PACKAGING DESIGN FOR RECYCLING

A GLOBAL RECOMMENDATION FOR CIRCULAR PACKAGING DESIGN

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A GLOBAL RECOMMENDATION FOR
'CIRCULAR PACKAGING DESIGN'

FH CAMPUS WIEN
UNIVERSITY OF APPLIED SCIENCES

ECR COMMUNITY
EFFICIENT CONSUMER RESPONSE

WPO
WORLD PACKAGING ORGANISATION

CONCEPTION AND TEXT

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CONTENT-RELATED INPUT

Participants of ECR Austria Workinggroup 'Circular Packaging Design'

GRAPHIC REALISATION

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COVER

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This global recommendation is based on the work of the ECR Austria Circular Packaging Initiative, that has been put in place by ECR Austria in collaboration with University of Applied Sciences FH Campus Wien.

FOREWORD

Declan Carolan

Birgit Schröder

Co-Chairs, ECR Community

ECR Community is delighted to support the publication of these global recommendations for circular packaging design for recycling. This publication aims to promote knowledge development within the retail and CPG sector as companies transition to new packaging designs that help to minimise their environmental impact, while ensuring packaging remains fit for purpose and continues to look good.

We recognise both the challenges and opportunities that the transition to a circular economy will bring and understand that circular packaging and supporting recycling systems are a crucial step in this process. The EU's 'Circular Economy Package' will significantly disrupt the packaging landscape and it is critical that retailers and manufacturers remain ahead of the curve, especially for those operating in multiple markets.

As retailers and manufacturers start to publicly commit to significantly reducing their plastic packaging over the coming years, these recommendations should help to guide the conversation. The use of a straightforward traffic light system with colour coding, makes it easy to read and understand for all senior executives. Getting buy in from across the business and from those in your supply chain is essential when making such changes.

ECR Community is well positioned to disseminate this publication globally to its members. We are a global association for all ECR National organisations in the Retail & Consumer Product Group sector. As a not for profit, we provide a neutral platform to develop and share best practices among our network of ECR Nationals and their members. A key focus area for us is the circular economy, given the impact that this transition will have on retailers and manufacturers over the coming years.

These global guidelines build on two years of work by ECR Austria, FH Campus Wien and its partners to publish the ECR Austria 'Packaging Design for Recycling' and 'Sustainability Assessment of Packaging'. We now call on our ECR Nationals to disseminate these Recommendations to their members.

FOREWORD

Nerida Kelton
WPO Vice President –
Sustainability & Save Food

Johannes Bergmair
WPO General Secretary

The World is facing enormous challenges. Principal amongst these are climate change, environmental destruction, scarce resources, globalisation, population growth as well as demographic change.
One of the commonly recognized ways for human societies to adapt to these challenges is moving from a linear to a circular economy. Today we are consuming raw materials more than the world is able to produce. Renewable raw materials would last for less than 6 months every year if we would limit consumption to the annual growth. In order to ensure that the world remains sustainable for the future human generations we have no other alternative but to learn to live in a circular economy. For this reason, WPO aims at highlighting the issue of a circular economy and the role(s) of packaging within it.

'Better Quality of Life, Through Better Packaging, For More People'

This is our vision at WPO World Packaging Organisation. We know that Packaging is an indispensable tool for every society on the planet. There is no culture on earth that can do without packaging. But too often, packaging is viewed by many as a problem. Our goal is to educate people, through our membership, about the important and valuable aspects of packaging. The world cannot do without packaging, but we must learn to make packaging even more effective; and we must educate people everywhere to respect the purpose of packaging and to incorporate this tool into the process of building an ever more sustainable society.

The World Packaging Organisation is a non-profit, non-governmental, international federation of national packaging institutes and associations, regional packaging federations and other interested parties including corporations and trade associations.
Founded 1968 in Tokyo by visionary leaders from the global packaging community, the purpose of the organisation includes:

- Encourage the development of packaging technology, science, access and engineering;
- Contribute to the development of international trade; and
- Stimulate education and training in packaging.

Some months ago, when the WPO had the idea to develop an international Circular Packaging Design Guideline the project seemed an impossible pipe dream. As we proudly release the first component of this guideline to the world, we have shown that a dream can become a reality. This resource was simply not possible without our wonderful collaborative partners who worked alongside the WPO at every stage of the project. The WPO sees this new resource as the first step to developing a consistent global notion of Circular Design Thinking for materials and Packaging. The next step is to encourage all of our 53 Member countries to not only use the tool but also work with the WPO to develop more localised versions that suit their countries and regions. This is the only way to provide better quality of life, through better packaging, for more people globally.

DISCLAIMER

The information in this guide is based on the Circular Packaging Design Guideline of the FH Campus Wien and has been adapted to match. The FH Campus Wien guideline is available to participating stakeholders along the entire value chain as a technically sound framework for packaging development.

The team behind the Department of Packaging and Resource Management at the University of Applied Sciences FH Campus Wien conducts research in the areas of sustainable packaging development and circular design, as well as methods for assessing the **sustainability** and safety of packaging. The guideline is continuously updated and adapted to changes in collection, sorting and recycling technology, as well as to future material developments. The changes are coordinated and continuously developed in the 'Circular Packaging' stakeholder forum.

The ECR Guideline for Recyclable Packaging Design aims to prepare the contents of the Circular Packaging Design Guideline for a broader target group in a practice-oriented way and focuses on the **packaging system.** A clear data basis (e.g. technical specification) is a prerequisite for the specific evaluation of individual packaging solutions. An assessment can, therefore, only be made on a case-by-case basis.

Innovations and continuous updating

This text should not be seen as an obstacle to innovation (e.g. bio-based materials, new barrier technologies or developments in sorting and recycling technology, etc.), given that new technologies can lead to an improvement in ecological performance and must, in each case, be analysed separately. Changes in collection, sorting and recycling technology, as well as all future material developments, will be followed up as the FH Campus Wien Circular Packaging Design Guideline continues to evolve.

Product-specific requirements

These guidelines can be applied to products from the Food, Near-Food and Non-Food segments. The packaging for the different segments usually does not differ from a technical perspective with regard to the recyclable packaging design. Only the requirements for barrier and sealing techniques in use will vary, but these are listed in the tables and can be applied if necessary. It should be noted that, in relation to the use of secondary materials and plastic recyclate for the production of new packaging, there are different requirements for the Food, Near-Food and Non-Food sectors that are rooted in law.
The Guideline is, therefore, applicable to all primary, secondary and tertiary packaging, as well as food, near-food and non-food packaging, provided that product-specific regulations of the packaging system are observed.

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1. INTRODUCTION – SUSTAINABILITY AND THE CIRCULAR ECONOMY

A holistic view of packaging is essential for sustainable product development. The holistic approach to packaging design includes:

Environmental sustainability:
- Product Protection
- Circularity
- Environment

Other aspects:
- Technical feasibility
- Processability through packaging equipment and processes User-friendliness for consumers
- Information to consumers

When optimising packaging, contradictions between individual requirements often lead to conflicting goals. The core objectives in sustainable packaging development are to deliver on a Circular Economy and the reduction in the sources of ecological impact on the environment. Contradictions in these areas arise, for example, in the use of **flexible packaging** solutions, which are often complex to recycle, or **rigid packaging solutions** which usually have a higher ecological impact than flexible packaging. Design for recycling is part of circular product design and represents an important basis for holistic sustainability assessment.

1.1 Legal framework conditions for the Circular Economy

Packaging fulfils a variety of essential tasks. From protection, storage and transport functions to aspects such as easier use and the provision of product information. These services contribute significantly to sustainability, because without packaging, sensitive products can be damaged or food losses can occur. In addition, the production of the packaged goods in many cases has a significantly higher environmental impact than the production of the packaging itself. Therefore, product protection and the avoidance of product losses due to premature spoilage or the insufficient **emptying ability** of the packaging should be given high priority.

Even though packaging can contribute to a sustainable economy, as a consumer good, its public reputation tends to be negative. In addition, problems such as **littering**, the generation of emissions and the consumption of resources are in the spotlight. In recent years, a growing demand for greater sustainability in packaging design has definitely been apparent.

Sustainable packaging offers maximum functionality with the best possible product protection, it causes minimal ecological damage and is as circular as possible. The **circularity of packaging,** in particular, is becoming ever more urgent, as the European Union is demanding a reduction in the use of resources, the reusing of products and packaging and significantly higher **Material recycling** quotas as part of the **EU Circular Economy Package,** and is pushing the use of recycled material as a **secondary raw material.**

The Circular Economy Package in the EU that entered into force in July 2018 includes provisions for enhancing circular approaches to raw materials at the European level. In 2018, the package of measures led to amendments to the **EU Packaging and Packaging Waste Directives (94/62/EC)** in combination with the **Landfill Directive (1999/31/EC)** and the **overarching Waste Framework Directive(2008/98/EC).** The Package also includes a specific paper on plastics A European Strategy for Plastics in a Circular Economy, in short **EU Plastics Strategy**). The focus is on increasing the recycling rates of all packaging materials and expanding the **extended producer responsibility,** as well as restricting the marketing of individual plastic articles. Producers of plastic packaging, in particular, are facing important challenges, given that mandatory recycling rates will be raised from the current level of **26% to 55% by 2030 (2018/852/EC amending Directive 94/62/EC).** The new

Single-Use Plastics Directive (2019/904/EC) also contains regulations on single-use products made entirely (or partly) of plastic. The directive prohibits, for example, the use of drinking straws, cotton buds, **oxo-degradable plastic** and disposable cutlery and promotes the reduction of beverage cups. In addition, Article 9 of the directive prescribes the **separate collection of beverage bottles up to three litres (including their closures) with a quota of 77 % (by 2025) and 90 % (by 2029).** Similarly, from 3 July 2024 (in accordance with Article 6), beverage containers of up to three litres made wholly (or partly) of plastic may only be placed on the market if the closures or lids on the packaging remain attached to the container for the duration of the intended use. Takeaway packaging made of **EPS** is completely banned. The basis for these measures is the waste hierarchy, which is described in the following text.

