BIODEGRADABLE GRANULES

Specifications of bio-based biodegradable granules

Blending and polymerizing with aliphatic materials (*PHBV, PCL, PLA), modified tapioca and corn starch are made into bio-based biodegradable products with unique formulas and technology.

***Poly-hydroxybutyrate-valerate, starch poly-caprolactone, Polilactide acid**

Item	Unit	Blending Bio granule	Directly processing bio granule	Completely biodegradable granule
Appearance		Yellow	Buff	White
Density	g/cm3	1.05-1.10	0.98-1.10	1.0-1.15
Moisture	%	0.6-1.6	0.6-1.2	1-2
MFR	g/10min	0-5	0-9	3-10
Tensile Strength	MPa	>12	>12	>12
Tensile Elongation	%	>250	>100	>150
Content biomass	%	>65	>50	>99
Softening point	C	>65	>65	>70
Application of bio-based biodegradable granule		Blending w/the common used for the film and bags, and for the injection products. Maximum of the biodegradable granule is less than 60%. Data of tensile strength & rate of elongation for breaking are the data after blending.	It can be processed directly for disposable film blowing, injection and vacuum molding products, such as golf tee, cutlery, seed pots and food containers.	Without any polyolefin materials, high plasticization, applying to film blowing, injection, vacuum modeling.

BIOPOLYMERS DEFINITION

PHBV:

***Creation**:* Made from renewable natural sources like sugar and corn .

***Use**:* It is biocompatible and therefore can be implanted in the body without causing inflammations.
Non toxic product.
Category: biopolymers, made from natural sources like sugar.
More than 100 different monomers can be combined within this family to give materials with extremely different properties.

They can be either thermoplastic or elastic materials, with melting-points ranging from 40 to 180°C.

***Disposal**:* It biodegrades in microbe active environments in 5-6 weeks.
The action of some enzymes produced by microbes soluble PHB which is then absorbed through the cell wall and metabolized.

PHB is normally broken down to carbon dioxide and water when degrade conditions.
In absence of oxygen the degradation is faster, and methane is also produced.
PHB is not degraded in biologically inactive systems such as sanitary landfills.

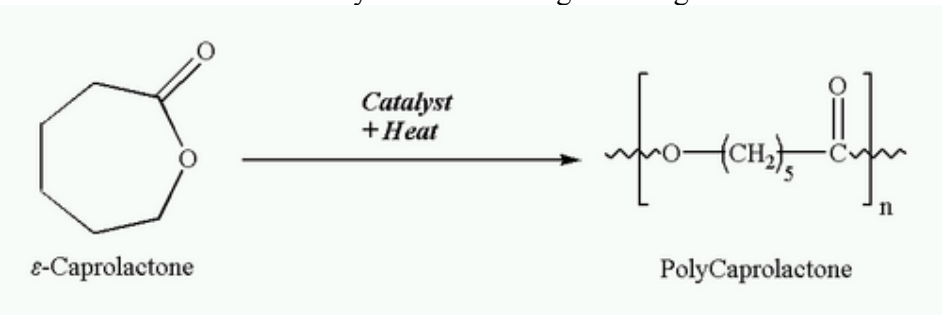
PCL:

Polycaprolactone is a biodegradable thermoplastic polymer. It is fully biodegradable.

Polycaprolactone has good water, oil, solvent and chlorine resistance. It has a low melting-point (58-60 °C) and low viscosity, and it is easy to process.

It is used mainly in biodegradable compost bags, sutures, and fibers.
Disposal: Fully biodegradable.
The low melting-point makes the material suited for composting as a means of disposal, due to the temperature obtained during composting routinely exceeding 60 °C.

Degradation time is very short. PCL is mixed with starch to obtain a good biodegradable material at a low price.
The mix has been successfully used for making trash bags.



PCL is degraded by hydrolysis of its ester linkages in physiological conditions (such as in the human body) and has therefore received a great deal of attention for use as an

implantable biomaterial. In particular it is especially interesting for the preparation of long term implantable devices, owing to its degradation which is even slower than that of polylactide.

PCL is an Food and Drug Administration (FDA) approved material that is used in the human body as (for example) a drug delivery device, suture adhesion barrier and is being investigated as a scaffold for tissue repair via tissue engineering.

Biodegradable plastics are derived from plant sources such as hemp oil, soy bean oil and corn. This is regarded as a much more sustainable activity, as it relies considerably less on fossil fuel imports and **produces less greenhouse emissions**, **between 0.8 and 3.2 tons of carbon dioxide less per ton of biodegradable plastics compared to the same weight in petroleum-based plastics**. Many biodegradable plastics are truly biodegradable and will degrade in commercial composting units. Some biodegradable plastics will even biodegrade in the less aggressive conditions of a home compost heap. However, biodegradable plastics can also be formulated to be durable.

PLA (polylactide acid):

Polylactide acid (PLA) is a transparent biodegradable plastic made from natural resources. It not only resembles conventional petrochemical mass plastics (like PE or PP) in its characteristics, but it can also be processed easily on standard equipment that already exists for the production of conventional plastics. PLA and PLA-Blends generally come in the form of granulates with various properties and are used in the plastic processing industry for the production of foil, moulds, tins, cups, bottles and other packaging.

It resembles clear polystyrene, provides good aesthetics (gloss and clarity), but it is stiff and brittle and needs modifications for most practical applications (i.e. plasticizers increase its flexibility).

It can be processed like most thermoplastics into fibres, films, thermoformed or injection moulded.
Used for compost bags, plant pots, diapers and packaging.

Category Biopolymers
Products Compostable bag
Processes Most conventional plastic processes like:
Blow moulding, injection moulding, extrusion, vacuum forming, fiber spinning

Environmental notes: Lactic acid can be obtained on the basis of renewable starch containing resources (e.g. corn, wheat or sugar beat) by fermentation, or by chemical synthesis of non-renewable resources.

Disposal: If composted properly it takes 3-4 weeks for complete degradation.
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The first stage of degradation (two weeks) is a hydrolysis to water soluble oligomers and lactic acid. The latter, as a naturally occurring substance, is a rapid metabolisation into CO2, water and biomass by a variety of micro-organisms.