



QUADERNO 2 From Nature to Nature: The Biomaterials





1. BIODEGRADABLE AND THERMOFORMABLE PLASTICS

Biodegradable plastics whose components are derived entirely or almost entirely from renewable raw materials. Recent advances in research and technology have shown that these plastics can be made from abundant agricultural resources.

They preserve non-renewable resources - petroleum, natural gas, and coal - and contribute little to the already burdensome problems of waste management.

The primary commercial application of these plastics is in packaging and display trays. Biodegradable trays look, feel and function the same as traditional plastic trays except that biodegradable trays are made from renewable resources, and are almost entirely compostable when they come into contact with water.

They are manufactured as flat sheet roll stock in a range of standard colours and gauges for industrial use. The standard colour range is natural, white, brown, black and gold.

Biodegradable finished products are priced competitively with plastic trays made from petrochemical plastics. Biodegradable trays are not subject to the dramatic price variations petrochemical products are exposed to.

The material is suitable for dry foods packaging such as biscuit and confectionery trays, blister packaging, and trays for electronic components. (NT6021)

PROPERTIES

Bio-Based Biodegradable Compostable Recyclable UV Resistant Hypoallergenic

WORKING PROCESSES

Injection Moulding Thermoforming Blow Moulding

2. CORN STARCH-BASED POLYMER MATERIAL

Material based on corn starch and thermoplastic biodegradable polymers; recyclable, biodegradable and compostable, it can be coupled with paper, cotton and different natural fibres.

It also offers antistatic properties. It is widely used in the packaging field; it is available as film to make bags for collecting and composting food and garden waste or in foils and rolls for industrial packaging. It is also possible to use as filler, providing resilience and excellent shock-absorbing properties.

It is particularly suitable for the packaging of pharmaceutical products, laboratory equipment, and consumer goods.

Thermoformed containers such as plant holders or for cosmetics packages can also be made. In the food industry plates, cutlery, cups, straws and lids can be manufactured through injection moulding and, in some cases successive lamination onto posterboard.

Finally, it can be utilised to create pens, cartridges, pencil sharpeners and rulers in the vast field of accessories. (NT6001)

PROPERTIES

Compostable Biodegradable Bio-Based Recyclable Thermal Insulating Impact Resistant Antistatic Transparent

WORKING PROCESSES

Blow Moulding Lamination/Coupling Thermoforming Injection Moulding





3. BIODEGRADABLE HOT-MELT ADHESIVES

Hot-melt adhesives (also called hot glue) are polymer adhesives usually based on EVA, polyolefin or polyurethane.

These adhesives are initially solid and then are heated and softened and deposed on the surface intended for gluing.

It is currently possible to obtain a PHA-based hot-melt, a biodegradable and compostable polymer made from the bacterial fermentation from sugars and lipids.

By controlling the polymerization process it is possible to make a mixture that can be used for hot-melt applications, suitable for wood, glass, aluminium, paper, and many kinds of textile fibres.

Due to its composition, hot-melt adhesive is biodegradable (it meets the ASTM D6400 and EN13432 standard) and compostable.

The softening temperature is 110° C but the useful heating temperature is $115-135^{\circ}$ C.

Primary applications are in textile, apparel, footwear, printing, in labelling and in hygiene products. (AD4520)

PROPERTIES

Biodegradable Compostable Bio-Based Hydrophobic Waterproof Electric Insulating Elastic Thermal Insulating

4. FLEXIBLE CORRUGATED PANEL IN CELLULOSE

Corrugated panel made of 100% cellulose. Cellulose layers are pressed and heated on a special corrugated mould, without adhesive or binding agents.

The result is a stable and light panel. It is available in six different types, with densities from 1.25 to 2.7 kg/m², thicknesses from 0.1 to 0.2 mm and distance between surface waves from 1 to 2.5 cm.

Its corrugated surface is the main property of the panel and thus allows for very high flexibility.

This flexibility makes it suitable for numerous applications in interior design, home furniture and exhibition, theatre scenography and wall coverings.

The corrugated surface can be printed on to obtain significant chromatic and optical effects, thus broadening its potential applications. The panel can be worked using standard carpentry tools.

The surface can be treated to obtain waterproof properties and improved fire resistance. It is also available with a trapeze-shaped profile allowing for the creation of flat panels that can be glued together or to other surfaces. (NT6051)

PROPERTIES

Flame Retardant Thermal Insulating Soundproof Bio-Based Biodegradable Elastic Anti-Slip Electrical Insulating

WORKING PROCESSES

Lamination/Coupling





5. COMPOSTABLE FILM FOR FOOD PACKAGING

Compostable film made from renewable resources such as cellulose.

This film meets the requirements of the European, American and Australian regulations for compostable packaging such as EN13432, AS4736 and ASTMD6400.

They are available in various thicknesses from 20 to 50 microns in transparent, white, coloured and metallic versions.