Circularity

Design for recycling is part of circular product design and represents an important basis for holistic **sustainability assessment.** Accordingly, circularity means that the packaging is designed in such a way that the highest possible recycling of the materials in use can be achieved. The goals here are resource conservation, the longest possible service life, material-identical recycling (closed-loop recycling) or the use of renewable materials. Circular packaging should therefore be designed and manufactured in such a way that it can be reused (reusable solution) and/or that the raw materials used can be reused to a large extent as **secondary raw materials** after the use phase (recycling) and/or consist of renewable raw materials.

However, according to the **waste hierarchy,** which pursues the goal of resource conservation, the avoidance of packaging waste should be given top priority. This is followed by measures for reuse and a recyclable packaging design. The following illustration shows the measures that should be applied, above all, to the design of circulatory **packaging systems.**

1. Reduce

Reducing the use of materials to avoid the generation of packaging waste.

2. Reuse

Enabling the reuse of the packaging material used, for example, after cleaning.

3. Recycle

Design of packaging to enable high quality recycling.

Nevertheless, the option that offers the best environmental performance over the entire **life cycle of the packaging** should always be chosen. In this assessment, many factors – as well as regionally specific recycling structures – must be taken into account.

1.2 Definitions of terms

The following chapter defines basic terms that are used in the context of circular product design.

1.2.1 Recycling rate

According to Directive 2018/852/EC amending Directive 94/62/EC on packaging and packaging waste (Article 1) of the European Commission, the weight of packaging waste generated and recycled in a given calendar year in relation to the quantity introduced to the market is used to calculate the recycling rate. The actual determination of the weight of packaging waste counted as recycled should, in principle, be made at the point where the packaging waste enters the recycling process. This means that it is the quantity that has already passed through the material-specific sorting process. Losses from pre-treatment steps were taken into account. In the case of plastics, for example, this includes the material that is fed directly into the extruder for remelting.

1.2.2 Recyclability

Products must meet the following criteria to be recyclable: The material used is collected by country-specific and region-specific collection systems and can be sorted using the latest technological standards. Furthermore, it is recycled in a recycling process that uses state-of-the-art technology. The resulting **secondary raw materials** harbour significant market potential, which can be used as substitutes for material-identical new materials. Recyclability is, therefore, to be distinguished from the actual recycling rate.

1.2.3 Sorting capability

Sortability is a basic requirement for recyclability. It must be ensured that material-specific, state-of-the-art sorting techniques can be used. The sorting capability depends, on the one hand, on the detectability and correct identification (e.g. material recognition by a specific **near-infrared** spectrum) and, on the other hand, on the sortability of the packaging itself (e.g. ejection by means of compressed air).

1.2.4 Use of recycled material

DIN EN ISO 14021 defines recycled material before and after use as follows: **Pre-consumer material** is material that is separated from the waste stream during the manufacturing process. It does not include the reuse of materials from post-processing, regrinding or scrap that is generated in the course of a technical process and can be reused in the same process (also known as **PIR**, post-industrial recycled content). **Postconsumer material** is material from households, commercial and industrial establishments or institutes (which are the final consumers of the product) that can no longer be used for the intended purpose. It includes material recycled from the supply chain (also known as **PCR**, post-consumer recycled or **PCW**, post-consumer waste). When discussing packaging with recycled material content, the use of post-consumer material applies.

2. INTRODUCTION – RECYCLABLE PACKAGING DESIGN

In order to be able to apply recyclable packaging design, a certain fundamental knowledge of sorting and recycling processes is necessary. Packaging must, therefore, be suitable for state-of-the-art sorting and recycling processes in addition to its basic functions (e.g. storage, transport, product protection, product presentation and convenience).

2.1 Recycling processes at a glance

The following is an overview of the current recycling processes for packaging materials.

2.1.1 Plastics recycling

The term 'material-' or 'mechanical' recycling refers to a mechanical treatment process in which the basic chemical structure of the **polymer** is preserved. The plastic waste is sorted, subjected to intensive physical cleaning to remove potential impurities, shredded and then remelted or **compounded** into new material. By contrast, with chemical recycling (also called tertiary or raw material recycling), the polymer is chemically degraded into low molecular weight compounds, purified and then polymerised again. The umbrella term 'material recycling' combines both mechanical and raw material recycling. The **mechanical recycling process** for plastic packaging can include the following steps for **rigid packaging systems:**

1 In the first step, plastic packaging is collected separately via the yellow bin or the yellow bag. Then the waste is further separated by shape, density, size, colour and chemical composition and subsequently sorted.

2 Afterwards, the sorted waste, which is now available in separate fractions, is pressed into bales to facilitate further transport from the sorting plant to the recycling plant.

3 The next step is a washing process to remove organic residues from the food packaging. These can interfere with the remaining process.

4 The material is ground for further processing and to a uniform size – so-called 'flakes'. Subsequently, further fine sorting can be carried out using the sink-float tank process for the separation of PET materials with a density below 1 g/cm³).

5 To convert the flakes into processable **plastic granulate** (recyclate), they are compounded, i.e. remelted in extruders. **Additives** can be mixed in here, while unwanted components can also be removed.

6 The resulting granulate can now be used as a raw material for renewed the production of plastic articles, either completely or as an addition to the primary fraction.

The most important process for the subsequent recycling process is the sorting technology, which is why recyclable design primarily aims to enable a clear material classification. The following technologies are used as standard for sorting plastic types:

- Magnetic sorting (for the separation of magnetic components, e.g. ferrous metal)
- **Eddy current separator** (for separating non-conductive metals, aluminium)
- Near-infrared spectroscopy **(NIR)** (material determination by means of reflection beam)
- After washing and shredding: Flotation (density-based separation of different types of plastics)
- Further processes, if necessary

In plastics recycling, sorting by means of **near-infrared** is crucial for the correct allocation of the material fraction of the basic packaging. If this recognition is not possible, the packaging cannot be assigned to the correct material stream and is either incorrectly assigned or rejected. This problem occurs, for example, with full-surface **sleeves** on bottles, if the sleeve material is not identical to the bottle material and/or the sleeve is printed over the entire surface and, therefore, the colour of the bottle (e.g. transparent) cannot be assigned. Similar problems arise from the use of the dye **Carbon black** (black), which absorbs the infrared beam and thus prevents an evaluation. A second important distinguishing feature is the material-specific density. The different types of plastic have an individual material density, which is also used for differentiation in sorting technology. If this specific density of a plastic type is artificially changed (e.g. by adding density-changing **additives** that increase the density of **PP** to over 1 g/cm³), the sorting process can no longer be used in the usual form because the distinguishing feature has been changed. A decisive limit is the density above or below 1 g/cm³. PET bottles, therefore, usually have a density of over 1 g/3cm³, and the closure made of **HDPE** and the label made of PP have a density of under 1 g/cm³. Due to this difference, sorting can be carried out very efficiently and easily using the so-called sink-float tank method.

Flotation (sink-float sorting) is a density-based separation process in which crushed plastic flakes are separated, usually with water as the flotation agent. In this way, **polymers** with a density of less than 1 g/cm³ (e.g. PP, PE) can be separated relatively easily from plastics with a higher density (e.g. PET, PS, PVC, etc.).

The following table shows the specific densities of the most common basic packaging plastics:

PLASTICS WITH A DENSITY < 1g/cm³	PLASTICS WITH A DENSITY > 1 g/cm³
PP	PS
LLDPE	PET
LDPE	PVC (flexible film)
HDPE	PLA

Numerous research projects on chemical recycling are currently under development. It is to be expected that, in the next few years, chemical recycling processes will also be used on a large scale. This is not yet the case, which is why chemical recycling processes are not discussed in this guide.

2.1.3 Glass recycling

Glass is a mixture of raw materials consisting primarily of quartz sand, soda and limestone. Depending on the intended use and colouring, other **additives** (e.g. chrome and iron oxide for green colouring) can be added. Due to its high stability, glass can theoretically be melted down an unlimited number of times and is thus ideally suited for material recycling.

Roughly speaking, the following steps can be distinguished in glass recycling:

1 The first step is the collection of waste glass sorted by colour into white and coloured glass. The separation is an important basis for achieving the required colour purities (white, brown, green). to be obtained, which is done by further optical sorting.

2 This is followed by a size reduction to the required grain sizes (approx. 20mm), which are necessary for the following sorting and feeding of the melting furnace..

3 Subsequently, foreign matter and impurities from use are separated in various sorting processes and further fine sorting is carried out according to colour.

4 The waste glass cullet is then added as a **secondary raw material** and melted in the glass melting plant together with **primary raw materials**.
The use of cullet is advantageous, on the one hand, due to the saving of primary raw materials and, on the other hand, due to the energy savings

The main interfering substances in waste glass cullet include:

Different coloured glass and added metal oxides, which lead to unwanted discolouration. Therefore, the standard colours brown, white and green are to be preferred (weakened shades such as light green can also be recycled without any problems).	**Ceramic material** (ceramics, stones, porcelain) and metallic materials can lead to increased corrosion of the glass tank or unwanted inclusions in the recycled glass.	**Organic substances** such as food residues have an effect on colouring and fining.

2.1.4 Metal recycling

Ferrous metal

Tinplate, a ferrous metal coated with a protective layer of tin, is mainly used for packaging. Particularly in the case of food contact, the tinned area is additionally coated with a lacquer or plastic layer to prevent tin ions from escaping. Due to their magnetic properties, ferrous metal packaging can be relatively easily detected in the sorting process using **magnetic separators.** The iron can then be pressed and remelted as often as desired. The molten metal can then be rolled into sheets and processed again into trays, cans and closures.

Aluminium

Aluminium is used for the production of packaging such as cans and trays, but also as a foil material for composites. Aluminium packaging is collected in the sorting process with the help of **eddy current separators**. The material is then pressed and can be remelted and further processed in aluminium smelters. Like ferrous metals, aluminium can be recycled very often and in a material-identical manner. This saves a large amount of energy and raw materials compared to primary aluminium production.

