LATI® HIGH PERFORMANCE THERMOPLASTICS

LATIGEA

& ENVIRONMENTALLY SUSTAINABLE COMPOUNDS

ABOUT LATI

LATI was founded in Italy in 1945. Since its establishment, the company has risen to a position of absolute prestige in the field of engineering thermoplastic compounds, in Italy and worldwide.

Today, LATI is:

- the independent company with the widest range of compounds in Europe;
- one of the world's most qualified suppliers of self-extinguishing compounds;
- a partner for the development of special high-performance products tailored to the needs of the individual customer.

The company has two plants in Italy with a potential output of 38,000 tons per year.

LATI products are used in the main application sectors, from automotive to precision mechanics, household appliances to electronics, and medical devices to biobased systems.

LATI distributes its engineering compounds across the major international markets through its ubiquitous sales network.

LATI's vocation is to satisfy its partners by providing a service with a high technical content, ranging from the preparation of compounds to technical support for the development of final projects, always respecting the customer's needs and offering maximum flexibility.

SUPPORT & SERVICE

LATI is able to support its customers from the earliest design stages, in the choice of the most suitable materials, and in the creation of new products. The company can even offer valuable assistance on board the machine, to ensure correct processing.

- **Co-design service**
  Thermal, mechanical and fluid dynamics simulations are carried out by highly experienced engineers, operating directly on the geometries provided by the customer and using mechanical and rheological characterisation methods that take into account the conditions of use.

- **Injection moulding assistance**
  Obtaining maximum thermal, mechanical and dimensional performance from a material can take a number of attempts and require lengthy process-tuning procedures. To address these needs, LATI has engineers with thirty years' experience in the field of injection moulding, presses and moulds.

- **Research & development**
  Offering a tailor-made product based on the customer's needs is of paramount importance to LATI. Each grade is optimised to provide the most appropriate answer to the application requirements, even if the formulation needed differs significantly from those already present in our range.

- **Regulations and standards**
  Specific regulatory support is also available for each LATI compound.
  Our team of experts is at the complete disposal of customers to ensure assistance for material certification procedures at globally accredited laboratories and organisations. LATI issues internal certificates of conformity complying with the rules applicable in each market.

INTRODUCTION

In recent years, plastics have increasingly been demonised as one of the main causes of land, sea and air pollution.

While, on the one hand, there certainly are issues concerning the excessive use of disposable items and the sustainable management of end-of-life plastics that need to be addressed, it is also true that much of the information published on social networking sites and media channels is not based on solid scientific evidence.

All this generates unjustified alarmism and, worse still, fuels dangerous misinformation among consumers.

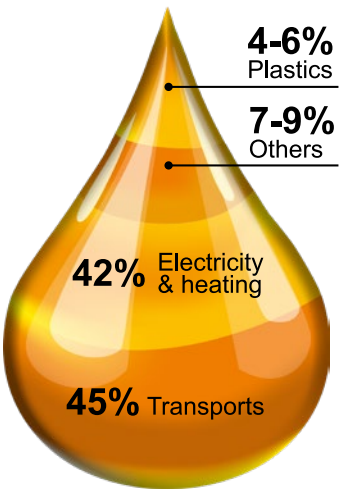
One clear effect of this situation is that terms and expressions such as “biodegradable”, “compostable”, “biopolymer”, “plastic free”, “recyclable” and “from renewable sources” have lost much of their true meaning, being used in the most inappropriate contexts, often for purely marketing purposes. This has had the effect of reinforcing the **prejudiced view** that **plastic is evil**.

Therefore, what is needed, above all, is clarity over the true meaning of the terms used in this brochure.

POLYMERS

Polymers are molecules that derive from the light fractions of crude oil.

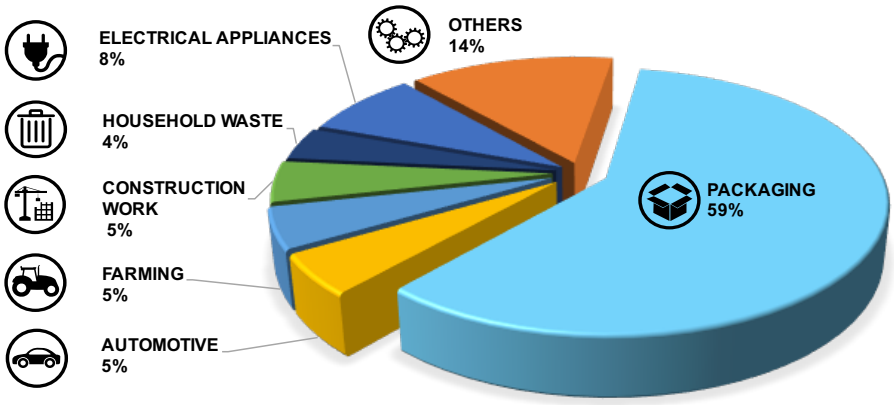
From the perspective of environmental impact and the exploitation of the world’s natural resources, it is already worth noting that only a very small proportion of oil and extracted gas is used to produce polymers: between 4% and 6% in Europe.



