenomena, either simultaneously or successively [CEN/TR15351]. The plastic degrades by oxidation until its molecular weight is low enough to be accessible to bacteria and fungi, who then recycle it back into nature. These plastics are tested for degradation, biodegradation, and ecotoxicity according to ASTM D6954-24."

Independent Verification

In 2025 Intertek carried out a detailed assessment of samples of polyethylene (PE) and polypropylene (PP) which had been tested by them according to ASTM D6954.

The samples had been exposed to photodegradation (Tier 1), during which their molecular weights reduced to below 5,000 Daltons (2,200 for PE and 4,900 for PP) These photo-oxidised samples were then exposed to biodegradation under controlled composting conditions (Tier 2) resulting in 94.55% biodegradation in the case of PE and 92.76% biodegradation in the case of PP.

Results of the chemical and residue analysis conducted on the 50 grams of biomass which remained after completion of ASTM D6954 testing, revealed the presence of one and two oxidised particles resembling PE and PP respectively. These findings may indicate incomplete mineralisation or they could have been low-molecular-weight oligomers formed during the degradation process that no longer retain the physical characteristics of conventional plastics. A polymer material with a molecular weight of less than 5,000 Daltons has typically lost its tensile strength and barrier properties, it is also hydrophilic and biodegradable and therefore not persistent.

This testing shows that plastics upgraded with d_2w technology are very useful for reducing microplastics and reducing the prevalence and accumulation of plastics in the environment.

On 4th September 2020 scientists at the Laboratoire d'Océanographie Microbienne (LOMIC) **reported on a four-year study (the OXOMAR project) sponsored by the French government,** of biodegradable plastics in the marine environment.

The purpose of OXOMAR was to investigate whether biodegradable plastics will fully biodegrade in a reasonable time in the marine environment, and to investigate whether biodegradable plastic or its by-products create any toxicity in the marine environment. It involved the complementary expertise of four independent laboratories (CNEP, LOMIC, ICCF, and IFREMER), and based on six published papers cited at C7.

They reported (at C6) "We have obtained congruent results from our multidisciplinary approach that **clearly shows that Oxo-biodegradable plastics biodegrade in seawater and do so with a significantly higher efficiency than conventional plastics.** The oxidation level obtained due to the d_2w prodegradant catalyst was found to be of crucial importance in the degradation process."

Further evidence of Biodegradation

In 2018 the scientific evidence was ***reviewed by a distinguished former deputy judge of the High Court in England.***

This has been confirmed by later research ***published by Queen Mary University London in February 2020***.

See also the ***evidence given by scientists in response to the Call-for-evidence by the European Chemicals Agency;*** and ***the evidence given by Intertek***

Policies & Legislation

Many governments are committed to a "circular economy" but no government in the western world has a policy for dealing with plastic waste which has escaped into the open environment and cannot therefore fit into a circular economy. Their blind spot is that despite their best efforts a significant amount of plastic continues to get into the open environment and create microplastics, and it cannot realistically be collected for recycling or anything else.

D_2w biodegradable technology is specifically designed to deal with this problem, and it is now compulsory in the UAE, Saudi Arabia, Jordan, **Yemen**, and Bahrain. The EU has moved in the opposite direction, to the great disbenefit of the European environment. See **https://www.biodeg.org/eu-news/**

The plastics industry could have addressed this environmental problem, to the great benefit of themselves and the environment, but instead of engaging with the experts in the biodegradable plastics industry and seeking to understand it better and to explain it to their customers and to the public, most of them have continued to make conventional PE and PP products and to maintain that recycling will solve the problem.

It must be obvious that recycling cannot deal with the plastic which escapes into the open environment from which it cannot be collected. Nor can the type of plastic marketed as compostable deal with the problem, for it has to be collected and taken for composting. In fact, **it is difficult to see that there is any useful role for plastics in composting at all.**

Endorsements of this Paper

This paper has been reviewed by **Jordi Labs in the United States**, who say: *"We reviewed the document and consider it scientifically sound."* Jordi Labs specialize in polymer analysis and have more than 40 years' experience performing regulatory, quality control and failure testing. They are one of the few labs in the United States specialized in this type of testing.

This paper has also been reviewed by Professor Telmo Ojeda, of the **Instituto Federal Rio Grande do Sul** in Brazil who says *"All the propositions in the document are sufficiently supported by scientific evidence."*

It has also been endorsed by Eng. Fernando Eovídio da Rosa Figueiredo - Court expert in environmental science for the Court of Justice of the State of São Paulo since 2023. He says *"I endorse all the points addressed in the document."*

The Paper has also been endorsed by the FUNVERDE INSTITUTE, an environmental NGO who say *"This document presents a solid analysis based on scientific evidence regarding the issue of microplastics and proposes oxo-biodegradable technology as a viable solution to mitigate the accumulation of plastics in the open environment. We recognize that recycling, while essential, is insufficient to address plastic waste that escapes management systems—a problem that threatens terrestrial and aquatic ecosystems, including those we protect through our work in Brazil. The oxo-biodegradable approach, by transforming PE and PP into biodegradable materials in natural environments, aligns with our mission to promote sustainability and protect biodiversity, complementing our initiatives for waste reduction and environmental education."*

In September 2024 scientists at **Lambton Manufacturing Innovation Centre** in Ontario, Canada verified this paper. They concluded that oxo-degradable plastics (i.e. ordinary plastics) create microplastics, but oxo-biodegradable plastics do not.


Ciencia y Tecnología

Centro de Investigación en Química Aplicada
Dr. Ricardo López/Dr. Ruben Saldivar/Dr. Enrique Saldivar
Subject: Microplastics
Saltillo Coahuila, México, May 9th 2025

To: **Symphony Environmental Technologies**

CENTRO DE INVESTIGACIÓN EN QUÍMICA APLICADA (CIQA), based on the evidence and arguments discussed, agrees with the next:

- Recycling is useful, but cannot deal with plastic which escapes into the open environment from which it cannot realistically be collected under the present policies and common practices in industry and society.
- PE and PP are commonly used for packaging and will fragment and create microplastics after exposure to UV light and weathering.
- The fragments and microplastics of these polymers are persistent because they are not biodegradable.
- PE and PP film products will biodegrade if made with a d2w/PE masterbatch, and tested to international Standard ASTM 6954, and therefore could significantly reduce the accumulation of LDPE in the open environment.
- Oxo-degradable and Oxo-biodegradable plastics are not the same, and are defined by CEN in TR15351.
- Oxo-biodegradable plastic is not the same as the type of plastic marketed as "compostable," and is not intended for composting.

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2025 La Mujer Indígena

Letter of endorsement from Mexico

Making Plastic Smarter
Symphony environmental 30 YEARS

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