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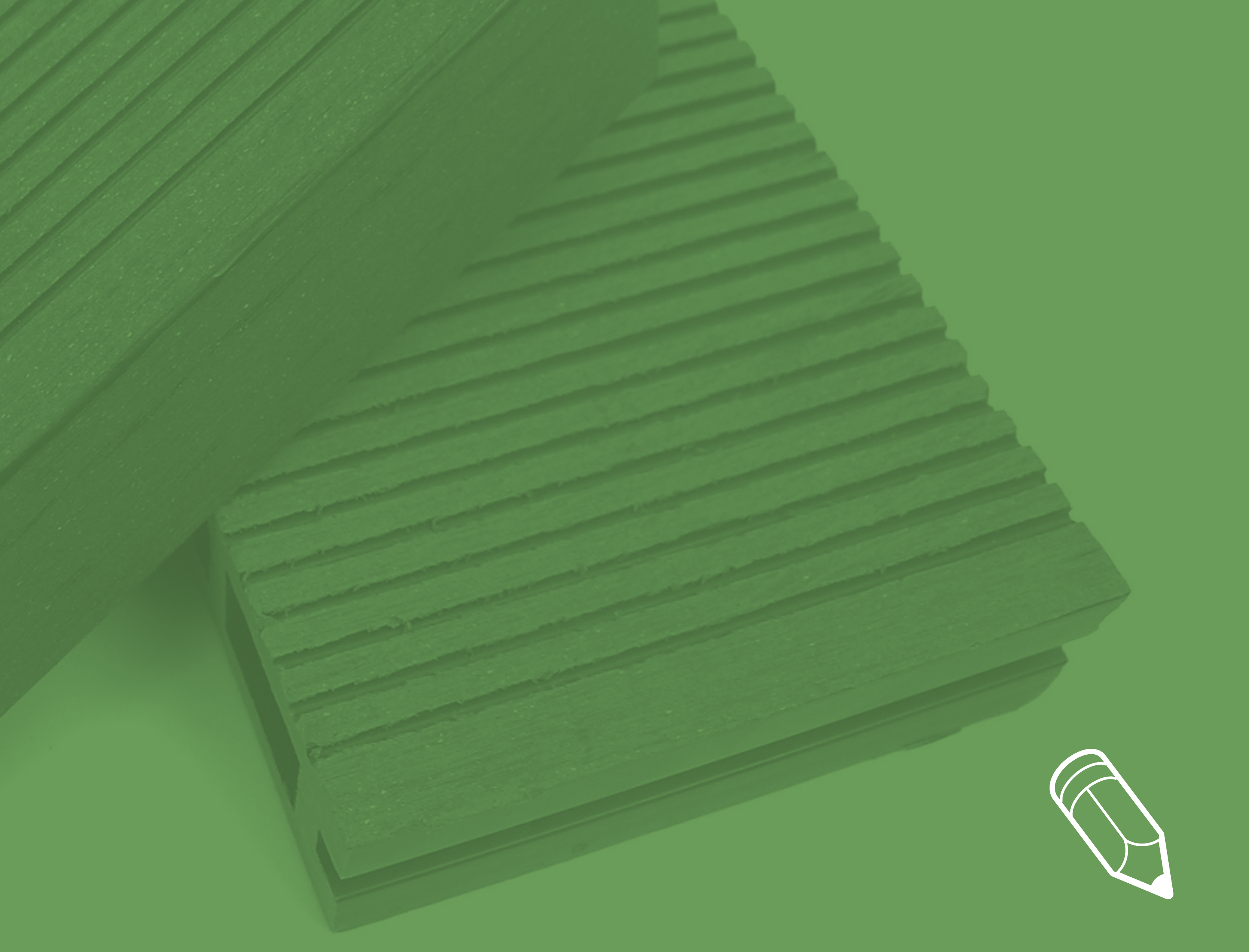
NOTEBOOK 1

New Materials and Technologies



NOTEBOOK 1
New Materials and Technologies

As we have mentioned, the choice of the correct materials to create packaging for the Food and Beverage sector is a complicated one, which must take into account numerous implications: material costs, the technologies involved in the working, compatibility with food contact, its methods of transport and use and waste management.

In evaluating the environmental impact linked with the life cycle of a product (LCA), materials play a decisive role.

The origin (natural or artificial), extraction processes and initial transformation for obtaining a raw material must be carefully evaluated and solutions must be found to minimize impacts in these early phases as well.