This means that the main reason for the continued **reduction of fossil reserves** does not lie in the production of plastics or chemicals in general.

This issue can also be put into context by considering another aspect, which we term end of life: what happens to plastic objects once they reach the end of their use cycle and become waste, and what are the main areas generating this waste?

As the pie chart shows, most plastic waste comes from **packaging** and single-use or disposable products that, although made from polymers capable of lasting for years, actually have a very short cycle of use.



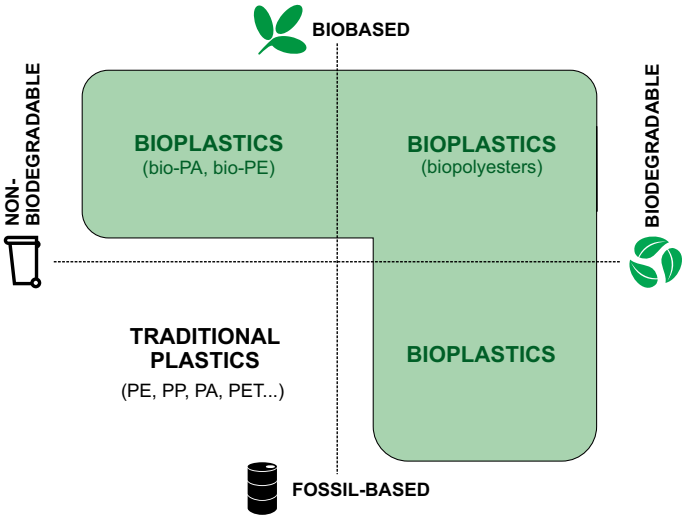
Clearly, then, these are the products that should be the main target of efforts to bring about more careful and sustainable use and waste management in this field.

Such efforts include the growing availability of new materials, generally referred to as bioplastics. But what are **bioplastics** exactly?

The term *bioplastics*, as most commonly applied, refers to polymers that meet at least one of the following two descriptions (or, preferably, both):

PLASTICS COMING TOTALLY OR PARTIALLY FROM RENEWABLE SOURCES
(corn starch, sugar cane, biomass, castor oil, etc.)

BIODEGRADABLE/COMPOSTABLE PLASTICS
(used in certain conditions and/or in special treatment plants).

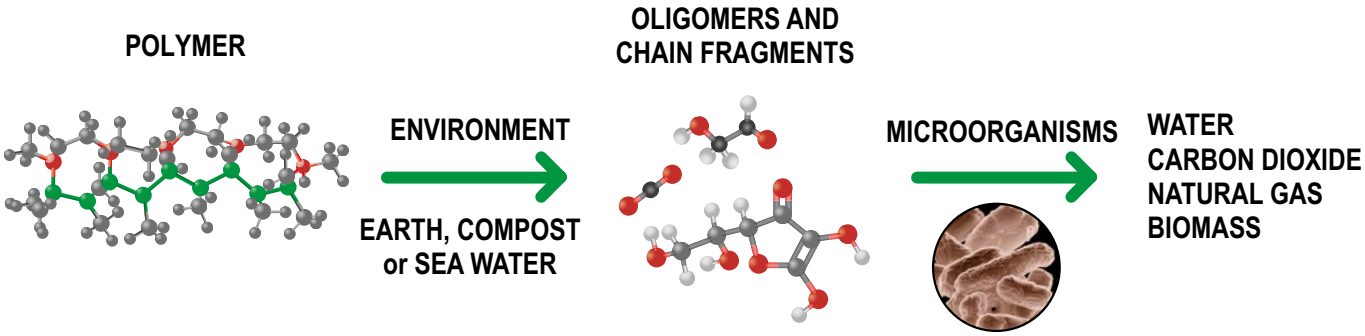


What this distinction reveals, however, is that it is difficult to classify materials within the category of bioplastics.

For example, there exist polymers that derive from the distillation of crude oil but are biodegradable (such as polybutyrate and polycaprolactone); similarly, it is possible to produce conventional, non-biodegradable polymers from completely natural sources (such as polyethylene from sugarcane or polyamides from castor oil).

BIODEGRADABILITY AND COMPOSTABILITY

The degradation of polymers can occur in different ways and in different environments, but essentially it is a process that exploits the ability of certain microorganisms to assimilate the molecules making up the plastic material.