The basic steps in metal recycling are shown below using the diagram:

2.2 General information and recommendations

The ready-for-sale packaging should be designed with **sustainability** criteria in mind, so that collection and sorting – as well as recycling – are made possible to a high degree.

In order to ensure the recyclability of packaging, various recommendations apply, which differ depending on the type of packaging and material. In addition, it is crucial which part potential consumers play in this context. In principle, the 'correct' separation of components should not be made dependent on end users (consumers), as their behaviour cannot be directly influenced. If this is not possible, measures should be taken to make it as easy as possible for the end consumer to separate the products correctly, such as clearly legible information on the packaging and clear labelling of the material type, as well as visible and easy-to-use perforations for removing the decoration. If the active participation of the final consumer is foreseen or assumed (e.g. when separating a cardboard wrap from a plastic cup), the correct separation and disposal of the components must be proven and documented by way of empirical surveys (e.g. case study).

The following general information and recommendations for a recyclable design refer to essential design criteria depending on the material used, its **additives**, the decorative elements, other components and closure systems, as well as their suitability for state-of-the-art sorting processes and mechanical recycling processes. Based on these recommendations, decisions for a recyclable product design can also be made independently of specific packaging types. The recommendations serve as an overarching guide for the reader.

Preferred finishes:

- Optimally reusable packaging (returnable) with recyclable design.
- Greatest possible reduction in the use of packaging materials (without negatively affecting product protection).
- Use of recycled materials/recyclates where possible.
- Push **mono-materials,** use material combinations that are recyclable. Economical colouring.
- **EuPIA**-compliant printing inks and coatings.
- Use adhesives that do not have a negative impact on sorting and recycling processes.
- Winding aids/closures should be firmly attached to the packaging to avoid the creation of small parts.
- If possible, laser engraving for **best-before date** and batch numbers.
- The packaging should be designed in such a way that residual emptying is as effective as possible.
- In the sense of 'design for recycling', packaging should be designed in such a way that, in the event of a necessary separation of individual **packaging components** the participation of the final consumer is not necessary for the disposal.[1]

The following should be avoided:

- Rare materials that are not recyclable and / only exist in small quantities on the market.
- **Additives** that lead to quality problems in the recyclate during recycling processes (e.g. due to potentially **contaminating** degradation products).
- In addition, dyes based on **Carbon black** can lead to misclassification of the material or rejection during **NIR** detection in the plastic sorting process (however, NIR-detectable black and dark dyes are already on the market).

2.3 Material-specific recommendations

The variety of packaging materials available on the market today makes it possible to optimally match the material to the product and thus guarantee the best possible product protection. Within these material categories, there is a multitude of different designs and packaging types, which are described in detail in the following sections. The recommendations listed here are to be seen as generally valid material-specific recommendations that also provide guidance for packaging types that are not explicitly described in this document

2.3.1 Plastics

- Use materials that are as widely available as possible (**PP, PE, PET**).
- Recyclable material combinations (ideally **mono-materials**).
- The surface area of the base material should, at best, be covered to a max. 50 %[2] with the sleeve/label/banderole.
- Easy mechanical separability of the individual components in the sorting process.
- If possible, use transparent materials.
- As few additives as possible.
- Adhesives recyclable or washable under certain conditions.
- No barrier layers, but if necessary: **carbon plasma coating**[3], **SiOx**- or **$Al^{2}O^{3}$** barrier.

- Avoid small parts that can be separated by the last consumer (**Littering**).
- Non-recyclable material composites (see specific design recommendations).
- Density-changing **additives** (for example, density-increasing additives in PE and PP packaging lead to problems in sorting).
- Use of **Carbon black** -based inks

2.3.2 Paper/ Carton

- The fibres for the production come from coniferous and deciduous trees in the best case.
- If possible without coating, if necessary -> single-sided plastic coatings or **plastic laminate** (fibre content in the best case > 95 %).[4]
- **Adhesive applications** that do not lead to the formation of problematic **stickies**. Inks that can be removed in the **de-inking process**.
- As little colouring as possible and minimal printing with **EuPIA**-compliant colours

- Plastic coatings on both sides.
- Wax coatings.
- Silicone paper (exception: feed to special recycling plants).
- Wet-strengthened fibre components.[6]
- Integrated windows and other plastic components which cannot be easily separated from paper

2.3.3 Glass

- Standard colouring in green, brown, white (transparent) or related shades.
- Regular three-component packing glass (quartz sand, soda, **limestone**).
- Engravings and paper labels (wet-strength).

- No packaging glass, such as heat-resistant glass (e.g.: boro-silicate glass).
- Lead crystal, cryolite glass.
- Ceramic parts.
- Full-surface, colour-coated bottles.
- Full-surface **sleeves**.
- Permanently adhesive and large-area plastic labels.

2.3.4 Tinplate

- Ferromagnetic metals.
- Paint coating.
- Closure also made of ferromagnetic metal.
- Decoration by means of embossing or paper banderole.

- Aerosol cans with hydrocarbon-based propellants and/or residual contents.
- Non-compliant colours.

2.3.5 Aluminium

- **Non-ferrous metal parts**
- Direct printing process.
- Embossing or direct printing.
- Paint coating.
- Closures made of aluminium

- Aluminium in material composite.[6]
- Non-compliant colours.
- Aerosol cans with hydrocarbon substance-based propellants and/or residual content.

2.4 Alternative materials and material connections

2.4.1 Rare plastics

As a rule, recycling can only take place in an economically viable manner if the input material is available in large and as homogeneous quantities as possible. For materials that are rarely found on the market, there are, therefore, often no suitable recycling streams, despite their possibly good recyclability. A recycling-friendly design of packaging should, therefore, focus on the use of a few common materials. The rare materials that should not be used include polycarbonate (**PC**) and polyvinyl chloride (**PVC)**.

2.4.2 Compostable plastics

The goal of compostability runs counter to the recycling process, as material that can be composted well has often already lost its quality by the time it arrives in the recycling stream.

However, for products for which **material recycling** is ruled out due to assumed heavy pollution or for other reasons, the use of biodegradable materials could be recommended in the future (e.g. coffee capsules, packaging for fresh meat, etc.). However, proof of industrial composting must be available and this must also be communicated to the end consumer.

Within the framework of a life cycle assessment, the potential advantages of using compostable plastics can be evaluated. **Oxo-degradable plastics** (plastics that can decompose in the environment due to their **additives**) are not recommended at all. Apart from the damage to the quality of the recyclate, **microplastics** are produced through incomplete decomposition. In addition, the placing on the market of oxo-degradable plastics without this is prohibited from 03 July 2021 within the framework of the EU Single-Use Plastics Directive (2019/904, Article 5).

2.4.3 Special fibres for paper/ cardboard / carton

Here, the effects of non-wood-based fibres (e.g.: grass, hemp, cotton, etc.) on the recycling process have not yet been completely clarified.

A low input of these materials into the recovered paper stream is considered uncritical for the recycling process.

2.4.4 Composite materials with plastic content

Composite materials or multi-layer materials: **'multilayer'**), materials made of two or more different materials can combine the best properties of the respective materials. A common application of composite materials is films, which fulfil a high barrier function and, therefore, extend the shelf life of food products.

Composite materials can provide a high level of product protection with a reduced packaging weight, but can make recycling more difficult and even prevent it. Recyclable plastic composites are listed on a material-specific basis in the chapter 'Design recommendations for packaging types'.

3. DESIGN RECOMMENDATIONS FOR PACKAGING TYPES

Recommendations for a recyclable packaging design are suggested below. Detailed design recommendations can already be given for many common types of packaging. For some other types, these are currently still under development, which is why general recommendations are available here. For a fully recyclable design, the criteria from the **'best case'** category must be selected. **'if necessary'** criteria also allow for recycling, but there are no individual restrictions (such as the reduction of recyclate quality). The criteria **'to be avoided'** should generally be excluded, as they either prevent clear sorting or lead to unwanted **contamination** in the recycling process. These are generally valid recommendations that can be applied on the basis of the current data. Further details will be worked out in cooperation with the FH Campus Wien.

The colour coding system

The following recommendations for the design of recyclable packaging have been classified according to packaging type and packaging material in order to ensure the most practical applicability of the recommendation. The different types of packaging are defined as follows

BOTTLES	TRAYS AND CUPS	FLEXIBLE PACKAGING
TUBES	CANS	FOLDING BOXES
COMPOSITE BEVERAGE CARTON	DESIGN RECOMMENDATIONS FOR PACKAGING TYPES (UNDER DEVELOPMENT)	

The main criteria

The design recommendations are given for each of three main criteria, which, in turn, summarise the most important design features:

MATERIAL
- Material and **additives**
- Barriers
- Colour

DECORATION AND OTHER COMPONENTS
- Labels, banderoles and **sleeves**
- **Coding** by the bottler
- Printing inks
- Designs
- Label adhesive

CLOSURE SYSTEM
- Closures
- Seals, sealing foils
- Opening aids

The traffic light system

Packaging types for which detailed recommendations already exist are divided into three categories (green, yellow, red). Design recommendations for packaging types – for which a further level of detail is currently being worked on – are divided into the categories green and red. In some cases, further comments are made on individual design criteria, which can be found in Chapter 5 / Glossary.

- **best case**
- **if necessary**
- **to be avoided**

3.1 BOTTLES

3.1.1 PET

MATERIAL

Transparent mono-PET is best suited for high-quality and material-identical recycling.

If barrier requirements exist, a silicon oxide (**SiOx**), an aluminium oxide (**Al_2O_3**) barrier or a **carbon plasma coating** (only for coloured bottles) can be used, as these do not significantly affect the quality of the recyclate.

Pale, light, dark or opaque material can be collected or recycled, but of lower quality than transparent material.

Additives such as **UV stabilisers**, **optical brighteners** and **oxygen absorbers** should only be added if necessary.