Because they have a heat sealable layer on both sides, they have excellent hermetic properties against the flow of gas and contaminants as well as good chemical resistance to oils and fats.

There are also metallic versions available which provide increased barrier properties to gases, aromas and moisture.

They are used in food packaging applications such as for snacks, cereals, cookies, chips, bread, and vegetables.

They can also be treated to make the surface printable with common inks used in the packaging sector or with natural inks as well; in some cases they can be treated to make the surface anti-static.

In order to maintain film quality it is recommended to store it in an environment with temperatures between 17 and 23 $^\circ C$ and relative humidity between 35 and 55%. (NT6045)

PROPERTIES

Uv Resistant Suitable For Food Contact Compostable Reduced Emissions Bio-Based Biodegradable Transparent Thermal Insulating Electrical Insulating Antistatic

WORKING PROCESSES

Lamination/Coupling Welding

6. FIBRES AND FABRICS DERIVED FROM CORN

Natural fibres and fabrics made of 100% PLA (Polylactic Acid) derived from corn. The production and application of this corn-based fibre means a reduction in gases responsible for the greenhouse effect.

PLA is a melt-processable natural polymer. The fibres created combine the qualities of natural fibres and the performance of synthetic ones, offering strength, resistance, resilience, and good moisture management properties balanced with comfort and softness. Compared to traditional natural fibres, these products offer lower specific weight and higher tenacity.

PLA has a lower heat of combustion than PET and burns with less smoke than synthetic polymers. PLA has outstanding UV resistance and provides a low refractive index which allows for the achievement of intense colours after dyeing.

These fibres can be easily recycled, burned or composted back into safe, natural materials. Their applications are in fashion, furnishings and lining, as well as in a range of ecological felt for personal hygiene and garden textile applications.

The natural stain resistance inherent in these fibres makes them ideal for carpets for home, office, transportation and trade show events. (FT1128)

PROPERTIES

Biodegradable Recyclable Compostable Bio-Based Uv Resistant Stain Resistant Thermal Insulating Breathable Elastic Electrical Insulating



7. RECYCLED PAPER AND BIO-RESIN COMPOSITE MATERIAL

Green composite material made from 100% recycled paper and a petroleum-free phenolic resin that is obtained from natural substances like cashew nuts.

The material has very good mechanical and chemical features, it is resistant to temperatures up to $175^{\circ}C$ ($350^{\circ}F$), it is hydrophobic and has a certified class A fire rating. IT is generally produced as sheets which can be worked with standard wood-working instruments. Due to their pleasant appearance and ease of cleaning, they are often used in making counter tops and tables for residential furnishing as well as in restaurants and cafés.

The material is strong and durable, with great scratch, dent and chip resistance; it has a warm appearance and, thanks to a non-porous surface, provides a lifetime of stain resistance; it demonstrates great colour stability and resists the effects of ultraviolet exposure.

Sheets are available in different tones such as chocolate, gunmetal, leather, mocha, etc. Thanks to its high surface resistance to scratches and abrasions it is also used in making cutting boards. It may also be used as external coverings for buildings. (CP2135)

PROPERTIES

Thermal Insulating Soundproof Waterproof **Bio-Based** Recyclable **Reduced Emissions** Recycled Electrical Insulating Uv Resistant Suitable for Food Contact Hydrophobic **Corrosion Resistant** Low Friction Stain Resistant Impact Resistant Cut Resistant Scratch Resistant Abrasion Resistant

WORKING PROCESSES

Machining

8. PLASTIC VEGETABLE COMPOSITES

Granules obtained by mixing a virgin or recycled polymer matrix with a variable percentage (70-80%) of vegetable fibres (wheat, oats, maize, soybean, hazelnut, apple, beetroot, cacao) from discards of other processes, thus optimising other processes that already use vegetable products for uses in the food, cosmetic and pharmaceutical industry.

These granules, which are suitable for injection and extrusion moulding, are the raw materials that are used to obtain profiles with the appearance of wood.

Products moulded from these granules are 100% recyclable, resistant to water, moisture and weather conditions; they offer good dimensional stability, mechanical features and processability similar to polymers but with the environmental impact, workability and beauty of wood. (NT6035)

PROPERTIES

Electrical Insulating Thermal Insulating Waterproof Recyclable Bio-Based Recycled Uv Resistant

WORKING PROCESSES

Injection Moulding



9. WOOD FIBRE-REINFORCED POLYMERS FOR INJECTION AND EXTRUSION MOULDING

Wood fibre-reinforced polymers suitable for injection and extrusion moulding. Because they are plastic matrices they can use PP, PE, ABS, PS and POM but a formulation is also available where the base polymer is biodegradable PLA, so in this case the final granule is 100% biodegradable and without any environmental impact.

