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**REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND  
THE COUNCIL**

**on the impact of the use of oxo-degradable plastic, including oxo-degradable plastic  
carrier bags, on the environment**

## 1. INTRODUCTION

On 29 April 2015 the European Parliament and the Council adopted Directive (EU) 2015/720<sup>1</sup> amending Directive 94/62/EC<sup>2</sup> as regards reducing the consumption of lightweight plastic carrier bags.

The main objective of this Directive is to reduce the consumption of lightweight plastic carrier bags, thereby reducing the littering of these bags and their accumulation in the environment, where they aggravate the widespread problem of plastic waste in the environment and in particular marine pollution.

Article 20a (2) of the Packaging Directive tasks the Commission to present a report to the European Parliament and to the Council examining the impact of the use of oxo-degradable plastic carrier bags on the environment and, if appropriate, present a legislative proposal.

The purpose of the current report is to inform the European Parliament and the Council of the Commission's follow-up to the mandate.

The Commission examined the impact of so-called oxo-degradable plastic on the environment beyond plastic carrier bags and underpinned its assessment by a study published in April 2017<sup>3</sup>, addressing the following three key issues:

- the biodegradability of oxo-degradable plastic in various environments,
- environmental impacts in relation to littering, and
- issues related to recycling.

Within these areas, a number of distinct hypotheses were defined, relating to claims and assumptions from the oxo-degradable industry about the material. On the basis of evidence gathered with respect to the hypotheses, these were analysed to ascertain whether they can be supported or refuted.

The study is based on an appraisal of literature, including scientific reports, and information from stakeholders and technical experts.

## 2. BIODEGRADATION, COMPOSTING AND OXO-DEGRADATION

For a good understanding of the issues discussed it is necessary to define and explain the processes of biodegradation, composting and oxo-degradation.

'Biodegradation' is a process by which material disintegrates and is decomposed by micro-organisms into elements that are found in nature, such as CO<sub>2</sub>, water and biomass. Biodegradation can occur in an oxygen rich environment (aerobic biodegradation) or in an oxygen poor environment (anaerobic biodegradation).

'Composting' is enhanced biodegradation under managed conditions, predominantly characterised by forced aeration and natural heat production resulting from the biological

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<sup>1</sup> Directive (EU) 2015/720. OJ L 115 of 6.05.2015, p. 11

<sup>2</sup> Directive 94/62/EC of 20 December 1994 on packaging and packaging waste. OJ L 365 of 31.12.1994, p. 10

<sup>3</sup> Final report of the study on the impact of the use of "oxo-degradable" plastic on the environment available on the Commission's webpage: <https://publications.europa.eu/en/publication-detail/-/publication/bb3ec82e-9a9f-11e6-9bca-01aa75ed71a1/language-en/format-PDF/source-56357670>

activity taking place inside the material. The resulting output material, compost, contains valuable nutrients and may act as a soil improver.

In theory, almost all materials<sup>4</sup> ultimately may biodegrade, even in the open environment though some will do so only after sometimes hundreds of years or more. Looking at biodegradation of plastics as a means to avoid pollution hence only makes practical sense if this is linked to a “reasonable” time frame<sup>5</sup>. It should also be assessed taking into account specific conditions and/or environments, such as the marine environment, where biodegradation is particularly challenging.

Biopolymers biodegrade quickly, both under controlled conditions and in the open environment.

Biodegradation of materials resulting from artificial synthesis, such as conventional plastics, is theoretically possible when the material is broken down into small particles and the molecule mass of the material is sufficiently reduced to enable biodegradation. Factors such as light, humidity, oxygen and temperature determine the degradation rate. In the open environment it may take a long time, up to hundreds of years, for conventional plastics to biodegrade. Plastics marked as "biodegradable" only biodegrade under specific environmental conditions. Biodegradation does not depend on the resource basis of a material: biodegradable plastic (as conventional plastic) can be fossil-based or bio-based.<sup>6</sup>

So called oxo-plastics or oxo-degradable plastics are conventional plastics which include additives to accelerate the fragmentation of the material into very small pieces, triggered by UV radiation or heat exposure. Due to these additives, the plastic fragments over time into plastic particles, and finally microplastics, with similar properties to microplastics originating from the fragmentation of conventional plastics.

This accelerated fragmentation would also accelerate biodegradation. Some stakeholders present “oxo-biodegradation” as the solution to environmental impacts of plastic in the open environment. They claim that even when littered, oxo-degradable plastic fragments and biodegrades in the open environment without leaving any toxic residues or plastic fragments behind.

The question is however whether in uncontrolled conditions in the open environment, in landfills or in the marine environment, the plastic fragments will undergo full biodegradation within a reasonable time-frame. If this is not the case, oxo-degradable plastic will contribute to the microplastics release in the (marine) environment while misleading consumers. As recent research shows, microplastics released in the marine environment get into the food chain and end up being consumed by humans.