In principle, the use of barriers should be avoided. However, **PA** barriers (mass fraction <5 wt %), a multilayermaterial with **PGA**, **PTN** alloys and **TPE** or **PO**-based barriers can be used under certain circumstances.

It is important to avoid the use of materials with a density <1 g/cm^3 and density-changing additives in the **polymer,** as **PET** sorting is based on density separation.

Barriers made of **EVOH** and **PA** (mass fraction > 5 wt. %) as well as other inserted barriers can sometimes strongly impair the recyclate quality.

Other types of PET (e.g. **PET-G**) as well as a composite with other plastics such as **PLA, PVC** and **PS** are not compatible with the PET fraction and are considered interfering materials.

Special additives such as oxygen/bio/**Oxo-degradable** additives, **nanoparticles** and a **PA additive** damage the recyclate. Furthermore, the addition of oxo-degradable additives will be banned throughout the EU from 2021 due to the Single-Use Plastics Directive.

Carbon black -based colours can prevent sorting. Metallic and fluorescent colours must be avoided due to the **contamination** of the recyclate.

DECORATION AND OTHER COMPONENTS

Direct printing on the packaging should be avoided if possible. If this is necessary, the printing inks must at least be **EuPIA-**compliant and **non-bleeding** to avoid potential **contamination.**

The **batch coding** and the indication of the **best-before date** should ideally be carried out in the form of an embossing or laser marking.

If labels and **sleeves** are used, they should cover a maximum of 50% of the packaging[8] and be made of a material with a density < 1g/cm³ (e.g. **PP**, **PE**) so that they can be separated in the sorting process.

Wet-strength paper labels are preferable to conventional paper labels because no fibres come out of them in the washing process that can contaminate the recyclate.

The batch coding and indication of the best-before date can, if necessary, also be carried out by means of minimal direct printing with other **coding** systems (e.g. **ink-jet**), provided that food-grade inks are used.

Extensive direct printing on the packaging is disadvantageous, as released printing inks can impair the clarity of the recyclate or contaminate the recycling stream via released printing inks in the wash water (potential formation of **NIAS**).

Large-scale decorations covering more than 50% of the packaging surface[8] can impair the sorting of the packaging.

Labels and sleeves made of a material with a density > 1 g/cm³ (e.g. **PVC,** OPS, **PLA**), **PET** as well as non-wet-strength paper labels can contaminate the PET fraction.

Adhesive materials containing metal or aluminium (with a layer thickness of > 5 µm) can lead to unwanted sorting into the metal fraction.

CLOSURE SYSTEM

Closures are best made of PP, **HDPE** or other materials with a density < 1 g/cm³, as they can be separated from PET in the recycling process.

If sealing foils are used, they must be easy to remove without leaving any residue.

Closure systems without **liners** are preferred. If necessary, **EVA** or **TPE** liners should be used.

From 2024 onwards, the adhesion of the closure (according to Article 6, 2019/904/EC) must be guaranteed for the time of intended use for beverage containers up to 3 litres.

If a sealing and other components made of silicone are necessary, they should have a density < 1 g/cm³ to enable separation in the sorting process.

Components made of metal, aluminium-containing materials (with a layer thickness > 5 µm), **duroplast**, **PS, POM** and PVC are considered interfering materials, as they interfere with the sorting and reprocessing of the material and can damage extruders and equipment, among other things.

This also applies to non-removable sealing films or silicones, glass and metal springs of pump systems or materials with a density > 1 g/cm³.

3.1.2 PE

MATERIAL

In the best case, **PE** bottles are as unpigmented as possible (transparent) or white and consist of PE **mono-material** without a barrier.

If barrier requirements exist, a silicon oxide (**SiOx**), an aluminium oxide (**Al_2O_3**) barrier or a **carbon plasma coating** (for coloured bottles only) can be used, as these do not significantly affect the quality of the recyclate.

A **multi-layer composite** can be used if necessary, if it is made up of different PE types (e.g. **LDPE,HDPE**).

Multilayer composites with small amounts of **PP** are recyclable.

Additives can be added if the density of the base material remains < 1 g/cm³ and thus the density grading is not impaired.

If necessary, an **EVOH** barrier layer can be used, provided that applicable limit values are complied with.[10]

A material compound with **PS, PVC**, **PLA**, **PET** and **PET-G** should be avoided, as this contaminates the PE fraction.

The use of density-altering additives (e.g. talc, **$CaCO^3$**) as well as **foaming agents** for chemical expansion, which lead to an increase in density to ≥ 1 g/cm³, can cause problems in sorting, as the material-specific classification is no longer possible.

Barrier layers or the composite with **PVDC**, **PA**, **PE-X** and **EVOH10** (if applicable limits are exceeded) represent interfering substances in the recycling of the material, as they **contaminate** the recyclate.

The addition of **oxo-degradable** additives damages the recyclate and is banned throughout the EU from 2021 due to the Single-Use Plastics Directive.

Dark colouring can have a negative effect on the recyclate quality.

Carbon black -based colours can prevent sorting.

DECORATION AND OTHER COMPONENTS

If the packaging is printed directly, the printing inks must at least be **EuPIA**-compliant and **non-bleeding** to prevent potential **contamination.**

Minimal printing with light or glazing colours is advantageous.

If labels and **sleeves** are used, they should be made of the same base material as the bottle body (e.g. **HDPE, LDPE**, **MDPE, LLDPE)**.

If the decoration is made of a material other than **PE**, a maximum of 50% of the packaging surface should be covered so as not to hinder the correct sorting of the base material.[8]

The **batch coding** and the indication of the **best-before date** should ideally be carried out in the form of an embossing or laser marking.

Wet-strength paper labels are preferable to conventional paper labels as they do not release fibres that contaminate the recyclate.

Labels and sleeves made of **PP**, **OPP** and **PET** can be used if necessary, provided that a maximum of 50% of the packaging surface is covered.[8]

In addition, all labels made of a material other than **PE** or **PP** should be water washable to ensure separation from the PE fraction and no adhesive residue should remain.

The batch coding and indication of the best-before date can, if necessary, also be carried out by means of minimal direct printing with other coding systems (e.g. **ink-jet**), provided that food-grade inks are used.

Labels made of other materials that are not water-washable can negatively affect the sorting or recyclate quality of the PE fraction.

PVC sleeves and labels should generally be avoided, even if they are water-washable.

Large-area decorations (> 50% of the packaging surface) and full-surface sleeves made of a material other than PE can impair the sorting of the packaging).[8]

Adhesive materials containing metal or aluminium (with a layer thickness of > 5 µm) can lead to unwanted sorting into the metal fraction.

Bleeding inks should be avoided.

CLOSURE SYSTEM

Closures are ideally made of the same base material as the bottle (e.g. HDPE, LDPE, LLDPE, MDPE). Ideally, the cap and the bottle are also the same colour.

Closure systems without **liners** are preferable. If necessary, **EVA** or **TPE** liners should be used.

If sealing foils are used, they must be easy to remove without leaving any residue.

From 2024 onwards, the adhesion of the closure (according to Article 6, 2019/904/EC) must be guaranteed for the time of intended use for beverage containers up to 3 litres.

Flexible closures made of PE and PP **plastic laminates** are compatible with the PE fraction in small quantities[9].

PP closures can lead to contamination in larger quantities.[9]

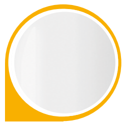
Closures made of other materials such as PET, **PET-G**, **PS** and **PLA** should be avoided, as these can lead to secondary contamination of the PE fraction.

Metals, **thermosets, EPS**, PVC as well as seals and silicones that cannot be completely removed are considered interfering substances.

Pump systems made of other materials (especially with glass & metal springs) also represent interfering materials.

Sealing foils that are not completely removable and contain an aluminium component (layer thickness > 5 µm) can impair the sorting.

3.1.3 PP



MATERIAL

In the best case, **PP** bottles are as unpigmented as possible (transparent) or white and consist of **PP mono-material** without barrier.

If barrier requirements exist, a silicon oxide (**SiOx**), an aluminium oxide (**Al_2O_3**) barrier or a **carbon plasma coating** (for coloured bottles only) can be used, as these do not significantly affect the quality of the recyclate.

A **multi-layer composite material** can be used if necessary, if this is made up of different PP types (e.g. **OPP**, **BOPP**).

Multilayer composites with small amounts of **PE** are recyclable.[9]

Additives can be added if the density of the base material remains < 1 g/cm³ and thus the density grading is not impaired.

If necessary, an **EVOH** barrier layer can be used, provided that applicable limit values are complied with.[10]

A material compound with **PS**, **PVC**, **PLA**, **PET** and **PET-G** should be avoided, as this contaminates the PP fraction.

The use of density-altering additives (e.g. talc, **$CaCO^3$**) as well as **foaming agents** for chemical expansion, which lead to an increase in density to ≥ 1 g/cm³, can cause problems in sorting, as the material-specific classification is no longer possible.

Barrier layers or the composite with **PVDC**, **PA** and EVOH (if applicable limits are exceeded) represent interfering substances in the recycling of the material, as they **contaminate** the recyclate.

The addition of **oxo-degradable** additives damages the recyclate and is banned throughout the EU from 2021 due to the Single-Use Plastics Directive.

Dark colouring can have a negative effect on the recyclate quality.

Carbon black -based colours can prevent sorting.

DECORATION AND OTHER COMPONENTS

If the packaging is printed directly, the printing inks must at least be **EuPIA**-compliant and **non-bleeding** in order to prevent potential **contamination**.

Minimal printing with light or glazing colours is advantageous.

If labels and **sleeves** are used, they should be made of the same base material (**PP**) as the bottle.

If the decoration is made of a material other than PP, a maximum of 50% of the packaging surface should be covered so as not to hinder the correct sorting of the base material.[8]

The **batch coding** and the indication of the **best-before date** should ideally be carried out in the form of an embossing or laser marking.

Wet-strength paper labels are preferable to conventional paper labels as they do not release fibres that contaminate the recyclate.

Labels and sleeves made of **PE** and **PET** can be used if necessary, provided that a maximum of 50% of the packaging surface is covered [8].

