OXO-DEGRADABLE, COMPOSTABLE, BIODEGRADABLE, RECYCLING, ZUBIOX EXPLAINED ….

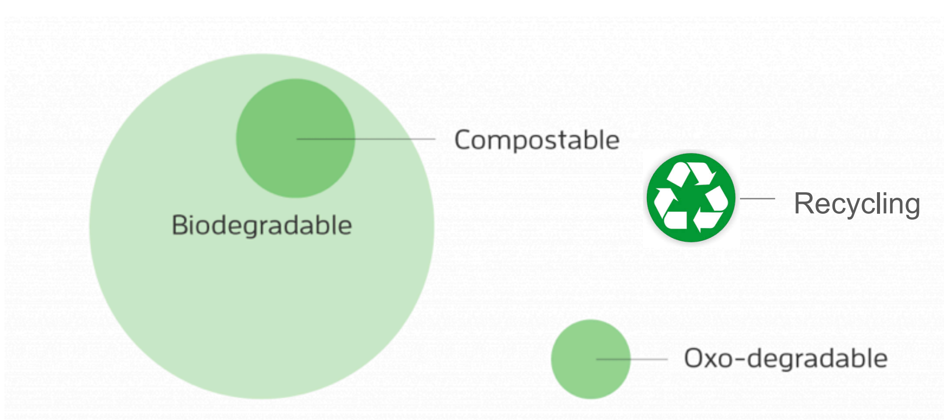
Polymers amazing abilities to protect, preserve, and provide food products to the consumer have the potential to become a serious environmental hazard through the traditional disposal methods of landfilling, recycling, and incineration. New landfill sites are not being developed quickly, and incineration can contribute to air pollution and global warming. Recycling is either not done or is still very limited in many countries around the world and can only be done on certain simple materials.

Since 1950 the world has produced 18 trillion pounds of plastic waste. This is the space of about 25,000 Empire State Buildings. More dramatic is the fact that 40% of this waste comes from packaging, only 9 % has been recycled, 12% incinerated and 79% remains in the landfills or in the environment as garbage.

As consumer demand for sustainable products grows, its important to understand the different possible solutions to handle disposal of plastic products.

A major source of confusion is the difference between three terms: Biodegradability, compostability, oxo-degradability and recyclability. Although these terms are often used interchangeably, they are not synonymous. Confusion regarding common terminology such as these, especially where it concerns the disposal of plastic products, can have dire consequences. Companies need to understand the distinctions between each category in order to accurately and honestly market their products. And consumers need to understand these terms in order to make educated purchasing decisions and properly dispose of products at the end of use.

Following you will find a brief description of each of these technologies.



OXO DEGRADABLE, OXO BIODEGRADABLE

These products are made from conventional plastics and supplemented with metal ion additives in order to mimic biodegradation. In truth, however, these additives only facilitate a fragmentation of the materials, which do not fully degrade but break down into very small fragments that remain in the environment – a process that would be more accurately described by the term "oxo-fragmentation". While often confused with biodegradable plastics, oxo-degradables are a category unto themselves. They are neither a bioplastic nor a biodegradable plastic, but rather a conventional plastic mixed with an additive in order to imitate biodegradation. Oxo-degradable plastics quickly fragment into smaller and smaller pieces, called microplastics, but don't break down at the molecular or polymer level like biodegradable and compostable plastics. The resulting microplastics are left in the environment indefinitely resulting with no evidence to suggest they will eventually break down.

Companies offering additive-mediated conventional plastic materials promise a "quick solution" to countries that have no or nearly no waste management infrastructure, but this promise comes with great dangers to the environment. If these additive-mediated fragmentable plastics are littered and end up in the landscape, they start to disintegrate due to the effect of the additives that trigger the breakdown into fragments, which remain in the environment. Oxo-degradable products are not recyclable and can leave behind the microplastics containing harmful metals creating a serious environmental issue with the contamination of water, soil and animal life.

In 2017, over 150 organizations worldwide, including EUBP and many of its members, endorsed a statement by the New Plastics Economy initiative of the Ellen MacArthur Foundation that proposes banning oxo-degradable and/or oxo-biodegradable plastic packaging worldwide

COMPOSTABLE

They are derived generally from renewable raw materials like starch (corn, potato, tapioca, etc.) cellulose, soy protein, lactic acid etc. are not hazardous/toxic in production and decompose back into carbon dioxide, water, biomass when composted. Some compostable plastics may not be derived from renewable materials, but instead, derived from petroleum or made by bacteria though a process of microbial fermentation.