However, the choice of materials also has significant repercussions throughout the entire evaluation of the life cycle.

The industrial processes needed to create a product and the transport phase of that product inevitably depend on the materials chosen. New, more eco-efficient technologies, lighter materials and more careful planning can contribute to minimising impacts in all of these phases.

The products of today are the waste of tomorrow; it is, therefore, important to identify and favour materials which are most suitable for the best practices of waste management; that is, reusable, recyclable, biodegradable and/or compostable materials.

The following "notebooks" attempt to answer these issues by presenting materials that can reduce product weight (Material Notes n.4), natural or biodegradable materials (Material Notes n.2) and materials that can enhance management at a product's end-of-life (Material Notes n. 3)

As reported in the document FBP-Main Issues, a final but fundamental feature connected to the FBP sector regards the capacity for material to protect the product from physical and biological degradation, thus limiting the waste of foodstuff, whose production requires energy and has impacts on the environment.

In this day and age the utilisation of new materials represents one of the most effective tools in lending added value in the form of technological innovation to products as well as in terms of ecological sustainability.

This notebook strives to describe materials that are currently used in the Food and Beverage sector as well as new features found within the market, with a final look toward upcoming technological developments.

The materials used in the packaging sector can be divided into 5 families.

1. GLASS

Primarily manufactured from silica sand, glass is highly resistance to loads, high temperatures and chemical products. Moreover, it demonstrates excellent barrier properties to gases and liquids.

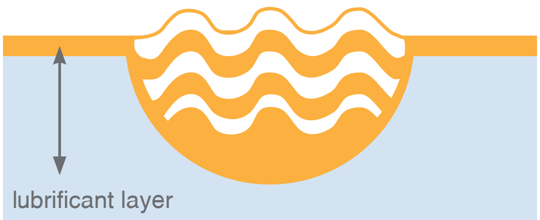
Green or brown colouring allow for protection from light and degradation from UV radiation as well. Glass is used to create impermeable containers that are easy to open, especially bottles.

Manufacturing is one of the phases in the life cycle of packaging that has the most impact, which is on par with equivalent plastic products where higher temperatures and continuous movement of parts is necessary. Compared to plastic, however, the final weight of the bottle is at least five times heavier; this translates into greater energy expenditure in terms of movement and transport.

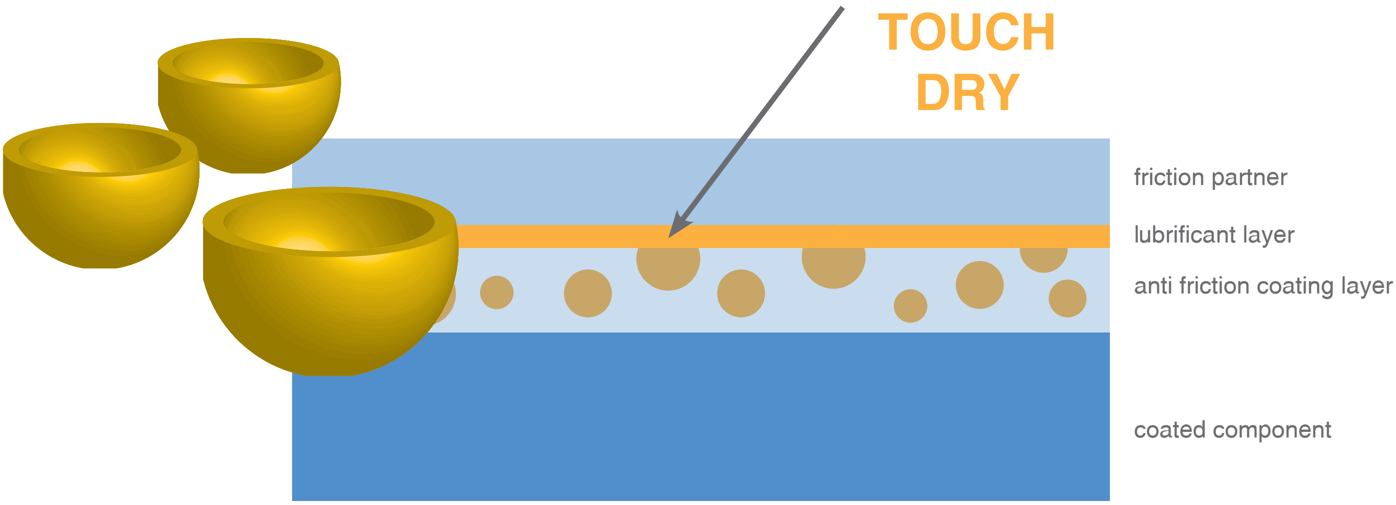
The reduction of friction in manufacturing systems, for example, can limit the overall energy consumption of the process. Also, alternatives to the traditional systems of oil and grease lubrication are beneficial. For example, a unique coating exists which contains a special lubricating oil.