There is also a question of whether the claimed biodegradation of oxo-degradable plastics may impact on consumers’ littering behaviour.

Furthermore, questions relating to the recycling process arise, as the inherent and even programmed fragmentation through oxidising agents in the plastic waste streams may have a negative impact on plastic recycling.

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<sup>4</sup> These include materials resulting from artificial synthesis processes (e.g. plastics) and those resulting from natural synthesis processes (“biopolymers”, such as cellulose and proteins), excluding rocks and metals.

<sup>5</sup> Defining a ‘reasonable’ time frame might differ from product to product depending also on the use of the product and its impact on the environment; the environmental impact is correlated with the time taken for complete breakdown of the polymer.

<sup>6</sup> Bio-based plastics have the same properties as conventional plastics but are derived from biomass, as defined in European Standard EN 16575.

### **3. ISSUES RELATING TO BIODEGRADABILITY OF OXO-DEGRADABLE PLASTIC, INCLUDING PLASTIC CARRIER BAGS**

#### **3.1 Fragmentation and biodegradation in the open environment**

A considerable number of studies have demonstrated that oxo-degradable plastic in the open environment, when exposed to heat and/or UV light for an extended period, indeed oxidises to the point where the plastic becomes brittle and fragments<sup>7</sup>.

This first stage of degradation prepares the oxo-degradable plastic for biodegradation by reducing the molecular weight of the plastic to the point where it may be consumed by biological organisms<sup>8</sup>.

While oxidising additives will, in an open environment, accelerate fragmentation of traditional polymers, the pace of fragmentation varies significantly depending on conditions determined by temperature, light intensity and moisture. It is clear that oxo-degradable plastic is prohibited from degradation if not first exposed to UV radiation and, to a certain extent, heat. As these conditions vary from day to day and according to local conditions, it is very difficult, if not impossible, to specify timescales in which e.g. an oxo-degradable plastic carrier bag will fragment in the open environment. There is therefore no conclusive evidence of a degree of fragmentation resulting in a sufficiently low molecular weight of the plastic that may enable a possible biodegradation.

A major issue for oxo-degradable plastic is the trade-off between the intended service life and the period that might be needed for degradation in the open environment. Even if biodegradation may be facilitated by careful engineering of the chemical package, evidence is not available to definitely conclude that this will happen in real world situations. If the circumstances for fragmentation to take place are absent or insufficient, biodegradation will not take place<sup>9</sup>.

#### **3.2 Composting**

Composting requires material not only to biodegrade, but to also become part of usable compost and provide the soil with nutrients. The evidence suggests that oxo-degradable plastic is not suitable for any form of composting or anaerobic digestion and will not meet the current standards for packaging recoverable through composting in the EU<sup>10</sup>. Remaining plastic fragments and potentially generated microplastics might adversely affect the quality of the compost.

#### **3.3 Fragmentation and biodegradation in landfills**

The fragmentation of oxo-degradable plastic requires oxygen. In most parts of a landfill, especially the inner parts, little oxygen is present. Evidence to date suggests that in the deeper layers of landfill (where the material has no access to a sufficient amount of air and only anaerobic degradation is possible) there is little or no

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<sup>7</sup> Final report, *supra* footnote 3, Table 3, p.21

<sup>8</sup> DEFRA: *Review of standards for biodegradable plastic carrier bags*, December 2015, review of evidence from Loughborough University, cited in Final report, *supra* footnote 3, p.16

<sup>9</sup> Final report, *supra* footnote 3, Executive summary, E.1.1, ii

<sup>10</sup> Final report, *supra* footnote 3, 4.1.2.1. p.31

biodegradation of oxo-degradable plastic. In the outer layers of a landfill, where the material has access to air, aerobic degradation is possible.

The key distinction from an environmental protection point of view is that aerobic degradation produces CO<sub>2</sub> whereas anaerobic degradation produces methane, which is a greenhouse gas 25 times more harmful (on a 100 years' time horizon) than CO<sub>2</sub>.

Consequently, if some biodegradation were to take place in the deeper layers of a landfill, oxo-degradable plastic would be marginally worse than conventional plastic from a greenhouse gas point of view, because conventional plastic does not biodegrade in these conditions.

### **3.4 Fragmentation and biodegradation in the marine environment**

There is currently insufficient evidence to provide assurance that oxo-degradable plastic, including plastic carrier bags, will biodegrade in the marine environment within reasonable time.

Few tests have been conducted, and currently no recognized standards exist that could serve as benchmark and allow a certification.