In addition, all labels made of a material other than PP or PE should be water-washable to ensure separation from the PP fraction and no adhesive residue should remain.

The batch coding and indication of the best-before date can, if necessary, also be carried out by means of minimal direct printing with other **coding systems** (e.g. **ink-jet**), provided that food-grade inks are used.

Labels made of other materials that are not water-washable can negatively affect the sorting or recyclate quality of the PP fraction.

PVC sleeves and labels should generally be avoided, even if they are water-washable.

Large-area decorations (> 50% of the packaging surface) and full-surface sleeves made of a material other than PP can impair the sorting of the packaging) [8].

Adhesive materials containing metal or aluminium (with a layer thickness of > 5 µm) can lead to unwanted sorting into the metal fraction.

Bleeding inks should be avoided.

CLOSURE SYSTEM

Closures should ideally be made of the same basic material (PP) as the bottle. Ideally, the cap and the bottle are also the same colour.

Closure systems without **liners** are preferable. If necessary, **EVA** or **TPE** liners should be used.

If sealing foils are used, they must be easy to remove without leaving any residue.

Flexible closures made of PE and PP **plastic laminates** are compatible with the PP fraction in small quantities [9].

From 2024 onwards, the adhesion of the closure (according to Article 6, 2019/904/EC) must be guaranteed for the time of intended use for beverage containers up to 3 litres.

PE closures can lead to contamination in larger quantities [9].

Closures made of other materials such as PET, **PET-G**, **PS** and **PLA** should be avoided, as these can lead to secondary contamination of the PE fraction.

Metals, **thermosets**, **EPS**, PVC as well as seals and silicones that cannot be completely removed are considered interfering substances.

Pump systems made of other materials (especially with glass & metal springs) also represent interfering materials.

Sealing foils that are not completely removable and contain an aluminium component (layer thickness > 5 µm) can impair the sorting.

3.1.4 GLASS

MATERIAL

Regular three-component packaging glass (silica sand, soda, **limestone**) in standard colouring transparent/white, green or brown (or related quartz) can be recycled effectively.

The heavy metal concentration in the material must comply with Commission Decision 2001/171/EC, in order to prevent **contamination.**

The use of alternative, opaque or metallic shades makes it more difficult to match the required standard shades in recycled glass again.

Black or dark-blue coloured glass should, therefore, be avoided.

Non-packaging glass such as heat-resistant glass (e.g. Boro silicate glass), lead crystal, cryolite glass and enamel components are major impurities that affect the recyclate quality of packaging glass.

DECORATION AND OTHER COMPONENTS

Decoration on glass packaging should preferably be done by engraving.

Wet-strength paper labels and direct printing with **EuPIA-**compliant coatings and inks can also be used without any problems.

If the glass container is fully colour-coated, this can lead to problems with the detection and sorting of the material.

Plastic labels should only be used when necessary.

Permanently-adhering and large-area **sleeves** and plastic labels can, under certain circumstances, interfere with the sorting and impact processing of the glass.

CLOSURE SYSTEM

Closures made of ferromagnetic (alloy) metals can be easily separated during magnetic sorting.

Closures made of plastic and aluminium can also be separated and thus do not interfere with the glass melt.

Closures made of ceramic and swing stoppers with ceramic or porcelain components respectively can lead to unwanted inclusions in the recycled glass and should be avoided.

3.2 TRAYS AND CUPS

3.2.1 PE

MATERIAL

In the best case, **PE** trays and cups are as unpigmented as possible (transparent) or white and consist of PE **mono-material** without a barrier.

If barrier requirements exist, a silicon oxide (**SiOx**), an aluminium oxide (**Al_2O_3**) barrier or a **carbon plasma coating** (for coloured cups only) can be used, as these do not significantly affect the quality of the recyclate.

A **multi-layer composite material** can be used if necessary, if this is made up of different PE types (e.g. **LDPE, HDPE)**. Multilayer composite materials with small amounts of **PP** are also recyclable[9].

Additives can be added if the density of the base material remains < 1 g/cm^3 and thus the density grading is not impaired.

If necessary, an **EVOH** barrier layer can be used, provided that applicable limit values are complied with[10].

The metallisation (aluminium vapour deposition) of the base material can cause problems in sorting under certain circumstances[11]. In addition, this can lead to a deterioration of the recyclate quality (grey colouration).

A material compound with **PS**, **PVC, PLA**, **PET** and **PET-G** should be avoided, as this contaminates the PE fraction.

The use of density-altering additives (e.g. talc, **$CaCO^3$**) as well as **foaming agents** for chemical expansion, which lead to an increase in density to ≥ 1 g/cm^3, can cause problems in sorting, as the material-specific classification is no longer possible.

Barrier layers or the composite with **PVDC**, **PA**, **PE-X** and EVOH (if applicable limits are exceeded) represent interfering substances in the recycling of the material, as they **contaminate** the recyclate.

The addition of **oxo-degradable** additives damages the recyclate and is banned throughout the EU from 2021 due to the Single-Use Plastics Directive.

Dark colouring can have a negative effect on the recyclate quality.

Carbon black -based colours can prevent sorting

DECORATION AND OTHER COMPONENTS

If the packaging is printed directly, the printing inks must at least be **EuPIA**-compliant and **non-bleeding** in order to prevent potential **contamination.**

Minimal printing with light or glazing colours is advantageous.

If labels and **sleeves** are used, they should be made of the same base material as the packaging (e.g. **HDPE**, **LDPE**, **MDPE**, **LLDPE**).

In-mould labels made of **PE** can also be used. However, a high **degree of printing** can have a negative effect here, as the label is recycled together with the base material.

If the decoration is made of a material other than PE, a maximum of 50% of the packaging surface should be covered so as not to hinder the correct sorting of the base material[8].

The **batch coding** and the indication of the **best-before date** should best be carried out in the form of an embossing or laser marking.

Wet-strength paper labels are preferable to conventional paper labels as they do not release fibres that contaminate the recyclate.

Labels and sleeves made of **PP**, **OPP** and **PET** can be used if necessary, provided that a maximum of 50% of the packaging surface is covered[8].

In addition, all labels made of a material other than PE or PP should be water-washable, in order to ensure separation from the PE fraction and no adhesive residue should remain.

The batch coding and indication of the best-before date can, if necessary, also be done by minimal direct printing with other **coding** systems (e.g. **ink-jet**), provided that food-grade inks are used.

Labels made of other materials that are not water-washable can negatively affect the sorting or recyclate quality of the PE fraction.

PVC sleeves and labels should generally be avoided, even if they are water-washable.

Large-area decorations (> 50% of the packaging surface) and full-surface sleeves made of a material other than PE can impair the sorting of the packaging [8]. Adhesive materials containing metal or aluminium (with a layer thickness of > 5 µm) can lead to unwanted sorting into the metal fraction.

Bleeding inks should be avoided.

CLOSURE SYSTEM

Closures are ideally made of the same base material as the tray/cup (e.g. HDPE, LDPE, LLDPE, MDPE).

If sealing foils are used, they must be easy to remove without leaving any residue.

Flexible closures made of PE and PP **plastic laminates** are compatible with the PE fraction in small quantities.

PP closures can lead to contamination in larger quantities[9].

Closures made of other materials such as PET, **PET-G**, **PS** and **PLA** should be avoided, as these can lead to secondary contamination of the PE fraction.

Metals, **thermosets, EPS**, PVC as well as seals and silicones that cannot be completely removed are considered interfering substances.

Sealing foils that are not completely removable and contain an aluminium component (layer thickness > 5µm) can impair the sorting.

3.2.2 PP

MATERIAL

In the best case **PP** trays and cups are as unpigmented as possible (transparent) or white and consist of PP monomaterial without any barrier.

If barrier requirements exist, a silica (**SiOx**), alumina (**Al_2O_3**) barrier or **carbon plasma coating** [7] (for colored bottles only) can be used, as these do not significantly affect the quality of the recyclate.

A **multi-layer composite material** can be used if necessary, if this is made up of different PP types (e.g. **OPP**, **BOPP**).

Multilayer composites with small amounts of **PE** are recyclable.[9]

Additives can be added if the density of the base material remains < 1 g/cm^3 and thus the density grading is not impaired.

If necessary, an **EVOH** barrier layer can be used, provided that applicable limit values are complied with.[10]

The metallisation (aluminium vapour deposition) of the base material can cause problems in sorting under certain circumstances. In addition, this can lead to a deterioration of the recyclate quality (grey colouration).

A material compound with **PS**, **PVC**, **PLA**, **PET** and **PET-G** should be avoided, as this contaminates the PP fraction.

The use of density-altering additives (e.g. talc, **$CaCO^3$**) as well as **foaming agents** for chemical expansion, which lead to an increase in density to ≥ 1 g/cm^3, can cause problems in sorting, as the material-specific classification is no longer possible.

Barrier layers or the composite with **PVDC**, **PA** and EVOH[10] (if applicable limits are exceeded) represent interfering substances in the recycling of the material, as they **contaminate** the recyclate.

The addition of **oxo-degradable** additives damages the recyclate and is banned throughout the EU from 2021 due to the Single-Use Plastics Directive.

Dark colouring can have a negative effect on the recyclate quality.

Carbon black -based colours can prevent sorting.

DECORATION AND OTHER COMPONENTS

If the packaging is printed directly, the printing inks must at least be **EuPIA**-compliant and **non-bleeding** in order to prevent potential **contamination.**

Minimal printing with light or glazing colours is advantageous.

If labels and **sleeves** are used, they should be made of the same base material (**PP**) as the packaging.

In-mould labels made of PP can also be used. However, a high **degree of printing** can have a negative effect here, as the label is recycled together with the base material.

If the decoration is made of a material other than PP, a maximum of 50% of the packaging surface should be covered so as not to hinder the correct sorting of the base material. [8]

The **batch coding** and the indication of the **best-before date** should best be carried out in the form of an embossing or laser marking.

Wet-strength paper labels are preferable to conventional paper labels as they do not release fibres that contaminate the recyclate.