This coating is made of a water-based solvent that is dry to the touch, has microsphere additives and is only visible by microscope. In the case of rubbing, and therefore friction, the microspheres break, releasing the substance contained within which then forms a lubricating microfilm between the two parts in contact.

Glass packaging can reach high standards of eco-compatibility when it is reused, which occurs at a very high percentage in European countries. Recycling is a valid alternative to disposal, as 10% to 99% of glass weight is capable of being introduced as secondary raw material.



cross section: open microcapsule



2. METAL

Nowadays, metal is used to make containers, closing sheets and closing systems. The two most prevalent materials are stainless steel and aluminium, thanks to their high resistance, protection, and durability; the main products manufactured with metal are barrels, cans and tins. Both stainless steel and aluminium are currently recyclable.

Manufacturing using thin closing sheets is particularly significant. These sheets are then combined with plastic or paper/paperboard to make blisters or pouches of various dimensions. In doing this, weight is significantly reduced (a pouch containing liquid weighs 10% of its glass equivalent).

Aluminium and plastic can then be separated using high pressure and vacuum processes, allowing both materials to be recycled.

The manufacturing phase of metals requires considerable energy expenditure; this means that recycling is of the utmost importance, as the energy consumption in this phase proves much lower in comparison to the energy used in the primary production line.

3. PAPER AND PAPERBOARD

Paper is obtained from primarily plant-based fibrous raw materials, which is welded together and dried. Although the original raw material is renewable (wood) the collection phase, transport and transformation can require considerable amounts of energy.

The primary limitation of paper and paperboard regards its poor ability to control humidity and to block gases and liquids.

This type of material is used as primary packaging, sometimes combined with metallic closing sheets and/ or polymer sheets and then treated with special surface coatings which give it barrier properties and improve its aesthetic finish.

This combination, however, makes recycling problematic, as specific treatments become necessary which not only require high energy expenditure but ultimately make recycling difficult.

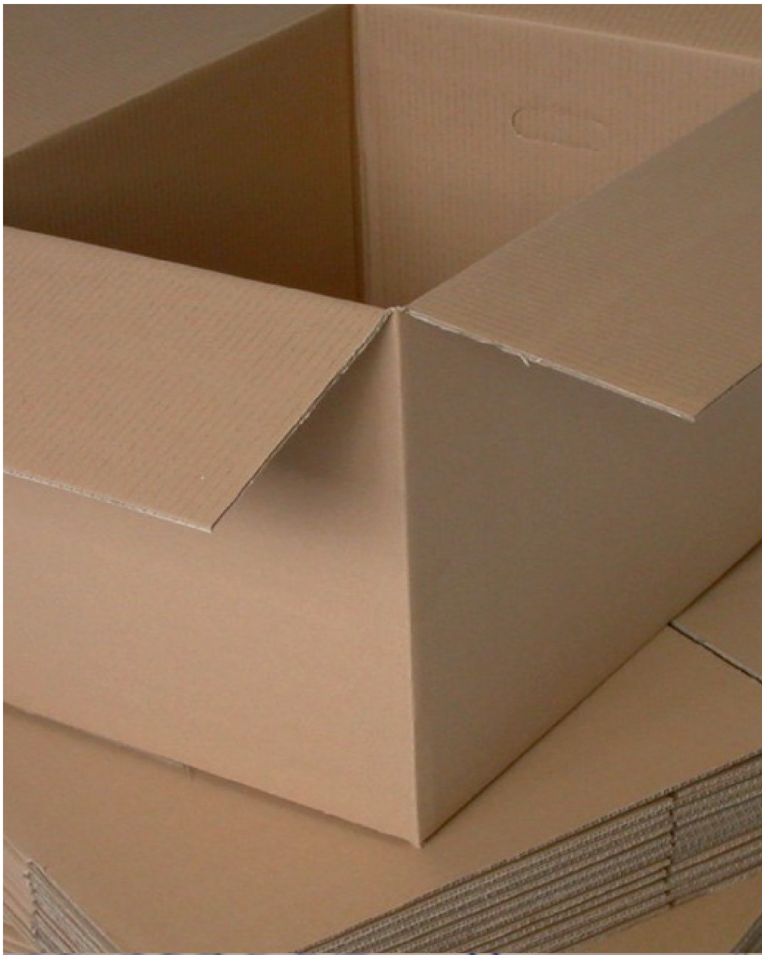
Paper and paperboard are also used as secondary and tertiary packaging, where the percentage of recycling is higher.