Even if assuming that oxo-degradable plastic may fragment in the marine environment to a level where biodegradation may be possible, any biodegradation in the marine environment is expected to be much slower than in land based open environments, due to the lower concentrations of oxygen and bacteria present. Furthermore, before a plastic carrier bag fragments, the damage caused to marine ecosystem marine fauna (e.g. turtles, seabirds or whales) can be substantial.

There is no conclusive evidence about the time needed for oxo-degradable plastic to fragment in marine environments, neither about the degree of fragmentation. Moreover as for any other plastic ending up in the marine environment, there is the risk that plastic fragments remain for a very long period in that environment and cause significant environmental damage and potential negative health impacts.

### **3.5 Conclusions on biodegradation and composting of oxo-degradable plastic, including plastic carrier bags, in uncontrolled conditions in different environments**

There is general agreement amongst both the scientific community and industry that in open environments oxidising additives will accelerate the fragmentation of traditional polymers.

However, for none of these environments a full biodegradation process has been documented. Most experiments were carried out over a too short time span to demonstrate full biodegradation and the results of measurements of molecular weight reduction in the initial stage of fragmentation were extrapolated following certain models. Therefore, no conclusive evidence is currently available to confirm that the fragmentation is sufficiently rapid and leads to a reduced molecular weight that allows subsequent biodegradation taking place within a reasonable time-frame.

The evidence also suggests that oxo-degradable plastic is not suitable for any form of composting or anaerobic digestion.

## **4. ISSUES RELATED TO LITTERING**

### **4.1 Potential toxic effects of the oxidising additives**

Potential toxic effects on soils of residual additives from oxo-degradable plastics have been identified as a concern.<sup>11</sup>

Conclusions valid for all oxidising additives used can however not be drawn, because different oxidising additives are used in different concentrations.

From the available evidence it appears that the oxo-degradable plastics industry can create products with minimal toxic impact on flora and fauna; however, it has not been conclusively proven that there are no negative effects.

A few test standards for oxo-degradable plastic specify some form of toxicity test, but these standards are not obligatory for products on the EU market; moreover, some of the standards describe checklists without defining pass/fail criteria for the toxicological test results.

In the absence of adequate standards in the EU, there is no guarantee that all oxo-degradable plastic on the market avoid negative toxic effects and uncertainty about real world toxicological impacts remains.

### **4.2 Potential increase in littering**

Even though no conclusive information is currently available on the disposal or littering of plastic according to the type of plastic, or on the influence of marketing oxo-degradable plastic on the disposal behaviour of consumers, presenting oxo-degradable plastic as the solution for plastic waste in the environment may influence littering behaviour by making it more likely that it is discarded inappropriately<sup>12</sup>. For specific oxo-degradable products such as agriculture mulches the littering issue is a given as those products are sold to farmers with the aim not to be collected after use (cf. take-back schemes for conventional plastics) but to be left on the land.

### **4.3 Marine litter**

The marine environment is where potentially most damage by plastic waste could arise, including fragmented plastic and microplastics; at the same time, subsequent collection or recovery of the plastic is least probable.

As oxo-degradable plastic is designed to fragment faster than conventional one it is less likely to be recovered during litter clean-up exercises, and likely to be more easily transported by wind and water. As these factors may contribute to oxo-degradable plastic being transported into the marine environment easier than conventional plastic it can be said that oxo-degradable plastic contributes to microplastics pollution and therefore poses environmental risks.

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<sup>11</sup> Even though not widespread, the use of cobalt has been observed by some studies and the possibility remains that producers can incorporate cobalt, or manganese, or other substances of concern, into their additives with no regulation on eco-toxicity to prevent this.  
Final report, *supra* footnote 3, p. 59-60

<sup>12</sup> See also, for the issue of littering behaviour and biodegradability, UNEP: *Biodegradable plastics and marine litter: misconceptions, concerns, and impacts on marine environments* (2015), p. 29

There is no conclusive evidence of full biodegradation in a reasonable time of oxo-degradable plastic in the marine environment.

There is also insufficient evidence to conclude whether oxo-degradable plastic would increase or decrease absolute quantities of plastic in marine environments. In the hypothesis that full biodegradation occurs on land, the quantity that may otherwise transfer to the marine environment would be reduced. However, full biodegradation on land is not proven to occur. Consequently, there is a risk that the fragmentation behaviour of oxo-degradable plastic exacerbates issues related to the presence of microplastics in the marine environment.

Furthermore, while rapid fragmentation may lead to less entanglement of animals in plastic, it at the same time increases physical ingestion of microplastics by marine animals.

As oxo-degradable plastic is likely to fragment quicker than conventional plastic, the negative impacts associated with the presence of microplastics in the marine environment are concentrated within a shorter period of time. This could ultimately be worse than spreading out the impacts over a longer period, due to an increase in the proportion of individuals, species and habitats affected, as well as the burden of impacts for an individual.

