COSMETIC PACKAGING AND SUSTAINABILITY

Bioplastics in the production of packaging and details for the cosmetic industry

CANDIANI

BIOPLASTICS

Today bioplastics, their use and their potential applications are certainly a highly topical issue; but what is actually the real meaning of the word starting from the headword mentioned in the Treccani encyclopedia: "Term used to refer to different types of plastic not produced from oil based products but with sustainable raw materials such as corn, wheat, sweet potatoes, sugarcane, seaweed, vegetable oils, etc.…".

The main target of bioplastics is to reduce the quantity of CO2 emitted during the production process (from monomer to polymer), cutting down the environmental impact, compared to traditional plastics, with great environmental benefits.

The **European Bioplastics association** defines bioplastics as plastic materials derived from **biomasses** and consequently the right definition would be **"bio-based" plastics**.

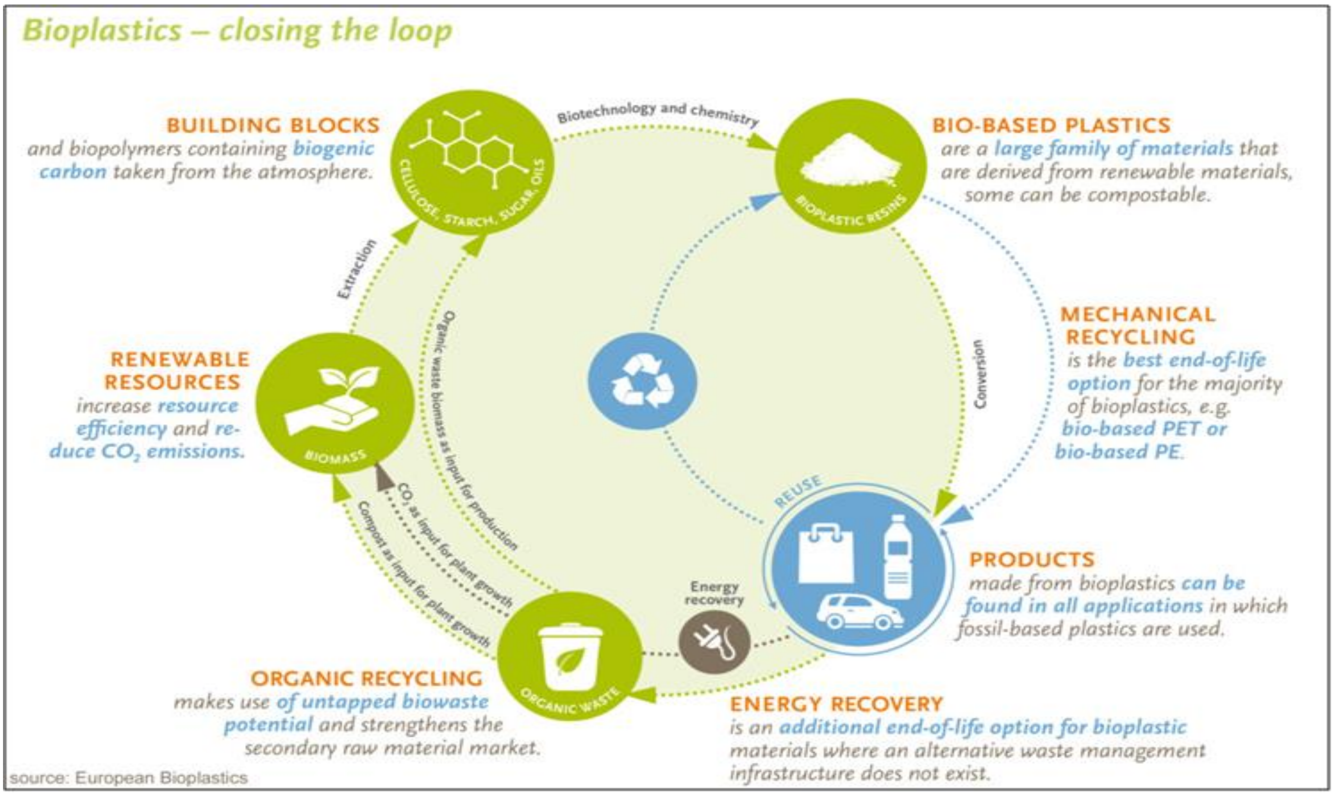
The word "biomass" is referred to a very large family of raw materials sharing the natural origin and the possibility to create a substrate of fermentative processes in order to obtain valuable chemical products (proteins, ethanol). They are mainly of vegetable origin and consequently renewable resources, able to regenerate quickly (annual and/or biennial cycles) thanks to solar energy and to biochemical activity of chlorophyll photosynthesis.