Labels and sleeves made of **PE** and **PET** can be used if necessary, provided that a maximum of 50% of the packaging surface is covered. [8]

In addition, all labels made of a material other than PP or PE should be water-washable, in order to ensure separation from the PP fraction and no adhesive residue should remain.

The batch coding and indication of the best-before date can, if necessary, also be done by minimal direct printing with other **coding** systems (e.g. **ink-jet**), provided that food-grade inks are used.

Labels made of other materials that are not water-washable can negatively affect the sorting or recyclate quality of the PP fraction.

PVC sleeves and labels should generally be avoided, even if they are water-washable.

Large-area decorations (> 50% of the packaging surface) and full-surface sleeves made of a material other than PP can impair the sorting of the packaging. [8] Adhesive materials containing metal or aluminium (with a layer thickness of > 5 µm) can lead to unwanted sorting into the metal fraction.

Bleeding inks should be avoided.

CLOSURE SYSTEM

In the best case, closures are made of the same basic material (PP) as the trays and cups.

If sealing foils are used, they must be easy to remove without leaving any residue.

Flexible closures made of PE and PP **plastic laminates** are compatible with the PP fraction in small quantities.[9]

PE closures can lead to contamination in larger quantities.[9]

Closures made of other materials such as **PET-G**, **PS**, and **PLA** should be avoided, as these can lead to secondary contamination of the PE fraction.

Metals, **thermosets**, **EPS** PVC as well as seals and silicones that cannot be completely removed are considered interfering substances.

Sealing foils that are not completely removable and contain an aluminium component (layer thickness > 5 µm) can impair the sorting.

3.2.3 PAPER/ CARDBOARD/ CARTON

MATERIAL

- The fibres for the production come from coniferous and deciduous trees in the best case.
- An uncoated and unlaminated version is preferable, especially to simplify the digestion of the fibre and to prevent **contamination.**
- A one-sided plastic coating / **plastic laminate** can be recycled if the fibre content is > 95 %.
- Mineral fillers such as kaolin, talc and calcium carbonate, as well as titanium dioxide (white pigment) and starch, can be used without hesitation as they do not interfere with the recycling process.

- Fibres from alternative, non-woody plants such as hemp, grass cotton etc. are a material that can potentially interfere with paper recycling. In small quantities, however, these are not critical.
- A one-sided plastic coating/plastic laminate can be used if required, if the fibre content remains between 95 % and 85 %.

- Pulping of the fibres is also made more difficult by a plastic coating on both sides, wax coatings, siliconised paper and wet-strengthened fibre portions[6].
- Similarly, one-sided plastic coatings/plastic laminates should be avoided if the fibre content is < 85 %.

DECORATION AND OTHER COMPONENTS

The printing shall be as minimal as possible and shall be carried out with **EuPIA**-compliant printing inks.

Adhesive components such as viewing windows, labels and other plastic components should be avoided. They should be designed in such a way that they can be easily separated in the recycling process or by the consumer.

If the packaging is metallised, the metallisation should not cover more than 60% of the packaging surface.

Viewing windows and other plastic components that cannot be easily separated from the paper are interfering materials.

It is essential to avoid inks containing mineral oil, as these may **contaminate the secondary fibres.**

CLOSURE SYSTEM

Paper tapes can be used as long as the **adhesive application** does not lead to the formation of problematic **stickies**[12].

In general, it is important to use adhesive applications that do not lead to the formation of problematic stickies in the recycling process[12].

When using staples and plastic adhesive tapes, care should be taken to ensure that they can be separated in the recycling process or in advance by end consumers.

3.2.4 GLASS

MATERIAL

✔ Regular three-component packaging glass (silica sand, soda, **limestone**) in standard colouring transparent/white, green or brown (or related quartz) can be recycled effectively.

The heavy metal concentration in the material must comply with Commission Decision 2001/171/EC, in order to prevent **contamination.**

~ The use of alternative, opaque or metallic shades makes it more difficult to match the required standard shades in recycled glass again.

✘ Black or dark-blue coloured glass should, therefore, be avoided.

Non-packaging glass such as heat-resistant glass (e.g. Boro silicate glass), lead crystal, cryolite glass and enamel components are major impurities that affect the recyclate quality of packaging glass

DECORATION AND OTHER COMPONENTS

✔ Decoration on glass packaging should preferably be done by engraving.

Wet-strength paper labels and direct printing with **EuPIA**-compliant coatings and inks c an also be used without any problems.

~ If the glass container is fully colour-coated, this can lead to problems with the detection and sorting of the material.

Plastic labels should only be used when necessary.

✘ Permanently-adhering and large-area **sleeves** and plastic labels can, under certain circumstances, interfere with the sorting and impact processing of the glass.

CLOSURE SYSTEM

✔ Closures made of ferromagnetic (alloy) metals can be easily separated during magnetic sorting.

Closures made of plastic and aluminium can also be separated and thus do not interfere with the glass melt.

✘ Closures made of ceramic and swing stoppers with ceramic or porcelain components respectively can lead to unwanted inclusions in the recycled glass and should be avoided.

3.2.5 ALUMINIUM

MATERIAL

- ✓ The aluminium used should only consist of **non-ferrous(NF) metal components** to prevent **contamination** in recycling.
- ✓ In a best case, it concerns a **mono-material package** in which all components are made of aluminium.
- ✓ A lacquer coating does not interfere with the conventional recycling process.
- ✗ For aluminium in composite materials (e.g. in combination with plastic), there is usually no possibility for **high-quality recycling.**

DECORATION AND OTHER COMPONENTS

- ✓ Embossing does not have a negative impact on recycling.
- ✓ Direct printing on the packaging should be carried out with **EuPIA**-compliant coatings and printing inks.
- ✗ Non-compliant inks can reduce the quality of the secondary material.
- ✗ **PVC** labels should be avoided as they can cause problems in the recycling process.

CLOSURE SYSTEM

- ✓ Closure systems made of aluminium can be recycled together with the base material and are, therefore, to be preferred.
- ~ Plastic closures should be designed in such a way that they can be separated before disposal or during the sorting process.

3.2.6 TINPLATE

MATERIAL

✔
- Only ferromagnetic (alloy) metals should be used to prevent **contamination** in recycling.
- A lacquer coating does not interfere with the conventional recycling process.

DECORATION AND OTHER COMPONENTS

✔
- Embossing does not have a negative impact on recycling.
- Direct printing on the packaging should be carried out with **EuPIA**-compliant coatings and printing inks.
- Paper banderoles can also be used without any problems.

✘
- Non-compliant inks can reduce the quality of the secondary material.
- **PVC** labels should be avoided as they can cause problems during processing in the recycling process.

CLOSURE SYSTEM

✔
- Paper adhesive tapes can be used as long as the **adhesive application** does not cause the formation of problematic **stickies**.[12]

~
- In general, it is important to use adhesive applications that do not cause the formation of problematic stickies in the recycling process.[12]

3.3 FLEXIBLE PACKAGING

3.3.1 ALUMINIUM

GENERAL

Disclaimer: In the current recycling structure, **material recycling** can only be assumed for flexible aluminium packaging that is collected separately. Aluminium-plastic composite foils are, therefore, excluded. If these foils are disposed of in the lightweight fraction, they are sorted out as contaminants in the sorting process and typically sent for thermal recycling. The following table thus primarily refers to the design of pure aluminium foils and blanks that are not in the composite.

GENERAL

✓	The aluminium used should only consist of **non-ferrous(NF) metal components** to prevent **contamination** in recycling.
✓	Embossing does not have a negative impact on recycling.
✓	Direct printing on the packaging should be done with **EuPIA**-compliant coatings and printing inks.
✗	For aluminium in composite materials (e.g. in combination with plastic), there is usually no possibility for **high-quality recycling**[6].
✗	Non-compliant inks can reduce the quality of the secondary material.

3.3.2 PE

MATERIAL

Non-conforming inks can reduce the quality of the secondary material.

If barrier requirements exist, a silicon oxide (**SiOx**) barrier, a **carbon plasma coating**[7] or an aluminum oxide (**Al_2O_3**) barrier can be used, as these do not significantly affect the quality of the recyclate.

A **multilayer composite material** can be used, if necessary, if it is made up of different **PE**-types (e.g. **LDPE**, **HDPE**). Multilayer composite materials with small amounts of **PP** are also recyclable[9].

Additives can be added if the density of the base material remains < 0.97 g/cm^3 and thus the density grading is not impaired.

If necessary, an **EVOH** barrier layer can be used, provided that applicable limit values are complied with[10].

The metallisation (aluminium vapour deposition) of the base material can cause problems in sorting under certain circumstances. In addition, this can lead to a deterioration of the recyclate quality (grey colouration).

A material compound with any other plastics should be avoided, as this will contaminate the PE fraction.

The use of density-altering additives (e.g. talc, **$CaCO^3$**) as well as **foaming agents** for chemical expansion, which lead to an increase in density to ≥ 1 g/cm^3, can cause problems in sorting, as the material-specific classification is no longer possible.

Barrier layers or the composite with **PVDC**, **PVC**, **PA**, aluminium[6] and **EVOH**[10] (if applicable limits are exceeded) represent interfering substances in the reprocessing of the material, as they contaminate the recyclate.

The addition of **oxo-degradable** additives damages the recyclate and is banned throughout the EU from 2021 due to the Single-Use Plastics Directive.

Dark colouring can have a negative effect on the recyclate quality.

Carbon black -based colours can prevent sorting.

DECORATION AND OTHER COMPONENTS

If the packaging is printed directly, the printing inks must at least be **EuPIA**-compliant and **non-bleeding** in order to prevent potential **contamination.**

Minimal printing with light or glazing colours is advantageous.

If labels are used, they should be made of the same base material as the packaging (e.g. **HDPE, LDPE, MDPE, LLDPE**).

If the decoration is made of a material other than PE, a maximum of 50% of the packaging surface should be covered so as not to hinder the correct sorting of the base material[8].