BIODEGRADABLE – this definition applies to a polymer whose macromolecules, in the environment, break down into molecules small enough to be digested by microorganisms. This process can take place over any length of time, and in the presence or absence of atmospheric oxygen.

The term biodegradable should be used carefully.
To provide correct information, the term should always be accompanied by reference to a **specific standard** that, in addition to defining the **time scale and mechanisms** of the biodegradation, also states the environment in which that type of biodegradation takes place.

Nowadays, the term biodegradable is often used inappropriately, sometimes purely for marketing purposes. This is confusing for consumers, and even induces people behave incorrectly. For example, they may wrongly think that items can be dispersed in the environment simply because they are labelled biodegradable.

COMPOSTABLE – this term defines a material that - in a reasonable time frame and in the right environmental conditions (in the presence of the necessary enzymes, moisture, temperature) - can be assimilated by the microorganisms that live in that environment, without leaving visible or toxic residues, and even helping to fertilise the soil.

According to the **EN 13432** standards, a material, in order to be defined compostable, must meet the following criteria:

- Degrade by at least 90% within 3 months under controlled aerobic composting conditions (ISO 14855) and/or consist of elements already listed as “natural” (wood pulp, untreated cellulose, etc.) and/or biodegradable;
- Feature low or zero concentration of heavy metals;
- Pass the decomposition test requiring that, within a certain time (3 months for industrial compost), the material breaks up into particles and more than 90% of these particles are smaller than 2 mm. This is the reason why, in order to certify a material as compostable, it is always necessary to define the thickness of the tested sample (which will be binding when determining the thickness of the moulded part);
- Transform into high-quality compost, enabling the growth of healthy plants;
- Show pH values, salt content, and a concentration of volatile compounds, nitrogen, phosphorus, magnesium and potassium within the set limits.

From this, it can be inferred that a biodegradable material is not necessarily compostable, while the reverse is true.
As these different types of biomaterials became increasingly widespread, it was necessary to establish new technical standards in order to test them and guarantee their level of environmental sustainability; these standards therefore set clear test times and conditions.

The development of new standards has gone hand in hand with the establishment of various organisations (recognised both nationally and internationally) qualified to certify – on the basis of appropriate tests conducted in accordance with specific regulations – a material’s level of sustainability. The organisations most recognised at international level include DIN CERTCO and TÜV Austria.
Both can help to facilitate transparent and correct communication along the entire supply chain.
TÜV Austria has created several categories according to which the biomaterial (or a moulded object made from a biomaterial) can be tested in order to obtain the relevant conformity mark. This, once obtained, can be used to inform consumers and promote the product as truly sustainable.

Let us look in more detail at the most important conformity marks:

OK BIOBASED

This mark certifies the quantity of “recent” carbon from a renewable, non-fossil source.

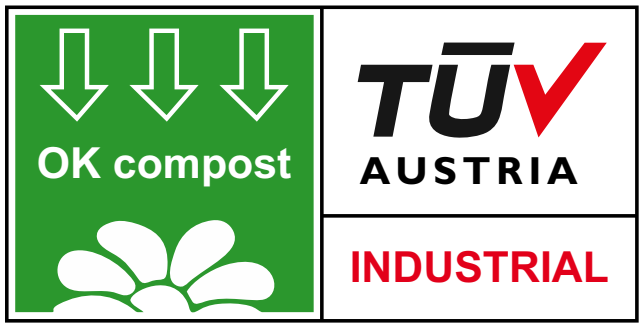
This is established using the 14C dating method. The certification envisages four categories according to the biobased content of the material as a whole. The biobased content rating is indicated by the number of stars assigned (ranging from one to four):

★	★★	★★★	★★★★
BETWEEN 20 AND 40% BIOBASED	BETWEEN 40 AND 60% BIOBASED	BETWEEN 60 AND 80% BIOBASED	MORE THAN 80% BIOBASED

The OK biobased mark by TÜV Austria, ASTM 06866

Since this certification is linked to the intrinsic chemical nature of the material, it is independent of the thickness of the product.

OK COMPOST (INDUSTRIAL/HOME)



This mark certifies **the compostability of a material** on the basis of specific tests conducted at specialised partner laboratories.
Here, a distinction is drawn between “home”, meaning that the material is suitable for disposal together with domestic compostable waste, and “industrial”, meaning that it must be included with separately collected waste destined for industrial composting.

“Home” is strictest of these two categories, as the temperatures reached by domestic compost (about 30°C) are much lower than those reached in industrial composters (up to 70°C).