Compostable plastics are those plastics which have been tested and certified by a third party to adhere to international standards such as ASTM D6400 (in the U.S.) or EN 13432 (in Europe) for biodegradation in an industrial composting facility environment. Materials certified according to ASTM D6400 or EN 13432 will disintegrate within 12 weeks and biodegrade at least 90% within 180 days in a municipal or industrial composting facility. Approximately 10% of solid material will be left at the end of the six-month-long process in the form of valuable compost, or biomass and water. These standards also ensure that the leftover compost will be free of toxins, so the compost will not cause harm when the facility sells it for gardening or agricultural applications. Unless otherwise denoted, certified compostable products must be disposed of in a designated municipal or industrial composting facility, not at home. Many certified compostable materials require the higher temperatures of industrial settings to biodegrade quickly enough, or in some cases at all.

Although some products can pass the criteria established to be labeled compostable the reality is that these products do not end up in industrial compost facilities. Industrial composting is generally comprised of food scraps, leaves, grass, etc., and operate under a biodegradation cycle of 30 to 45 days. As a result, bio polymers biodegrading over a 180-day period are not disposed into industrial composting, so they are not a viable solution today for waste reduction

Few areas in the U.S. have curbside collection for industrial composting

BIODEGRADABLE

Biodegradable plastics are plastics that can be decomposed by the action of living organisms, usually microbes, into water, carbon dioxide, methane and biomass. Biodegradable plastics are commonly produced with renewable raw materials, organic based raw materials, natural raw materials, micro-organisms, traditional petrochemicals, or the combinations of a number of them.

Biodegradability is a property related to the material chemical structure and is independent of the polymer origin. So, it is important to make the difference between the notions of bio based and biodegradable. While the words "bioplastic" and "biodegradable plastic" are similar, they are not synonymous. Not all bioplastics are biodegradable. Indeed, a petroleum-based polymer can be biodegradable or on the contrary, a polymer can be bio based but not biodegradable.

Bioplastics are plastics made from organic materials such as corn starch, and often made up of polylactic acid (PLA). PLA is synthesized from renewable biomass, typically from fermented plant starch. PLA is compostable, but non-biodegradable according to American and European standards because it does not biodegrade outside of artificial composting conditions.

Biodegradable plastics, on the other hand, refer to petroleum-based plastics that are combined with an additive that enhances the biodegradation process through a series of chemical and biological processes when disposed of in a biologically active landfill. Biodegradable plastics decompose much faster than their traditional counterparts which may take hundreds of years to break down. Biodegradation is the decomposition (fragmentation and assimilation) of a material under the action of micro-organisms (ex: bacteria, fungi). The biodegradation results in the formation of biogas (methane and carbon dioxide, water, and biomas which do not represent any kind of environmental hazard when disposed in today's landfills. This decomposition can be anaerobic (without oxygen) or aerobic (with oxygen). Biodegradable plastics have their own degradation kinetic depending on the considered biodegradation environment and thus variable shelf-life in use. The choice of the right material for the right application has to be done considering usage conditions and expected end-of-life.

RECYCLING

Plastic recycling refers to the process of recovering waste or scrap plastic and reprocessing the materials into functional and useful products. This activity is known as the plastic recycling process. The goal of recycling plastic is to reduce high rates of plastic pollution while putting less pressure on virgin materials to produce brand new plastic products. This approach helps to conserve resources and diverts plastics from landfills or unintended destinations such as oceans.

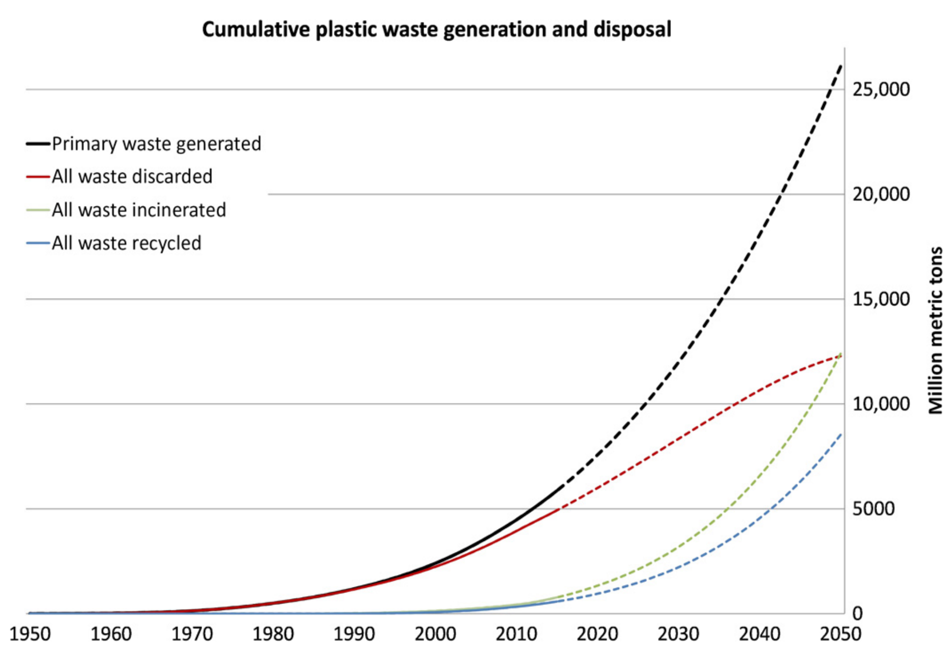
There are limits to how many times some materials can be recycled and limits on the type of film to be recycled. Mono material structures may be recycled but multilayer structures as coextruded or laminated make it difficult or impossible to recycle.