Therefore bioplastics derive from monomers that are not produced from fossil resources (oil or gas) and consequently they are not renewable. It is necessary to keep in mind that non-oil-based products, despite having a natural genesis and considering that they originate from living beings (vegetables or animals), but having been transformed in geological eras, they are not considered renewable sources.

For a correct scientific interpretation and to analyse the bioplastic applications, the idea of "renewability" and the one of "biodegradability" should be split:

- **renewability** refers to the polymer origin;
- **biodegradability** refers to the polymer end of life.

Not all bioplastics are compostable, but considering they are thermoplastic polymers, also the non-biodegradable "bio-based" plastics are a 100% recyclable material at the end of their life cycle as traditional thermoplastics, as explained in the blue path in picture 1 (source European Bioplastic).



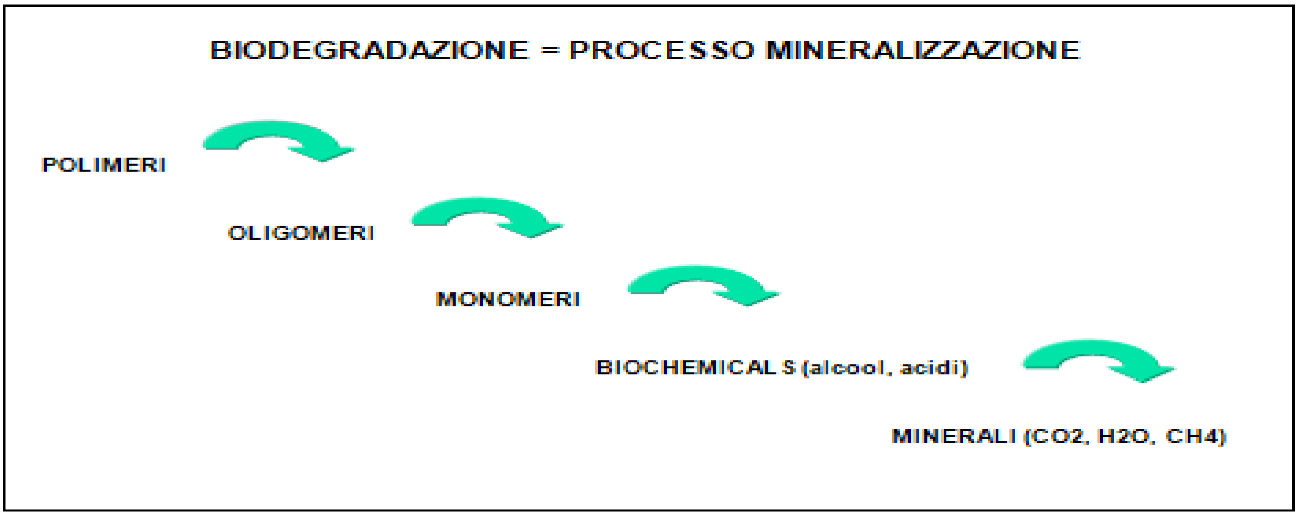
Picture 1

Compostable bioplastics follow the following degradation stages (Picture 2).

In the first stage bioplastics are degraded by the thermal action through a chemical reaction of depolymerisation of the molecular chains, leading to the creation of low molecular weights and oligomers.

In the next stage oligomers under the influence of biotic elements (bacteria, fungi, seaweed) are decomposed, in a relatively short time, at first in single monomers and in simple molecules (alcohol, acids) and finally in carbon dioxide, natural gas, water. The predominant mechanism is the enzyme action of the microorganisms (chemical and biochemical).

The complete biodegradation is similar to the mineralization process of organic products.