Since LATI manufactures products destined mainly for durable technical applications, what the company is aiming to do, at R&D level, is to create compounds that can be certified as industrially compostable.
Indeed, only low-thickness materials and/or poorly performing products can meet the strict Home compost criteria, and such materials are not suitable for the technical applications in which LATI materials are typically used. Since the certificate is issued on the basis of testing and compliance with the requirements of the material’s maximum thickness, it is essential during the design phase to discuss the thickness of interest.

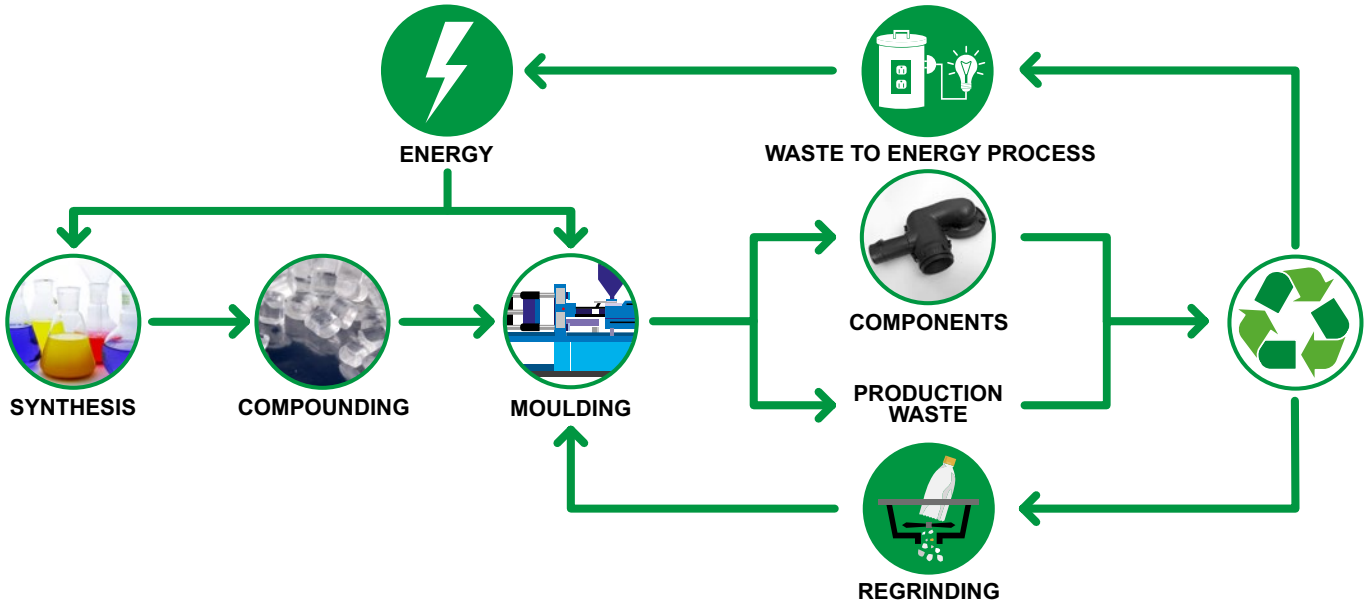
OK BIODEGRADABLE (SOIL/WATER/MARINE)

This mark is used to certify, on the basis of specific tests conducted at specialised partner laboratories, that a material is **biodegradable in certain environments** (soil, water and marine environment).

This certificate is used for products that, to an extent, can be expected to end up (albeit not intentionally) dispersed in the environment (such as fishing gear immersed in water and liable to dispersion as a result of occasional breakages during operations). With these products, degradability is more important than the technical characteristics typical of high-performance thermoplastic materials.
N.B.: We reiterate that the term “biodegradable” is, in itself, of no practical value, and may indeed be confusing for the consumer, unless it is accompanied by details of the conditions and environment in which the biodegradation takes place.

LATI COMPOUNDS

LATI’s mission has always been to produce thermoplastic compounds for the manufacture of technical components. Therefore, these are not disposable items: they are designed to be used over longer periods of time.
LATI produces thermoplastic compounds that are inherently suitable for repeated re-use through a process of recovery/grinding and re-melting.
In short, these are materials that can, potentially, always be recycled.
However, the process of separation and recovery is not always simple and systematic, and in situations where materials cannot be recovered and recycled (this applies, in particular, to more complex compounds), there is always the waste-to-energy option, which is a useful means of producing new energy:



One environmental sustainability avenue that LATI has been pursuing for some time is the use of recycled polymers in its compounds. These are obtained both through traditional mechanical recycling and through chemical recovery, which involves breaking polymers down into monomers and then re-polymerising them.

Recycled polymers, which can be used in compound matrices (as one of the components or as the only component), can be derived from polymer production waste – post-industrial waste – or from the recovery and reprocessing of end-of-life products – post-consumer waste.
When using recycled raw materials, quality control needs to be even more stringent given that the supply of these raw materials is often discontinuous, and therefore stable properties are rarely offered. This applies especially to the most critical case, i.e. post-consumer polymers.