Plastic recycling faces many challenges, ranging from mixed plastics to hard-to-remove residues. The cost-effective and efficient recycling of the mixed plastic stream is perhaps the biggest challenge facing the recycling industry. Most material recovery facilities and local authorities do not actively collect it due to a lack of equipment that can efficiently and easily separate them.

According with Janett Black (Georgia University), 79% of plastics ends in landfill, and they will remain there for hundreds of years, 12% is incinerated and only 9% is recycled. Besides that, according with Euromonitor International's Lifestyle Survey 2019 shows that 'recyclable' is the most trusted green label globally. However, the 'recyclability' of the packaging highly depends on the collecting and recycling infrastructure which varies across the world and tend to be very poor in developing markets. Mono layer structures are easy to recycle by nature without additives or special treatment.

In the case of packaging materials intended for the protein market (Red Meat, Poultry, Cheese etc.) where oxygen barrier, water vapor barrier, shrink ability and high mechanical strength are needed, the use of multilayer packaging is required. For coextruded or laminated structures, recycling is not an option, due to its complexity and diverse materials implied. More difficult, if we consider that they could be contaminated with animal protein, organic material, fat etc. Definitely all of this material will end up in Landfills if it is not incinerated.

The following graph shows the cumulative plastic waste generation and disposal for the USA up to now and what is expected in the coming years.



ZUBIOX

The **ZUBIOX** technology enhances the biodegradation of the fossil-based polymers in just a few years (instead of taking hundreds of years) in anaerobic landfill conditions as demonstrated by ASTM D511 testing.
ZUBIOX

ASTM D5511

Standard Test Method For Determining Anaerobic Biodegradation Of Plastic Materials Under High-Solids Anaerobic-Digestion Conditions

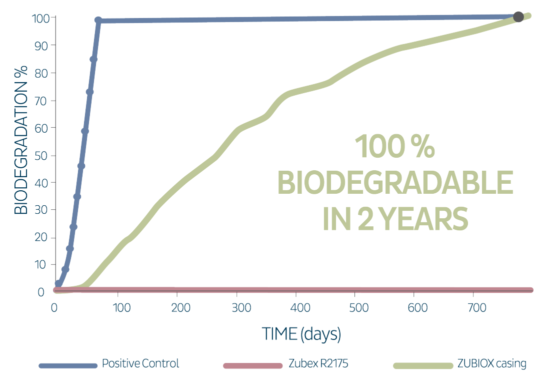
1.1 This test method covers the determination of the degree and rate of anaerobic biodegradation of plastic materials in high-solids anaerobic conditions. The test materials are exposed to a methanogenic inoculum derived from anaerobic digesters operating only on pretreated household waste. The anaerobic decomposition takes place under high-solids (more than 30 % total solids) and static non-mixed conditions.

1.2 This test method is designed to yield a percentage of conversion of carbon in the sample to carbon in the gaseous form under conditions found in high-solids anaerobic digesters, treating municipal solid waste **(1, 2, 3, 4)**. This test method may also resemble some conditions in biologically active landfills where the gas generated is recovered and biogas production is even actively promoted, for example, by inoculation (codeposition of anaerobic sewage sludge, anaerobic leachate recirculation), moisture control in the landfill (leachate recirculation), and temperature control (short-term injection of oxygen, heating of recirculated leachate) **(5, 6, 7)**.

1.3 This test method is designed to be applicable to all plastic materials that are not inhibitory to the microorganisms present in anaerobic digesters operating on household waste.