## **5. ISSUES RELATED TO THE RECYCLING PROCESS**

### **5.1 Identifying oxo-degradable plastic**

The inherent and programmed fragmentation as intended with the oxidising additives is not desirable for many products made of recycled plastic. Oxo-degradable plastic should therefore be identifiable and separated from other plastics collected for recycling.

Currently available technology can however not ensure identification and separate sorting of oxo-degradable plastic by re-processors. Consequently, recycling of oxo-degradable plastic will take place mixed with conventional plastic.

### **5.2 Quality issues and marketability of recyclates**

Significant concerns exist within the recycling industry that oxo-degradable plastic negatively affects the quality of recycled plastics. Tests have demonstrated that the presence of oxo-degradable plastic in a conventional plastic recycling system can lead to poor quality recyclate. Even though it also appears possible to produce high quality recyclate, there is no certainty about the absence of negative impact of the oxo-degradable plastic on the recyclate.<sup>13</sup>

Evidence suggests that the impacts of oxidising additives on recyclates can under certain circumstances be avoided with the inclusion of stabilisers. The appropriate quantity and chemistry of stabiliser would depend on the concentration and nature of the oxidising additives in the feedstock. However, as the concentration of oxo-degradable plastic in recyclate in real world situations is unknown, it is difficult to know the correct dosing of stabilisers.

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<sup>13</sup> Final report, *supra* footnote 3, p. 97-101

A major issue is furthermore that it is impossible to fully control the level of aging experienced by oxo-degradable plastics during the product use phase, prior to products becoming waste and entering recycling processes.

The existence of oxo-degradable plastic and the global nature of markets for secondary materials present risks to a more generalised use of recovered plastic in long-life products. The uncertainty of whether the recyclate may contain oxo-degradable plastic and of the degree of oxidation and degradation that might have occurred prior to recovery limits the end-use for the recyclate, having a negative impact on the price of the recyclate and on the competitive position of the plastic recycling industry.

## 6. CONCLUSIONS

Taking into consideration the key findings of the supporting study as well as other available reports<sup>14</sup>, there is no conclusive evidence on a number of important issues relating to beneficial effects of oxo-degradable plastic on the environment.

It is undisputed that oxo-degradable plastic, including plastic carrier bags, may degrade quicker in the open environment than conventional plastic. However, there is no evidence that oxo-degradable plastic will subsequently fully biodegrade in a reasonable time in the open environment, on landfills or in the marine environment. Sufficiently quick biodegradation is in particular not demonstrated for landfills and the marine environment.

A wide range of scientists, international and governmental institutions, testing laboratories, trade associations of plastics manufacturers, recyclers and other experts have therefore come to the conclusion that oxo-degradable plastics are not a solution for the environment and that oxo-degradable plastic is not suited for long-term use, recycling or composting.

There is a considerable risk that fragmented plastics will not fully biodegrade and a subsequent risk of an accelerated and accumulating amount of microplastics in the environment, especially the marine environment. The issue of microplastics is long acknowledged as a global problem in need of urgent action, not just in terms of clean-up of littering but also of plastic pollution prevention.

Claims presenting oxo-degradable plastic as an "oxo-biodegradable" solution to littering which has no negative impact on the environment, in particular by not leaving any fragments of plastic or toxic residues behind, are not substantiated by evidence.

In the absence of conclusive evidence of a beneficial effect on the environment and indeed indications to the contrary, given the related misleading claims to consumers and risks of resulting littering behaviour, EU wide measures should be considered. Therefore, in the

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<sup>14</sup> Cf. UNEP: *Biodegradable plastics and marine litter: misconceptions, concerns, and impacts on marine environments* (2015); OWS: *Benefits and challenges of oxo-biodegradable plastics* (2013); European Bioplastics: *'Oxo-biodegradable' plastics* (2009). European Bioplastics: *'Oxo-biodegradable' plastics and other plastics with additives for degradation* (2015); Ellen MacArthur Foundation: *The new Plastics Economy: rethinking the future of plastics* (2016); Ellen MacArthur Foundation: *The new Plastics Economy: oxo-degradable plastic packaging is not a solution to plastic pollution, and does not fit in a circular economy* (2017 – statement endorsed by over 150 organisations worldwide, including businesses and industry associations, non-governmental organisations and associations, public institutions, research organisations and scientists); EPA Network: *Recommendations towards the EU Plastics Strategy* (2017 - Discussion paper from the Interest Group Plastics of the European Network of the Heads of Environment Protection Agencies from Austria, Denmark, Finland, Iceland, Germany, Netherlands, Norway, Portugal, Romania, Scotland, Slovenia, Spain, and Switzerland)



context of the European plastics strategy, a process to restrict the use of oxo-plastics in the EU will be started.