Alongside this activity, for a number of years now the company has been developing a wide range of biopolymer-based compounds, with different properties and characteristics in terms of environmental impact. These compounds fall into two families: the LATIGEA and the BIO compounds.

Created with a view to environmental sustainability, LATIGEA is a family of materials that has no fossil-based:

LATIGEA®

- **B01... B19:** Polymer-based compounds derived totally or partially from renewable sources, and potentially biodegradable and/or compostable.
- **B20... B59:** Polymer-based compounds derived totally or partially from renewable sources, but not biodegradable or compostable.
- **B60... B70:** Biopolymer and fossil-based polymer blends.

BIOBASED COMPOUNDS, POTENTIALLY BIODEGRADABLE AND/OR COMPOSTABLE

These materials are developed from polymers obtained totally or partially from renewable sources (starch, sugarcane, castor oil, etc.). They are potentially biodegradable and/or compostable, although this depends on the thickness of the manufactured item and is an aspect that has to be verified directly on the compound obtained.

LATI's products are compounds. For this reason, even though the base resin used is declared biodegradable/compostable, it remains possible that the compounding process, involving the addition of additives, fillers and reinforcements, may alter and affect the biodegradability/ compostability of the base polymer.
Therefore, if the user wants a product that can be declared biodegradable/compostable, LATI can develop ad hoc formulations.

Given that the thickness of the manufactured item is a key factor, tests will nevertheless need to be carried out on the finished items in order to confirm that their biodegradability/compostability complies with current regulations.

The following are some of the products belonging to the LATIGEA range:

LATIGEA B01
*(**Amorphous PLA**-based compound)*

The LATI range currently includes about ten LATIGEA B01 codes, referring to different versions: basic, coloured, filled with wood flour or biomass (waste from the processing of tomatoes, hemp etc.), as well as various special grades: for 3D printing, density controlled, radiopaque and self-lubricating.

Some possible applications:

PEN BODY

LATIGEA B01 L/07 GREY:2865
(PLA with wood flour)

- Industrial compostability of the base resin certified for thicknesses of up to 1.65 mm
- Sustainable FSC-approved wood flour
- 98% of raw materials from renewable sources (OK Biobased certified)
- Completely free from heavy metals

SOFTAIR PELLETS

LATIMASS 37 B01-01 D025 NAT.:0102
(Density controlled PLA)

- Certified industrial compostability of the base resin
- Version with high specific weight (around 2.5 g/cm^3)

PEN CLICKER MECHANISM

LATILUB B01-02S NAT.:0070
(Self-lubricating PLA)

- Certified industrial compostability of the resin
- Self-lubricating with silicone oil

LATIGEA B03
(Biopolyester-based compound)

Semi-crystalline polymer partially obtained from renewable sources (around 50%). Compared with amorphous PLA, it is able to guarantee higher resilience and improved thermal resistance.

Some possible applications:

TOOTHBRUSH HANDLE

LATIGEA B03 L/25A NAT.:0194F3
(Biopolyester and wood flour)

- Certified compostability of the resin
- Sustainable FSC-approved wood flour
- Over 60% of the compound derived from renewable sources
- Mechanical and thermal properties similar to PP
- EU approved for food contact

BIOBASED COMPOUNDS, NON-BIODEGRADABLE/ NON-COMPOSTABLE

These compounds make up the most promising class of raw materials for technical applications.

They can be produced completely or partially from renewable sources, such as starch and sugar cane, and they have a very low environmental footprint.

These polymers can provide chemical, thermal and mechanical performances comparable with those of traditional polymers derived from petroleum.

This category can be divided into two groups:

- Biomaterials, named LATIGEA (from B20 up), that have no counterpart among the most common fossil-based ones;
- Biomaterials for which there is a fossil-based equivalent or similar material, and which therefore maintain the classic LATI nomenclature (LATAMID, LATENE etc.) followed by the extension BIO.

LATIGEA B20
(Semi-crystalline PLA-based compounds)

Semi-crystalline PLA is currently the biopolymer providing the best value for money.
It comes entirely from renewable sources and has excellent mechanical as well as thermal properties (HDT of around 130°C).

At present it is used mainly to produce 3D printer filaments, but it can also be used in injection moulding processes.
Its main differences compared with LATIGEA B01 (amorphous PLA) are the following:

PROPERTY	LATIGEA B01 (amorphous PLA)	LATIGEA B20 (semi-crystalline PLA)
Compostable	YES	NO
Appearance	transparent	opaque
Mould temperature	cold	90-100°C
Heat resistance	45-50°C	up to 130°C
Applications	non-technical	technical

One point regarding the potential **compostability** of the base resin used in LATIGEA B20 needs to be clarified.