The percentage of wood fibres, ranging from 10% and 55% - depending in part on the polymer resin - and the type of matrix modify the final performance of the product. Generally, when compared to non-reinforced resins, these composites exhibit higher mechanical properties and increase the thermal resistance of the final product.

They can be processed as normal polymers in traditional injection and extrusion moulding machinery as well as using traditional moulds. All the methods used in post handling of plastic products - ultrasound welding, machining, laser masking as well as additives and colouring agents - can also be used with these composites.

They are often used to manufacture small parts such as for furniture, design, and decoration. Many products obtained by injection moulding also find applications in the automotive field (handles) and in the electronics field (cellphone covers). Its high quality acoustic property also makes it suitable for guitar speakers. (CP2115)

PROPERTIES

Soundproof Bio-Based Recyclable Reduced Emissions Thermal Insulating Uv Resistant Waterproof Electrical Insulating

WORKING PROCESSES

Machining Injection Moulding

10. PACKAGING DERIVED FROM MUSHROOM MYCELIUM

Mushroom-based packaging. This material is obtained from agricultural crop waste bonded together with mushroom "roots" (called mycelium), which represent the mushroom vegetative apparatus and appear with long white filaments.

The mushroom mycellium, when put in a particular environment (indoor, in the dark, without water or petrochemical inputs), grows in 5-7 days and digests the agricultural byproducts, binding them into a structural soft material like a self-assembling glue.

To stop the growth it is necessary to dehydrate and heat the system; this final process ensures that there will never be any spores or allergen concerns. This material, which is entirely recyclable and compostable, therefore offers the advantage of being able to assume any shape, given that it suffices to manage the growth of fungus within and/or around the object that has the desired form.

For this reason it represents an excellent option for protective packaging made of natural materials. In contrast to traditional bioplastics, the technology which produces this natural material does not use agricultural products but rather takes advantage of leftovers from agriculture (e.g. rice hulls) or from industry (e.g. from the working of cotton).

Moreover, if this process is compared with the one used to obtain expanded polystyrene, it is completely natural, consumes 10 times less energy and produces reduced emissions in the atmosphere. It is applied in packaging for electronic objects or for foodstuff (wine bottles, etc.). (NT6048)

PROPERTIES

Thermal Insulating Soundproof Elastic Impact Resistant Electrical Insulating Compostable Recycled Bio-Based Energy Saving Biodegradable Reduced Emissions Recyclable





11. EXTENDIBLE PAPER SHAPED USING MOULDING TECHNIQUES

The base material is pure cellulose and chlorine free. The finished product is a composite material that can be coated with any polymer or laminated in thin sheets, depending on the sector it will be used in. It can be processed by any thermoforming techniques with moulds.

It can be impregnated with impermeable and protective substances. The added value of this paper is that it can be directly moulded, without using standard heat-working techniques.

This is possible thanks to improved resistance to breaking and its elongation properties which are much higher than normal paper.

The use of this product is advantageous as it reduces the use of plastics and the weight of products. It is compostable and recyclable, thus reducing the volume of wasted material.

Main sectors are: packaging (food stuff, pharmaceuticals, beverages); pharmaceutical (protective films and barriers); furnishings and automotive (for aesthetic particulars). (CP2091)

PROPERTIES

Thermo-Conductive Tri-Dimensional Compostable Recyclable Hydrophilic Uv Resistant Stain Resistant Elastic Waterproof Electrical Insulating

WORKING PROCESSES

Lamination/Coupling

12. BIODEGRADABLE FOAM FOR PACKAGING

Polylactic acid-based natural foam, biodegradable and compostable. Starting from white granules, the foam is produced by machines similar to those used in the process of polystyrene foaming and has very similar characteristics.

It is suitable for packaging as it is formable to shape and can also follow the customer design, similar to what occurs in traditional packaging made of polystyrene foam. It is available in a variety of densities generally from 25 kg/m³ to 50 kg/m³; it has high damping characteristics in accordance with related regulations for packaging materials such as ASTM 1596.

This type of foam meets the requirements of European Directive EC1994/45/EC concerning the absence of heavy metals and harmful substances, toxins or carcinogens, and also meets the European Directives 2002/95/EC and 2000/53/EC.

In addition, the carbon footprint of the product is very low when compared to traditional foam packaging. The foam does not disintegrate in compost at room temperature, because an industrial composting plant with at least 70° C is needed, combined with adequate moisture and bacterial components.

The foam is not susceptible to attack by termites in accordance with the standards of EN 117/118. The granule form is also used as an economical filler in composites where thermosetting resins are used (e.g. styrene) and fibre-reinforced glass, allowing for a reduction in styrene emissions and providing enhanced lightness to the final product. (SC5048)

PROPERTIES

Soundproof Reduced Emissions Compostable Biodegradable Bio-Based Breathable Thermal Insulating Vibro-Absorbent Impact Resistant