The **batch coding** and the indication of the **best-before date** should best be carried out in the form of an embossing or laser marking.

Wet-strength paper labels are preferable to conventional paper labels as they do not release fibres that contaminate the recyclate.

Labels made of **PP** can be used if necessary, provided that a maximum of 50% of the packaging surface is covered[8].

The batch coding and indication of the best-before date can, if necessary, also be done by minimal direct printing with other **coding** systems (e.g. **ink-jet**), provided that food-grade inks are used.

Labels made of materials other than PE, PP or paper should be avoided.

Large-scale decorations (> 50% of the packaging surface) made of a material other than PE can impair the sorting of the packaging[8].

Adhesive materials containing metal or aluminium (with a layer thickness of > 5 µm) can lead to unwanted sorting into the metal fraction.

Bleeding inks should be avoided.

CLOSURE SYSTEM

Closures are ideally made of the same base material as the film (e.g. HDPE, LDPE, LLDPE, MDPE).

If sealing foils are used, they must be easy to remove without leaving any residue.

Flexible closures made of PE and PP **plastic laminates** are compatible with the PE fraction in small quantities[9].

PP closures can lead to contamination in larger quantities.

Closures made of other materials such as **PET**, **PET-G**, **PS** and **PLA** should be avoided, as these can lead to secondary contamination of the PE fraction.

Metals, **thermosets**, **EPS** and **PVC** as well as seals and silicones that cannot be completely removed are considered interfering substances.

Sealing foils that are not completely removable and contain an aluminium component (layer thickness > 5 µm) can impair the sorting.

3.3.3 PP

MATERIAL

- In the best case PP flexibles are as unpigmented as possible (transparent) or white and consist of **PP monomaterial** without any barrier
- If barrier requirements exist, a silicon oxide (**SiOx**) barrier, a **carbon plasma coating**[7] or an aluminum oxide (**Al_2O_3**) barrier can be used, as these do not significantly affect the quality of the recyclate.

- A **multilayer composite material** can be used, if necessary, if it is made up of different **PE** types (e.g. **LDPE, HDPE**). Multilayer composite materials with small amounts of **PP** are also recyclable.
- **Additives** can be added if the density of the base material remains < 0.97 g/cm^3 and thus the density grading is not impaired.
- If necessary, an **EVOH** barrier layer can be used, provided that applicable limit values are complied with[10].
- The metallisation (aluminium vapour deposition) of the base material can cause problems in sorting under certain circumstances. In addition, this can lead to a deterioration of the recyclate quality (grey colouration).

- A material compound with any other plastics should be avoided, as this will contaminate the PE fraction.
- The use of density-altering additives (e.g. talc, **$CaCO^3$**) as well as **foaming agents** for chemical expansion, which lead to an increase in density to ≥ 1 g/cm^3, can cause problems in sorting, as the material-specific classification is no longer possible.
- Barrier layers or the composite with **PVDC**, **PVC**, **PA**, aluminium[6] and EVOH[10] (if applicable limits are exceeded) represent interfering substances in the reprocessing of the material, as they **contaminate** the recyclate.
- The addition of **oxo-degradable** additives damages the recyclate and is banned throughout the EU from 2021 due to the Single-Use Plastics Directive.
- Dark colouring can have a negative effect on the recyclate quality.
- **Carbon black** -based colours can prevent sorting.

DECORATION AND OTHER COMPONENTS

If the packaging is printed directly, the printing inks must at least be **EuPIA**-compliant and **non-bleeding** in order to prevent potential **contamination**.

Minimal printing with light or glazing colours is advantageous.

If labels are used, they should be made of the same base material as the packaging (e.g. **HDPE,LDPE, MDPE,LLDPE**).

If the decoration is made of a material other than PE, a maximum of 50% of the packaging surface should be covered so as not to hinder the correct sorting of the base material[8].

The **batch coding** and the indication of the **best-before date** should best be carried out in the form of an embossing or laser marking.

Wet-strength paper labels are preferable to conventional paper labels as they do not release fibres that contaminate the recyclate.

Labels made of **PP** can be used if necessary, provided that a maximum of 50% of the packaging surface is covered[8].

The batch coding and indication of the best-before date can, if necessary, also be done by minimal direct printing with other **coding** systems (e.g. **ink-jet**), provided that food-grade inks are used.

Labels made of materials other than PE, PP or paper should be avoided.

Large-scale decorations (> 50% of the packaging surface) made of a material other than PE can impair the sorting of the packaging[8].

Adhesive materials containing metal or aluminium (with a layer thickness of > 5 µm) can lead to unwanted sorting into the metal fraction.

Bleeding inks should be avoided.

CLOSURE SYSTEM

Closures are ideally made of the same base material as the film (e.g. HDPE, LDPE, LLDPE, MDPE).

If sealing foils are used, they must be easy to remove without leaving any residue.

Flexible closures made of PE and PP **plastic laminates** are compatible with the PE fraction in small quantities[9].

PP closures can lead to contamination in larger quantities[9].

Closures made of other materials such as **PET**, **PET-G**, **PS** and **PLA** should be avoided, as these can lead to secondary contamination of the PE fraction.

Metals, **thermosets**, **EPS** and **PVC** as well as seals and silicones that cannot be completely removed are considered interfering substances.

Sealing foils that are not completely removable and contain an aluminium component (layer thickness > 5 µm) can impair the sorting.

3.3.4 PAPER

MATERIAL

The fibres for the production come from coniferous and deciduous trees in the best case.

An uncoated and unlaminated version is preferable, especially to simplify the digestion of the fibre and to prevent **contamination**.

A one-sided plastic coating/**plastic laminate** can be recycled if the fibre content is > 95 %.

Mineral fillers such as kaolin, talc and calcium carbonate as well as titanium dioxide (white pigment) and starch can be used without hesitation as they do not interfere with the recycling process.

Fibres from alternative, non-woody plants such as hemp and cotton etc. are a material that can potentially interfere with paper recycling. In small quantities, however, these are not critical.

A one-sided plastic coating/laminate can be used if required, if the fibre content remains between 95 % and 85 %.

The disintegration of the fibres is also made more difficult by a plastic coating on both sides, wax coatings, siliconised paper and fibre components with a wet-strength finish.

Similarly, one-sided plastic coatings/plastic laminates should be avoided if the fibre content is < 85 %.

DECORATION AND OTHER COMPONENTS

The printing shall be as minimal as possible and shall be carried out with **EuPIA**-compliant printing inks.

Adhesive components such as viewing windows, labels and other plastic components should be avoided. They should be designed in such a way that they can be easily separated in the recycling process or by the end consumer.

If the packaging is metallised, the metallisation should not cover more than 60 % of the packaging surface.

Viewing windows and other plastic components that cannot be easily separated from the paper are interfering materials.

It is essential to avoid inks containing mineral oil, as these may contaminate the **secondary fibres.**

CLOSURE SYSTEM

Paper tapes can be used as long as the **adhesive application** does not lead to the formation of problematic **stickies**[12].

In general, it is important to use adhesive applications that do not lead to the formation of problematic stickies in the recycling process[12].

When using staples and plastic adhesive tapes, care should be taken to ensure that they can be separated in the recycling process or in advance by end consumers.

3.4 TUBES

3.4.1 ALUMINIUM

MATERIAL

✔
- The aluminium used should only consist of **non-ferrous(NF) metal components** to prevent **contamination** in recycling.
- In a best case, it concerns a **mono-material package** in which all components are made of aluminium.
- A lacquer coating does not interfere with the conventional recycling process

✘
- For aluminium in composite materials (e.g. in combination with plastic), there is usually no possibility for **high-quality recycling**.

DECORATION AND OTHER COMPONENTS

✔
- Embossing does not have a negative impact on recycling.
- Direct printing on the packaging should be carried out with **EuPIA**compliant coatings and printing inks.

✘
- Non-compliant inks can reduce the quality of the secondary material.
- **PVC** labels should be avoided as they can cause problems during processing in the recycling process.

CLOSURE SYSTEM

✔
- Closure systems made of aluminium can be recycled together with the base material and are, therefore, to be preferred.

~
- Plastic caps and valve caps should be designed in such a way that they can be separated before disposal or during the sorting process.

3.4.2 PE

MATERIAL

In the best case, **PE** trays and cups are as unpigmented as possible (transparent) or white and consist of PE **mono-material** without a barrier.

If barrier requirements exist, a silicon oxide (**SiO_x**), an aluminium oxide (**Al_2O_3**) barrier or a **carbon plasma coating** (for coloured cups only) can be used, as these do not significantly affect the quality of the recyclate.

A **multi-layer composite material** can be used if necessary, if this is made up of different PE types (e.g. **LDPE**, **HDPE**). Multilayer composite materials with small amounts of **PP** are also recyclable.[9]

Additives can be added if the density of the base material remains < 0.995 g/cm^3 and thus the density grading is not impaired.

The metallisation (aluminium vapour deposition) of the base material can cause problems in sorting under certain circumstances[11]. In addition, this can lead to a deterioration of the recyclate quality (grey colouration).

A material compound with **PS**, **PVC**, **PLA**, **PET** and **PET-G** should be avoided, as this contaminates the PE fraction.

The use of density-changing additives (e.g. talc, filled polyolefins (FPO), **$CaCO^3$**) as well as **foaming agents** for chemical expansion, which lead to an increase in density to ≥ 0.995 g/cm^3, can cause problems in sorting, as the material-specific classification is no longer possible.

Barrier layers or the composite with **PVDC**, **PA** and **PE-X** represent interfering substances in the recycling of the material, as they **contaminate** the recyclate. Aluminium components where the (metal) layer thickness exceeds 5 µm can lead to unwanted rejection of the packaging. Aluminium barrier laminates (ABL) with the PE/ALU/PE structure should, therefore, be avoided.

The addition of **oxo-degradable** additives damages the recyclate and is banned throughout the EU from 2021 due to the Single-Use Plastics Directive.

Dark colouring can have a negative effect on the recyclate quality

Carbon black -based colours can prevent sorting.