Initially, the crystallisation that characterises these materials seemed to be an impediment to their biodegradation; however, it now seems that these materials, too, up to certain thicknesses, are declared compostable by their producers.

Given that there is currently no evidence on their true biodegradability, it was deemed preferable, as a precaution, to consider them non-biodegradable/ non-compostable.

Among all the existing biomaterials, the totally or partially biobased products for which there is already a fossil-based counterpart or a similar material are the category that most resembles LATI's traditional range.

These are materials that are, in all respects, the same as or similar to traditional products (polyethylene, nylon, PBT, etc.). The difference is the source of the monomers: renewable instead of fossil.
Although they may appear to be less sustainable than other materials, in reality they are the ones on which we need to focus most, for the following reasons:

- Being the same as, or very similar to, traditional thermoplastics, they offer superior technical features;
- Deriving totally or partially from renewable sources (plant sources, such as sugar cane, that absorb CO2 from the atmosphere as they grow), they guarantee lower CO2 emission compared with fossil-based products;
- They can be marketed as biobased, through the aforementioned TÜV "OK BIOBASED" mark, for example.

There are several biopolymers of this type on the market, and new ones are being developed, such as the following:

BIOBASED VERSIONS OF CONVENTIONAL POLYMERS

- Bio-HDPE – almost entirely derived from sugar cane
- Bio-PBT – partially derived from renewable sources
- Bio-PETg – partially derived from renewable sources

BIOPOLYAMIDES
- PA11 – entirely derived from castor oil
- PA5.X – partially derived from biomass or sugar cane
- PA4.10 – partially derived from renewable sources
- Bio-PA6.10 – partially derived from renewable sources

The R&D department at LATI tests and evaluates these new products on a daily basis, and they can be expected to be used increasingly widely.

In view of several considerations concerning their actual availability, performance and cost, the following two products are the focus of current research efforts:

LATENE HD BIO

(HDPE-based compound almost entirely derived from renewable sources)

HDPE BIO has two advantages:

- It comes almost entirely (97%) from a renewable source (sugarcane);
- Its mechanical and thermal behaviour is entirely comparable to that of its fossil-based counterpart.

Within the LATI range, it is possible to work with two different basic viscosities:

- LATENE HD 7BIO, more viscous, suitable for filling greater thicknesses;
- LATENE HD 20BIO, more fluid, more suitable for filling smaller thicknesses.

Different versions have been created to date: coloured, filled with FSC wood flour or biomasses (tomato processing waste, shives), or with mineral fillers for greater dimensional stability and a higher modulus of elasticity.

Furthermore, many of these compounds are designed to be EU and FDA approved for contact with foodstuffs.

LATENE HD BIO can also be used in the development of more technical and functional grades, such as:

LATENE HD 7BIO-GW

This material combines excellent resilience with a GWFI of 850°C @ 1mm.

With regard to possible certifications, depending on the formulation of the compound, those wishing to produce items in LATENE HD BIO can aim to obtain the TÜV's OK BIOBASED certificate, from the single-star rating (at least 20% biobased) to the maximum four-star rating (over 80% biobased).

LATAMID SP5 BIO

(Compound based on bionylon partially derived from renewable sources)

Nowadays, there are numerous polyamides available on the market that are totally or partially based on renewable sources.

However, the choice should be guided by a series of key considerations:

- Price: the prices of these polyamides, although higher than those of their fossil counterparts, are still acceptable to the market;
- Satisfactory thermal and mechanical performance;
- True sustainability, which is not always guaranteed along the production chain;
- Good processability;
- Availability of supplies.

Bearing these factors in mind, the LATI R&D department has developed compounds, named LATAMID SP5 BIO, based on nylon partially (47%)

derived from renewable sources (biomasses or sugar cane).