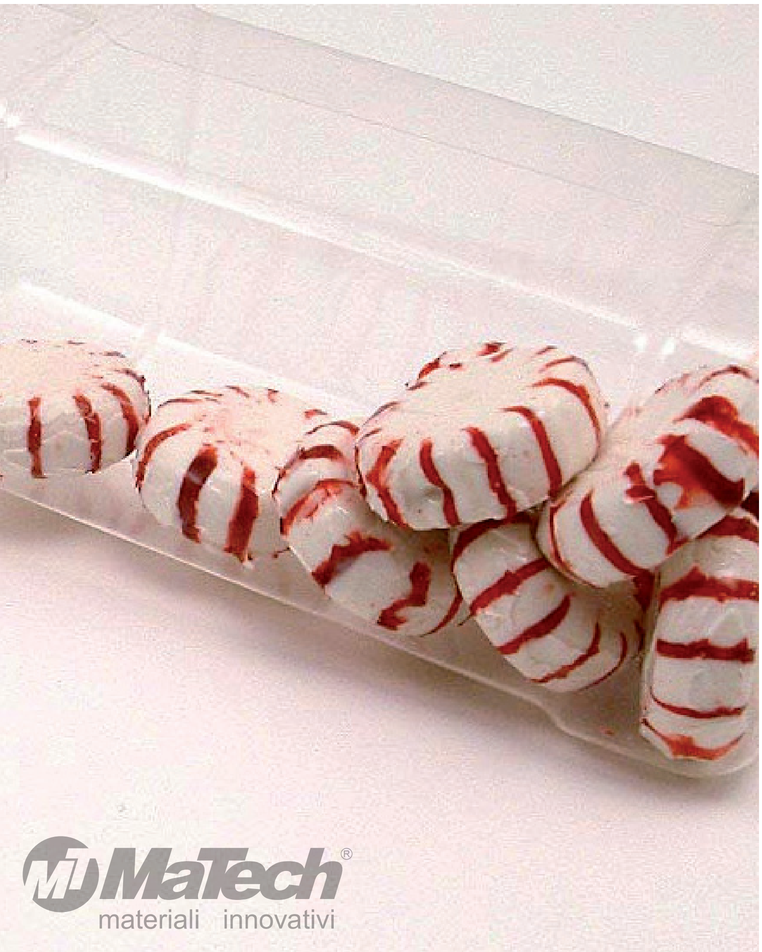
An innovative surface treatment for paper has recently been introduced to the market. It is an alternative to traditional barrier treatments and is able to offer barrier properties that are superior to polyethylene while creating less environmental impact.

It is a low density LDPE polyethylene and calcium carbonate-based ($CaCO_3$) coating made with thickness from a few microns up to the order of a millimetre.

This technology can therefore be defined “ecocompatible” as it allows for a considerable reduction in CO_2 emissions into the atmosphere as well as a reduction in the energy consumption needed for the manufacture of the packaging itself.

This treatment is used in the packaging sector on paper substrates, both virgin as well as recycled, and allows for a 60% reduction (in weight) in the use of plastic materials in comparison to packaging that uses pure LDPE as a barrier film.





4. POLYMERS

Obtained from petroleum, polymers are present in the world of packaging in a multitude of types. Specifically, the most commonly used polymers are polyethylene (PE), used primarily in sheets and flexible and thin packaging, polypropylene (PP), to make packages and closures, polyethylene terephthalate (PET) for bottles and jars, and polystyrene (PS) for foam. Polymer-based packaging can be reused, recycled or used for energy recovery.

One of the primary limitations of polymers lies in their fossil origin and the considerable stability of the product at end-of-life (waste). Therefore, polymers derived from renewable, recyclable and biodegradable resources are particularly advantageous. These are defined as biopolymers.