1.4 The values given in SI units are to be regarded as the standard.

1.5 This test method is equivalent to ISO DIS15985.

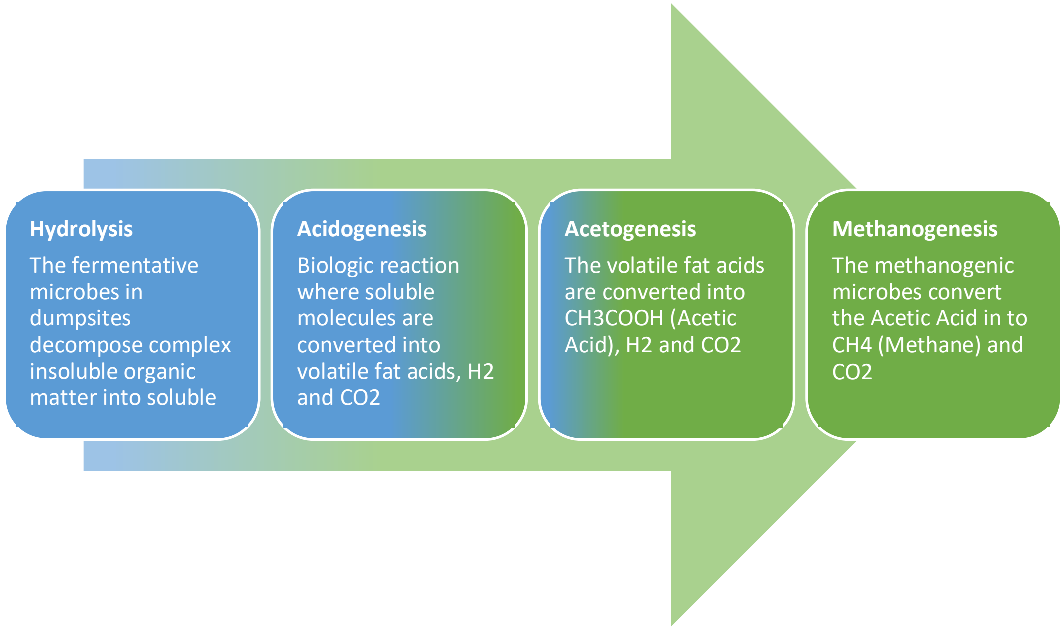


ZUBIOX products, look, feel and work as a typical plastic packaging, but in the landfills, their behavior is completely different. Traditional plastics repel water. **ZUBIOX** enhanced films, absorbs the moisture present in landfills attracting microbes to the plastic surface while moisture expands it and allows microbes to enter into the plastic structure. These microbes secrete enzymes that attract more microbes multiplying the effect. With natural action from live organisms, the result is that our products decompose into biomass, CO2 and CH4 (substances naturally obtained from the anaerobic biodegradation of organic waste in landfills).

It's important to consider that even though CO2 and CH4 are considered as very powerful greenhouse gases, they are present in any type of anaerobic biodegradation process.

Through a well-designed and biologically active landfill, gas generated can be recovered and biogas production is even actively promoted.

Following is a chart showing the biodegradation process of **ZUBIOX** products in landfills.



We understand that the ideal process would be recycling, but as mentioned before, considering all the implications for multilayer packaging, up to now, enhanced biodegradation its far more beneficial than throwing all of the plastic waste into landfills.

There's a lot of misinformation in the social media and from different plastic and government associations. Most of them, lack scientific data to prove their point. There are diverse opinions against this topic and many others that stand in favor of biodegradability. As far as we know, in our world now a days, biodegradable products can help to reduce the impact of multilayer plastics in the environment and for this kind of materials, that cannot be recycled, **ZUBIOX** is the best existing option.

ZUBIOX offers a great solution to join the global quest for a solution to plastic waste.

According to Adriaan S Luyt & Sarah S Malik from the Center for Advanced Materials, Qatar University, Doha, Qatar:
"Biodegradable polymers have a major advantage over nonbiodegradable polymers in terms of degradation. Usage of biodegradable polymers can lower the cost of labor used for the removal of conventional plastics from the environment since they degrade naturally. Moreover, decomposition and degradation of the biodegradable polymers stabilizes the environment and increases the longevity of the landfills by decreasing the garbage volume..."

Our actual line of **ZUBIOX** products offer shrinkable cook-in casings shrinkable vacuum bags and thermoforming films that give a sustainable solution to all food processors that want a cost-effective solution to join the environmental quest.

ZUBIOX CASINGS

Zubiox Casings are a line of biodegradable shrinkable casings designed for cook & strip and deli applications manufactured by a co-extrusion process with raw materials that comply with the FDA and the EU regulation 2002/72/EC for usage as packaging material in the food industry.

ZUBIOX SHRINKABLE BAGS

Zubiox biodegradable shrinkable vacuum bags are designed and manufactured under our new technology focused in protecting the environment manufactured by a co-extrusion process with raw materials that comply with the FDA and the EU regulation 2002/72/EC for usage as packaging material in the food industry.

epzilonZOX Eco-friendly Films

With our patented groundbreaking technology Epzilon Films we have designed a unique material that ensures the lowest thickness to deep draw ratio film in the market. All while maintaining thickness uniformity throughout the walls, base, fold, and corners of the formed tray. We can do all of this while reducing the amount of plastic without diminishing its gas barrier and puncture resistance.

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BIODEGRADABLE

ANAEROBIC BIODEGRADATION UNDER LANDFILL CONDITIONS