Reply to Ellen MacArthur Foundation

Review of the position paper "Joint position against oxo- and photo-degradable additives in plastics"

I am sorry to let you know that your statement is not in line with my understanding or the science in this field.

Below, I will try to briefly explain how oxo-biodegradable materials work.

Synthetic and natural polymers are normally not biodegradable until they are degraded into low molecular mass species that can be assimilated by micro-organisms. This means that biodegradation must be preceded by a degradation process that gives low molecular weight degradation products.

Polyolefins are hydrophobic hydrocarbon polymers, which are very resistant to peroxidation and biodegradation as commercial products, mainly due to the presence of antioxidants and stabilisers. They are also resistant to hydrolysis and for this reason they cannot hydro-biodegrade. However, they can be made oxo-biodegradable by the use of pro-oxidant additives. Thus, the material degrades by a free radical chain reaction involving oxygen from the atmosphere. The primary products are hydroperoxides, which can either thermolyse or photolyse under the catalytic action of a pro-oxidant, leading to chain scission and the production of low molecular mass oxidation products such as carboxylic acids, alcohols, ketones and low molecular mass hydrocarbon waxes. Most of the oxidation products formed are very similar to those formed from bio-based materials such as lignocelluloses and can be scavenged by the microorganisms. For instance, lignin, a major constituent of natural products is also an oxo-biodegradable polymer similar in structure to the synthetic phenol-formaldehyde resins and is very stable due to the presence of the polyphenolic antioxidant functions in the polymer chain.

Oxo-biodegradable (OBD) plastics can be given variable user lifetimes, depending on the formulation where the balance of suitable pro-degradant system and stabiliser (antioxidant) is of crucial importance. In order to control both the lifetime of a degradable plastic during use as well as the rate of subsequent biodegradation in the environment, the onset of pro-oxidant activity must be controlled by appropriate antioxidants.

Below are my comments to your statements

OBD plastics only fragment within a few years...

This assertion is not correct. The degradation process is not only a fragmentation but it 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 bio-assimilated.

OBD plastics have not been proved to be suitable for long-term reuse applications

As mentioned in the introduction, oxo-biodegradable plastics can be given variable user lifetimes, but the purpose is of course to use them in applications where biodegradability is desirable.

OBD plastics add economic risk and operational challenges to the recycling process.

Consumption of the OBD materials is negligible compared to the total demand for plastics. In this context, the presence of small amounts of oxo-degradable materials will not have any significance for the quality of the recylates. This has been proven in one of our papers.

OBD are not suitable for composting

This statement is correct.

Closing remark

OBD materials are not a general solution to our environmental problems but they provide benefits for the environment in some specific applications. For instance, because of the ability to control the degradation, they have been used in agricultural and forestry products for over forty years. In the case of mulching films, they are designed to biodegrade after cropping. Plastic films scattered on or in soil are expensive to collect for mechanical recycling or composting but agronomists have welcomed the opportunity to plough them into the soil to biodegrade without the labour cost of collecting them from the fields and for transportation.

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