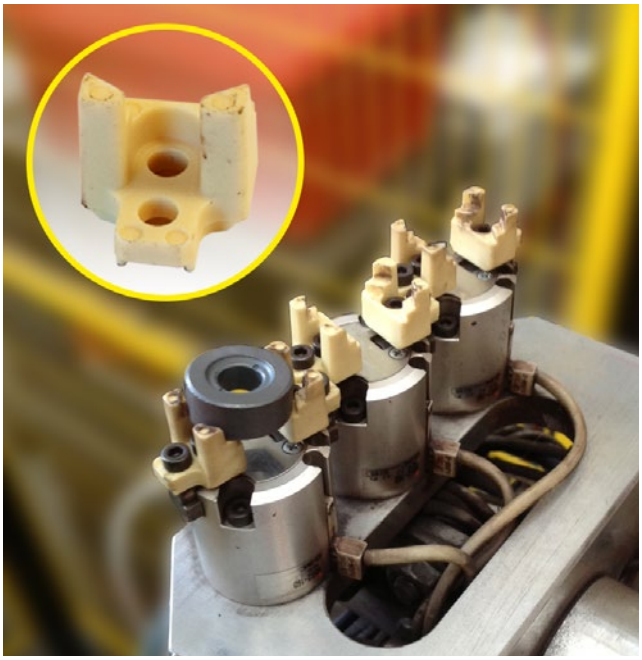
The hygroscopicity, shrink rates, processability and thermal and mechanical properties of these compounds are mid-way between those of PA6 and PA66, and therefore they can easily be used by anyone used to working with these fossil-based polymers.

From the price perspective, although they are inevitably more expensive than standard Nylon 6 and Nylon 66, their price is nowhere near as high as that of other well known, but far more costly polymers, such as Nylon 11, and is therefore acceptable to the market.

Different versions have been developed, such as the standard formulation, with 30% or 50% glass fibre reinforcement:
LATAMID SP5 BIO H2 G/30
LATAMID SP5 BIO H2 G/50

15% carbon fibre reinforced:
LATAMID SP5 K/15

Halogen-free, self-extinguishing:
LATAMID SP5 BIO H2 G/20-V2HF
LATAMID SP5 BIO H2 G/30-V0HF1



And special grades, e.g. self-lubricating, with aramid fibres:
LATILUB SP5 BIO Y/20

New versions are now being studied, such as conductive grades for ATEX applications and thermally conductive grades.

Given that LATAMID SP5 BIO is in effect an easily processable polyamide, it is possible, in theory, to develop any new compound (including special ones) based on those present in the LATI LATAMID range, but having a biobased content that guarantees greater environmental sustainability.

With regard to possible certifications, depending on the formulation of the compound, those wishing to produce items in LATER G BIO can aim to obtain the TÜV's OK BIOBASED certificate, from the single-star rating (at least 20% biobased) upwards.

LATER G BIO
(Compound based on PETg partially derived from renewable sources)

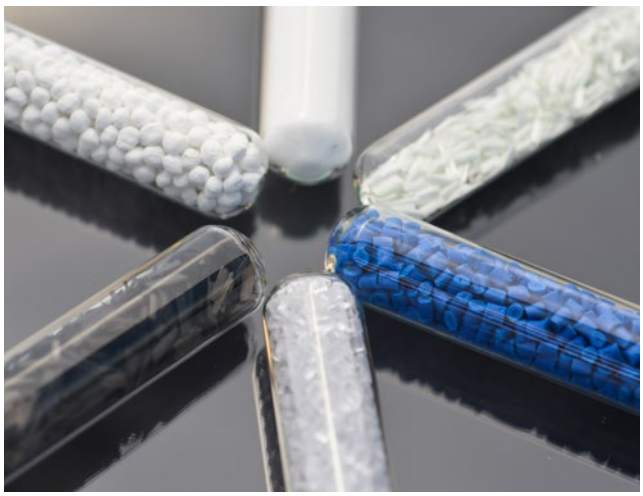
PETg is an amorphous resin featuring excellent properties in terms of dimensional stability, resilience and chemical resistance.

LATI has begun working on different, partially biobased (from 15% to 27%) versions.

In addition to the traditional grade, it has also developed compounds named HT whose higher HDT and VICAT test results make them similar to a polycarbonate also from a thermal perspective.

The LATER G BIO compounds can be considered for applications where the aim is to replace, with a more environmentally sustainable product, materials such as ABS or PC, while nevertheless maintaining the low isotropic shrinkage typical of amorphous ones.

With regard to possible certifications, depending on the formulation of the compound, those wishing to produce items in LATENE HD BIO can aim to obtain the TÜV's OK BIOBASED certificate with a single-star rating (at least 20% biobased).



3D - BIOMATERIALS

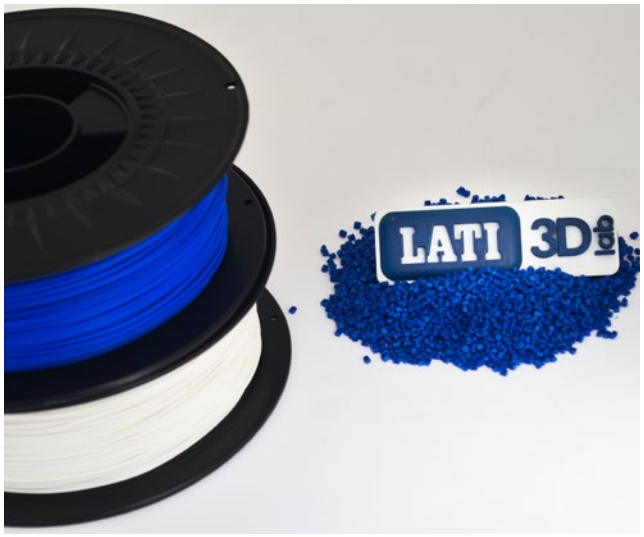
In the field of additive manufacturing, too, LATI offers technical solutions developed with close attention to the issue of environmental sustainability.