Picture 2

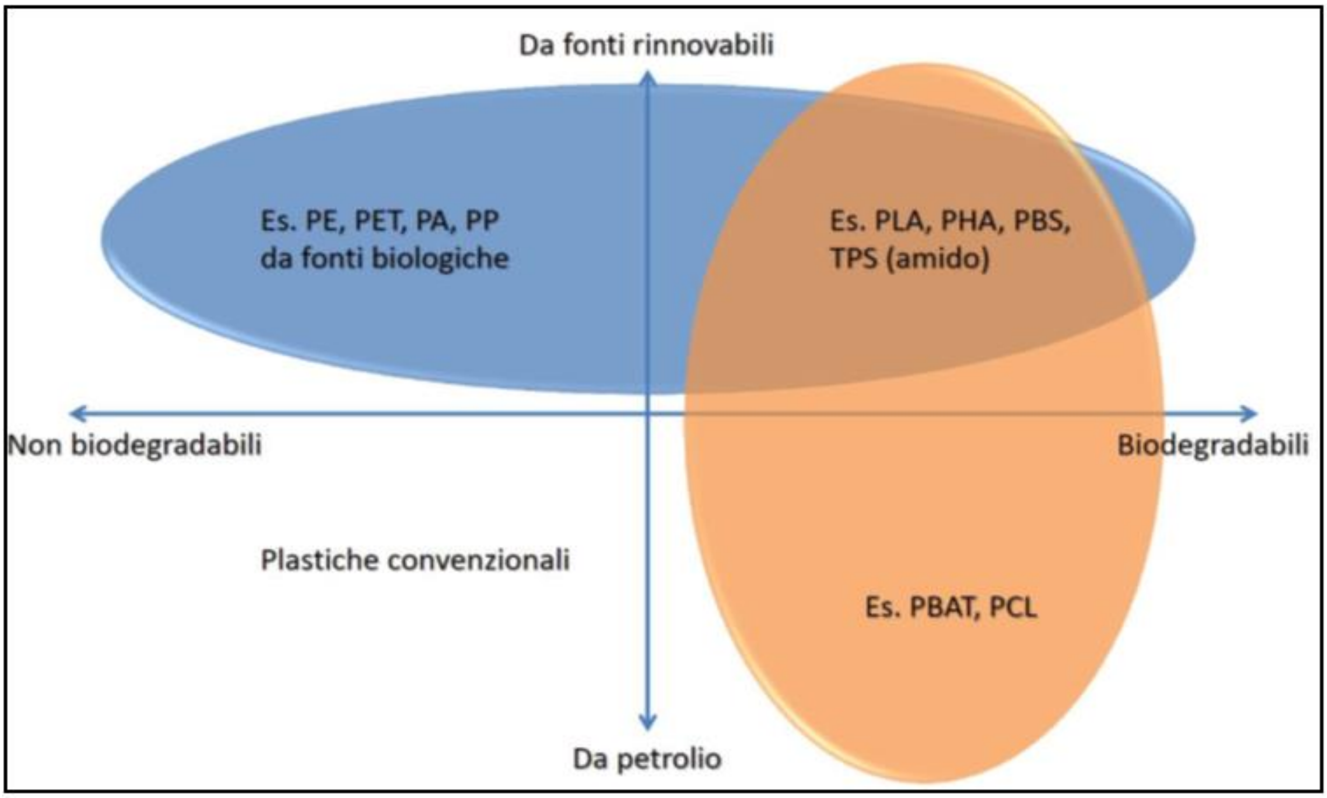
In many cases the idea of biodegradability is associated to the **composting property** of the polymer: biodegradable plastics can be treated in composting plants (industrial and/or RSU) and turned into "organic compost" by the degradative action of microorganisms and bacteria both in aerobic and anaerobic conditions.

The composting plants (constant temperature of approx. 60°C, controlled humidity and presence of microorganisms) normally optimize the process obtaining biomasses usable as fertilizer in the farming industry. Obviously the compostable materials are controlled and analysed as to avoid any transfers of toxic substances.

The **EN 13432 standard** referred to compostable packaging and the related ISO standards (14851, 14852, 14855) establish that a polymer is considered compostable when it biodegrades for 90% of its weight in 180 days' time and the maximum accepted residue is 10%.

In picture 3 (source European Bioplastic) the bio-based plastics (from renewable sources) are identified with the blue area and they are split into:

- non biodegradable polymers that are generally identified with prefix "bio" (ex. bioPE, bioPP, bioPET, bioPA, …);
- biodegradable polymers (ex. PLA, PHB, TPS).