Biopolymers are polymers which come from renewable resources, generally corn, sugar cane, potato starch or castor oil. As laid out in FBP Material notes n. 2, biodegradation means any process that allows for specific microbes to digest entire molecular structures present in polymer materials.

To date, the international organisations that have established standards and test methods are:

- American Society for Testing and Materials ASTM 6400-99
- European Standardisation Committee (CEN) EN 1 3432
- International Standards Organisation (150) I S 0 14855
- German Institute for Standardization (DIN) DI N V49000

ASTM, CEN and DIN standards specify criteria for biodegradation and eco-toxicity as a plastic can be considered “compostable”.

Polymers of this type are generally employed for the production of flexible extruded film in blow-moulding systems as a substitute for PE or PET. Also, through thermoforming, these materials are used for the production of various kinds of bowls, replacing PP and PS.

This is especially true for fast food restaurants, where problems with the high-volume disposal of these types of products can be offset with the use of biodegradable and compostable biopolymers in order to safeguard the environment.

Certain notable polymers such as those derived from PLA (polyactic acid) fall into this category.

As laid out in greater detail in FBP Material Notes n. 2, biodegradable PLA based-foam (sometimes with recycled paper added) is now available. This foam is particularly advantageous from a sustainability point of view, given the significant consumption that occurs in FBP.

These materials represent real alternatives to polystyrene foam and feature a non-polluting end-of-life cycle.

An example of a next-generation biopolymer is PHA (polyhydroxyalcanoate), which is a linear thermoplastic polyester synthesised by non-pathogenic bacteria, from sugars or lipids.

Although its discovery dates back a few decades, it has been possible to industrialise its production in quantities capable of satisfying market needs only in the last years with the exponential development of research into bioreactors.

There are 150 different grades of PHA, with mechanical properties that are very similar to polypropylene; the ability to produce it with elastomer properties is particularly interesting. It is biodegradable according to European norm EN13432 and is certified for food contact in accordance with FDA regulations.

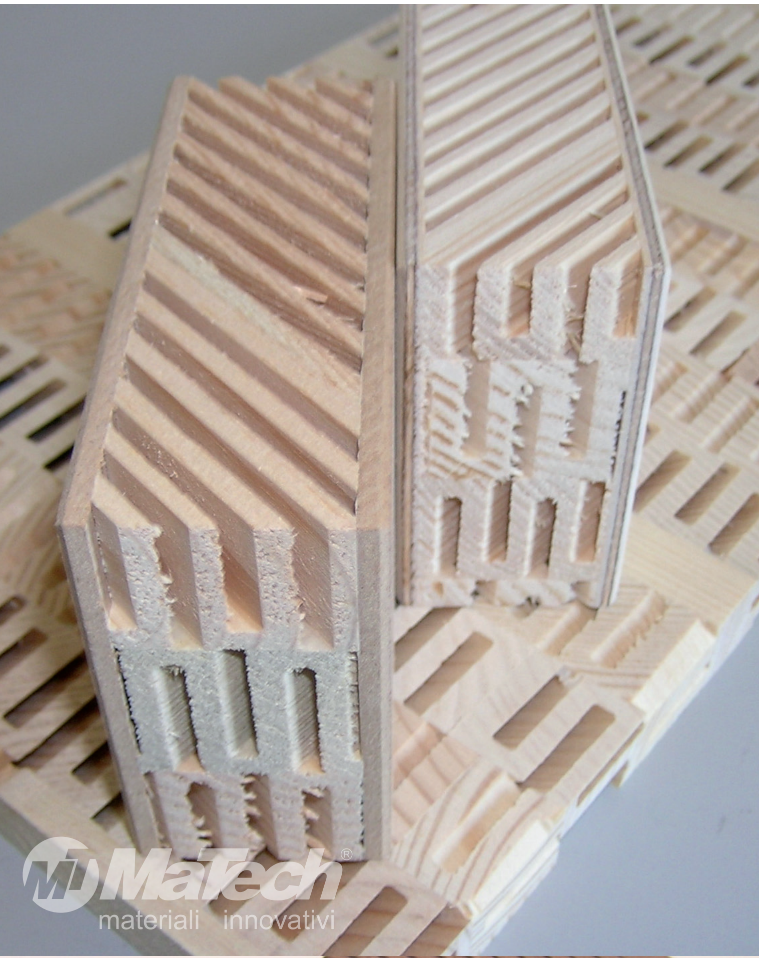
The feature that most distinguishes PLA is its high barrier properties to gas, which is quite similar to PET.