LATI3Dlab, the internal division of LATI that deals with materials for 3D printing, has developed a semi-crystalline PLA-based engineering compound named **LATIGEA AM B20 UVH TES/10**.

The material is perfect for extrusion of the filaments typically used in 3D FDM printers, but can also be processed using modern additive manufacturing technologies that directly print the pellet.

This adds up to a winning combination of environmental sustainability and strength for the compound.

Indeed, the material, being based on a resin entirely derived from renewable sources, overcomes the limits shown by typical PLAs available on the market.



The main properties of the compound are:

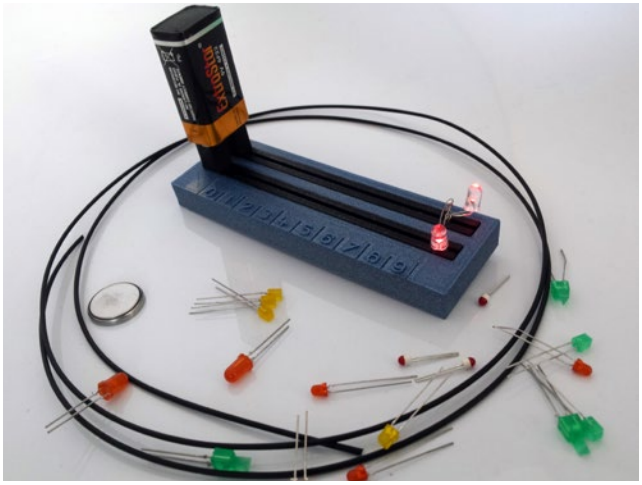
- Excellent mechanical strength and flexibility of the filament;
- High dimensional stability, low shrinkage;
- Improved resistance to UV rays and hydrolysis;
- Excellent aesthetic result and possibility of post-processing.

Furthermore, a few minutes of annealing at 100°C gives the material extraordinary thermal properties for a PLA (over 100°C as opposed to 50-55°C for traditional PLA).

SPECIAL 3D PRINTING FILAMENTS

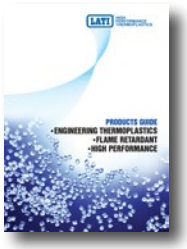
LATIOHM B61-01 AM CNT BK:3340
(Electrically conductive PLA for 3D printer filaments)

- Certified industrial compostability of the resin
- Electrically conductive



LATIGRAY B01-01 AM CX/70 NT:0102F3
(Radiopaque PLA for 3D printer filaments)

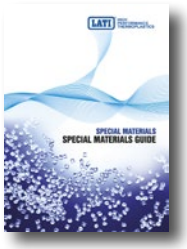
- Certified industrial compostability of the resin
- Electrically conductive or radiopaque



Products guide

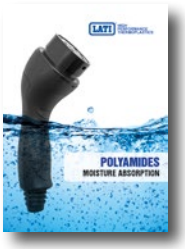
Engineering thermoplastics
flame retardant
high performance

Quick guide to LATI compounds



Special materials

Special materials guide

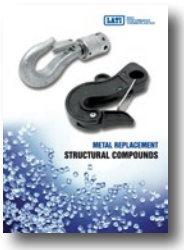


Polyamides

Moisture absorption

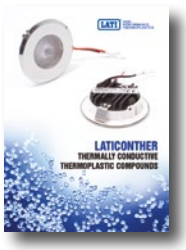
Latilub

Engineering polymers
featuring low coefficient
of friction and high wear
resistance



Metal replacement

Hi-performance compounds,
with high mechanical
properties



Laticonther

Thermally conductive
thermoplastic compounds

LATI Compounds

For water & food contact

Latigray

Radiopaque thermoplastic
compounds

Latiohm

Electrically conductive
compounds

LATI MDT

X-ray and magnetically
detectable thermoplastics

Latigea & environmentally sustainable compounds

Biobased compounds,
potentially biodegradable
and/or compostable

LATI Industria Termoplastici S.p.A. - Via F. Baracca, 7 - 21040 VEDANO OLONA (VA) Italy
Tel. +39-0332 409111 - Fax +39-0332 409307 - http://www.lati.com - email: marketing@it.lati.com