In order to analyse the "bio-based" content of a polymer the **ASTM D6866-18 standard** (March 2018 version) is used. The method implements the analysis of C14 to distinguish carbon derived from biomasses from the one derived from fossil resources.

In Europe there are laboratories and institutions certifying the origin of bioplastic and the main ones are:

- TUV Austria (former Belge Vincotte)
- DIN Certco (Germany)

Both analyse items made of bioplastics and provide certificates of the polymer origin and authorize the use of related labelling.

Biodegradable polymers can be classified into 5 groups:

- Biopolymers deriving from starches: mining and modification of biomasses and polysaccharides deriving from corn, potatoes, cereals, tapioca, rice;

Ex. Mater-Bi, Bioplast, Solanyl.

- Biopolymers deriving from Cellulose (cellulose acetate) and post-consume cellulose fibers (similar to cellophane);

Ex. Naturflex Innovia, Daicel, Clarifoil.

- Biopolymers obtained via chemical synthesis from bio-monomers (as lactic acid, derivatives, glycolic acid);

Ex. PLA Ingeo, PGA Kuredux.

- Biopolymers obtained via biotechnology monomers derived from the bacteria action on food processing waste, as polyhydroxyalkanoates (PHA, PHB and similar);

Ex. Mirel Metabolix, Bio-on.

- Polymers obtained from petrochemical origin monomers as polyvinylalcohol (PVOH), polycaprolactone (PCL), polybutylene adipate terephthalate (PBAT);

Ex. Ecoflex Ecovio, Biomax.

Biodegradable polymers are used in "disposable" applications, especially in the packaging industry.
The **"Bio-Based", non-biodegradable polymers,** currently available on the market, are mainly part of polyolefin and polyester families, even if they are present in all the main thermoplastic families, for instance polyamides and thermoplastic rubbers.
The ethyl alcohol production (ethanol) from renewable sources and the related converting into monomers as ethylene (bioPE) and ethylyne glycol (bioPET) is booming worldwide thanks to the fact that the packaging supply chain is involved in their development.
Chemical industries producing polymers, packaging industries and leading companies in consumer goods are investing huge funds into the development of eco-friendly packaging.
In any case it is important to reflect on the ethanol origin: several ongoing research projects and some already at an advanced stage (marketing) are trying to produce ethyl alcohol by using vegetable waste and by-products of other processes (food industry) with the purpose of not replacing agricultural production for food and zootechnical use.
In other cases there is a tendency to grow plant varieties in marginal areas and in some cases polluted fields, that cannot be used for human and zootechnical food production.
Finally please note that **non-biodegradable bioplastics**:
- are completely identical to the traditional ones;
- offer similar physical-mechanical properties;
- can be transformed with current technologies;
- are 100% recyclable materials.

The leading industries in **Cosmetics** are looking for "eco-friendly" and innovative solutions and they are involved in the introduction of Biopolymers in cosmetic packaging.
Unfortunately **biodegradable bioplastics** can show strong criticalities in case of primary packaging. The polymer degradation process is speeded us by direct contact with the chemical products forming cosmetic formulations and it can consequently cause tightness and durability problems of the material.
In the same time **non-biodegradable "bio-based" polymers**, for instance bioPolyolefin, bioPolyester and bioPolyamides, have already been introduced in the cosmetic industry: the request and development of eco-packaging made with this kind of polymers is booming in all potential applications.

A further help to sustainability can be offered by the use of recycled thermoplastic polymers, coming from industrial or household recovery, for instance rPET and rPE, where letter “r” indicates exactly a recycled material.

These polymers, similar but not exactly the same as the first quality ones, have however some limits:

- the inconstancy of some physical – mechanical properties;
- the basic colouring (that can sometimes hinder or make the special colouring difficult, especially in case of transparent materials);
- the aesthetics (of lower quality);
- the reduced window of transformation parameters;
- the limited availability and the irregular market supply.

In the cosmetic and perfumery industry, the possibility to use these materials should be a priori carefully assessed, that has however to be considered as an ecological advantage, deriving from the limited energetic cost used for recycling, with the final purpose of creating the hoped-for “circular economy” of packaging products.

The text included in this file presented by G.CANDIANI S.r.l. di Tradate (VA) has been prepared in cooperation with Dr. Carlo Galliani, plastic materials and elastomers chemist.

Source of images: European Bioplastic.

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