All of these qualities, together with its excellent resistance to UV exposure and stability to water, make it ideal material for food packaging in film form, as sheets for thermoforming or as a product carried out by injection moulding.

The search for eco-sustainable solutions has brought onto the market the availability of inks that respond to the requirements of the EN 13432 norm which currently regulates the European market for biodegradable and/or compostable products. These inks can be applied to biodegradable materials and PLA-based film derived from corn or cellulose.

Finally, In the field of plastic materials it is worth mentioning the recent development of citric-acid-based plasticising additives as a substitute for phthalates. These additives are used with PVC or cellulose derivatives, for example.

These additives have the property to reduce the hardness of the polymer, are suitable for food contact and are biodegradable. They can be used in the fields of foodstuff, pharmaceutical and medical, the toy sector and in cosmetics.



5. WOOD

Wood is primarily utilised for pallets and crates. It can be reused many times.

Because its raw material comes from reserved and controlled cultivation, wood has the lowest environmental impact in comparison with the previous families mentioned.

Further minimisation of packaging made from wood can be carried out thanks to more careful eco-designing (study of dimensions and efficient forms)

In this regards, we shall point out a special light-weight lamellar panel made in pine wood whose unique structure guarantees reduced weight, dimensional stability and good thermal-acoustic insulation.

These features are achieved thanks to a special production process that allows for the 90° cutting and gluing of various layers of wood. In this way, density values equal to 250 kg/m3 are reached and the natural tension within hardwood is reduced.

Today, discards from wood-working can be used as fillers for producing so-called WPC (Wood Polymer Composite). This involves compounds with polyolefinic matrices (PE, PP or PVC) added in variable percentages (up to 70%) with wood flour and wood powder.

In this way a master is obtained, which is processable with traditional polymer-working processes and creates an aesthetic effect that is similar to wood.

In some cases certain mechanical properties are increased (resistance to traction and elastic modulus) and physical properties such as impermeability and resistance to water are conferred.

THE PACKAGING OF THE FUTURE

Nowadays, the evolution of technology allows us to “design” the properties of materials according to the needs of product performance in which they will be inserted.

To give an example, a special polymer extruded into sheets which, thanks to a unique post-extrusion technique, can be bent an infinite number of times without yielding.

This material, which is polyethylene-based, has a melting temperature equal to 130°C. It is available in metal strip form of different thicknesses (from 0.4 mm to 1 mm) and widths (from 2.5 mm to 10 mm).

It can be multi-layer laminated in order to give the material the possibility to withstand bending in all directions. It is certified for contact with foodstuff according to Japanese norms.

Potential applications concern the sectors of safety devices (nose clips for masks) footwear (straps for women’s shoes), foodstuff (packets for coffee), biomedical, toys and fashion.

Thanks to its properties, this material can be used as a replacement for metals, thus allowing for improved waste management.

The real frontier packaging is pushing toward is smart materials and intelligent packaging (also called active packaging). Intelligent packaging is a type that does not only contain, protect or statically transport the product, but is able to monitor its contents and to communicate eventual chemical-physical variations within.

In this perspective, a number of special mono-use labels were created with a timer function controlled by a liquid through a porous structure.

By varying the combinations of liquids and membranes, these labels can be calibrated for periods of times ranging from a few minutes up to a year as well as be calibrated to function in specific environments: at room temperature, in the refrigerator or in the freezer.

Thanks to these properties, they are applied to the surface of food products with an adhesive in order to monitor their expiration date or the time in which they are kept at a certain temperature.

The use of microspheres containing active ingredients also falls into this category; they are applicable to textiles and paper but also polymers and metals.

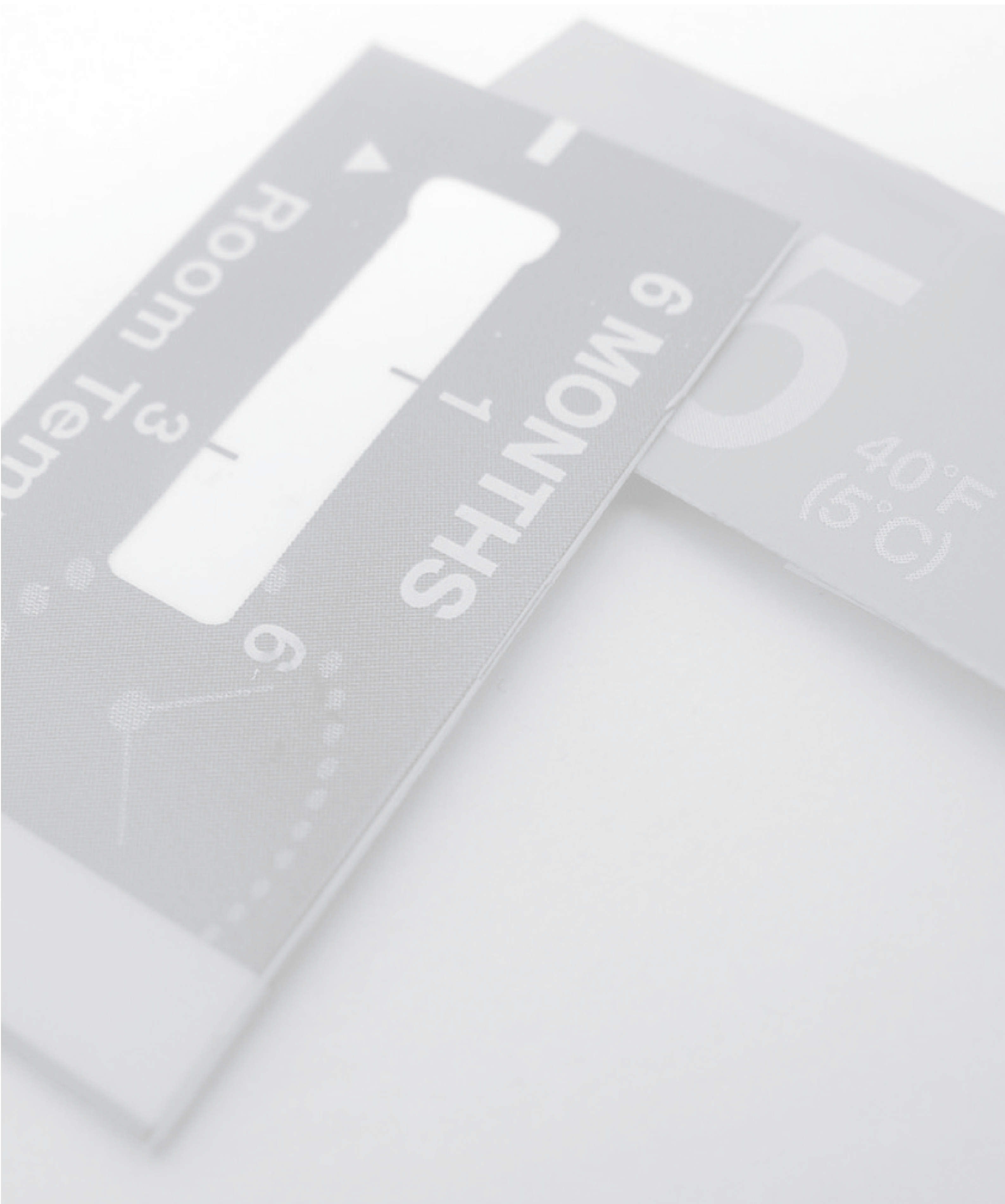
They can contain fragrances and aromas, be odour absorbent, sanitising and anti-microbial agents, and their ingredients come from herbal medicines (aloe vera, tea tree), Vitamin E, etc. The breaking of the microspheres always occurs by shear stress (typical of rubbing) and not by impact.

An extremely recent innovation in this technology consists in reducing the dimensions of capsules until an order of nanometres. In this manner the release of the principle ingredient is regulated even further; moreover, it is possible to achieve the breaking of the nanospheres with variations in pH, temperature, radiation, etc.

Studies are being conducted on the use of nano-encapsulation techniques in food products, but also in cosmetics and medical products, in order to add new properties and functions, such as protection from humidity, heat and other critical conditions linked with conservation.

Inorganic-based nanoadditives can also be inserted into polyethylene and polypropylene with the function of absorbing UV rays. These are nanometric particles (with dimensions of 50-100 nm) of metal oxides, which are zinc oxide-based (ZnO) or titanium dioxide-based (TiO_2).

In comparison with traditional inorganic additives, these materials offer greater UV protection and guarantee better final transparency and robustness. In food packaging they are utilised to prevent odour production and the loss of vitamins.


6 MONTHS
40°F
(5°C)

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