DECORATION AND OTHER COMPONENTS

- If the packaging is printed directly, the printing inks must at least be **EuPIA**-compliant and **non-bleeding** in order to prevent potential **contamination**.
- Minimal printing with light or glazing colours is advantageous.
- If labels are used, they should be made of the same base material as the packaging (e.g. **HDPE, LDPE, MDPE, LLDPE**).
- **In-mould labels** made of **PE** can also be used. However, a high **degree of printing** can have a negative effect here, as the label is recycled together with the base material.
- If the decoration is made of a material other than PE, a maximum of 50% of the packaging surface should be covered so as not to hinder the correct sorting of the base material[8].
- The **batch coding** and the indication of the **best-before date** should best be carried out in the form of an embossing or laser marking.

- Wet-strength paper labels are preferable to conventional paper labels as they do not release fibres that contaminate the recyclate.
- Labels made of **PP**/ **OPP** and **PET** can be used if necessary, provided that a maximum of 50% of the packaging surface is covered[8].
- In addition, all labels made of a material other than PE should be water-washable to ensure separation from the PE fraction and no adhesive residue should remain.
- The batch coding and indication of the best-before date can, if necessary, also be carried out by means of minimal direct printing with other **coding** systems (e.g. **ink-jet**), provided that food-grade inks are used.

- Labels made of other materials that are not water-washable can negatively affect the sorting or recyclate quality of the PP fraction.
- **PVC** labels should generally be avoided, even if they are water-washable.
- Large-scale decorations (> 50% of the packaging surface) made of a material other than PE can impair the sorting of the packaging[8].
- Adhesive materials containing metal or aluminium (with a layer thickness of > 5 µm) can lead to unwanted sorting into the metal fraction.
- Bleeding inks should be avoided.

CLOSURE SYSTEM

- Closures are ideally made of the same base material as the tube (e.g. HDPE, LDPE, LLDPE, MDPE).
- Closure systems without **liners** are preferable. If necessary, **EVA** or **TPE** liners should be used.
- If sealing foils are used, they must be easy to remove without leaving any residue.
- Flexible closures made of PE and PP **plastic laminates** are compatible with the PE fraction in small quantities[9].

- **PP** closures can lead to contamination in larger quantities[9].
- Closures made of other materials such as PET, **PET-G**, **PS** and **PLA** should be avoided, as these can lead to secondary contamination of the PE fraction.

- Metals, **thermosets**, **EPS**, PVC as well as seals and silicones that cannot be completely removed are considered interfering substances.
- Pump systems made of other materials (especially with glass & metal springs) also represent interfering materials.
- Sealing foils that are not completely removable and contain an aluminium component (layer thickness > 5 µm) can impair the sorting.

3.4.3 PP

MATERIAL

In the best case **PP** tubes are as unpigmented as possible (transparent) or white and consist of **PP mono-material** without barrier.

If barrier requirements exist, a silicon oxide (**SiOx**), an aluminium oxide (**Al_2O_3**) barrier or a **carbon plasma coating**[7] (for coloured bottles only) can be used, as these do not significantly affect the quality of the recyclate.

A **multi-layer composite material** can be used if necessary, if this is made up of different PP types (e.g. **OPP**, **BOPP**).

Multilayer composites with small amounts of PE are recyclable[9].

Additives can be added if the density of the base material remains < 0.995 g/cm^3 and thus the density grading is not impaired.

The metallisation (aluminium vapour deposition) of the base material can cause problems in sorting under certain circumstances. In addition, this can lead to a deterioration of the recyclate quality (grey colouration).

A material compound with **PS**, **PVC**, **PLA**, **PET** and **PET-G** should be avoided, as this contaminates the PP fraction.

The use of density-changing additives (e.g. talc, filled polyolefins (FPO), **$CaCO^3$**) as well as **foaming agents** for chemical expansion, which lead to an increase in density to ≥ 0,995 g/cm^3, can cause problems in sorting, as the material-specific classification is no longer possible.

Barrier layers or the composite with **PVDC** und **PA** represent interfering substances in the reprocessing of the material, as they **contaminate** the recyclate.

Aluminium components where the (metal) layer thickness exceeds 5 μm can lead to the unwanted rejection of the packaging. Aluminium barrier laminates (ABL) with the PP/ALU/PP structure should, therefore, be avoided.

The addition of **oxo-degradable** additives damages the recyclate and is banned throug-hout the EU from 2021 due to the Single-Use Plastics Directive.

Dark colouring can have a negative effect on the recyclate quality.

Carbon black -based colours can prevent sorting.

DECORATION AND OTHER COMPONENTS

If the packaging is printed directly, the printing inks must at least be **EuPIA**-compliant and **non-bleeding** in order to prevent potential **contamination**.

If labels are used, they should be made of the same base material (**PP**) as the tube body.

In-mould labels made of PP can also be used. However, a high **degree of printing** can have a negative effect here, as the label is recycled together with the base material.

If the decoration is made of a material other than PP, a maximum of 50% of the packaging surface should be covered so as not to hinder the correct sorting of the base material.[8]

The **batch coding** and the indication of the **best-before** date should best be carried out in the form of an embossing or laser marking.

Wet-strength paper labels are preferable to conventional paper labels as they do not release fibres that contaminate the recyclate.

Labels made of **PE** and **PET** can be used if necessary, provided that a maximum of 50% of the packaging surface is covered[8].

In addition, all labels that are made of a material other than PP or PE should be removed, be water washable to ensure separation from PP fraction and no adhesive residue should remain.

The batch coding and indication of the best-before date can, if necessary, also be done by minimal direct printing with other **coding** systems (e.g. **ink-jet**), provided that food-grade inks are used.

Labels made of other materials that are not water-washable can negatively affect the sorting or recyclate quality of the PP fraction.

PVC labels should generally be avoided, even if they are water-washable.

Large decorations (> 50% of the packaging surface) made of a material other than PP, can affect the sorting of the packaging[8].

Adhesive materials containing metal or aluminium (with a layer thickness of > 5 µm) can lead to unwanted sorting into the metal fraction.

Bleeding inks should be avoided.

CLOSURE SYSTEM

In a best case, closures are made of the same basic material (PP) as the tube.

Closure systems without **liners** are preferable. If necessary, **EVA**- or **TPE** liners can be used.

If sealing foils are used, they must be easy to remove without leaving any residue.

Flexible closures made of PE and PP **plastic laminates** are compatible with the PP fraction in small quantities[9].

PE closures can lead to contamination in larger quantities[9].

Closures made of other materials such as PET, **PET-G**, **PS** and **PLA** should be avoided, as these can lead to secondary contamination of the PE fraction.

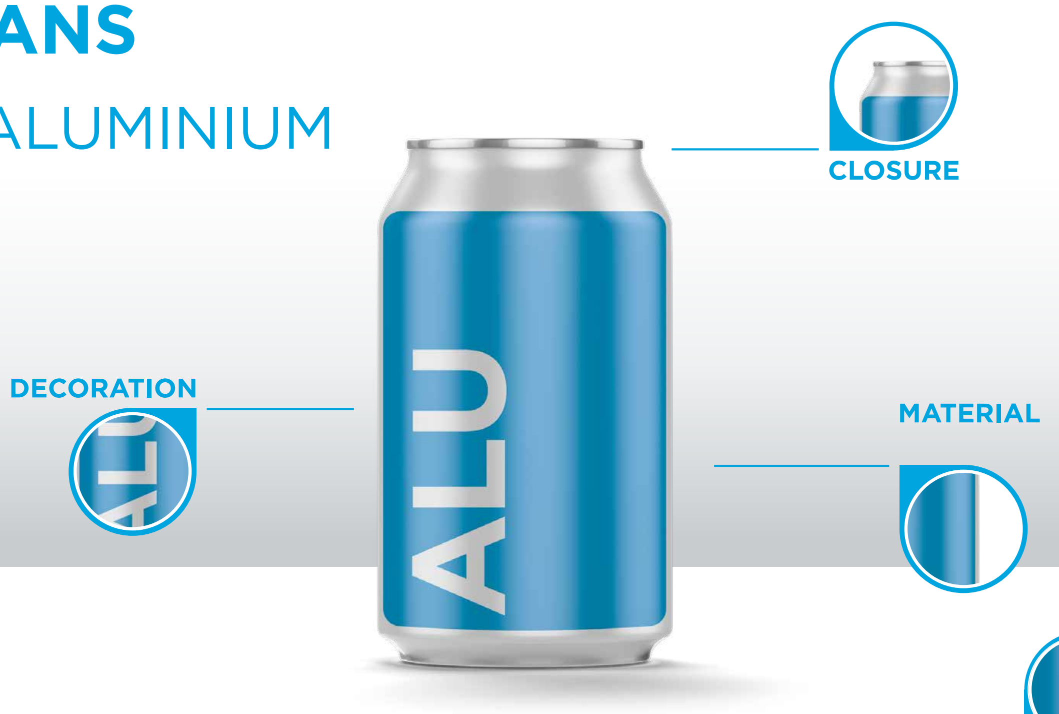
Metals, **thermosets, EPS**, PVC as well as seals and silicones that cannot be completely removed are considered interfering substances.

Sealing foils that are not completely removable and contain an aluminium component (layer thickness > 5 µm) can impair the sorting.

Pump systems made of other materials (especially with glass & metal springs) also represent interfering materials.

3.5 CANS

3.5.1 ALUMINIUM



MATERIAL

The aluminium used should only consist of **non-ferrous (NF) metal components** in order to prevent **contamination** in recycling.

In a best case, it concerns a **mono-material package** in which all components are made of aluminium.

A lacquer coating does not interfere with the conventional recycling process.

In the recycling process of aerosol cans, an additional treatment step is required, w hich is why the design is rather disadvantageous.

Aerosol cans with non-hydrocarbon-based propellants are preferable.

Spray systems with pump sprayers are refillable and propellant-free and can offer an alternative to aerosol cans, provided that individual parts made of other materials (e.g. plastic caps) can be easily separated in the recycling process.

Foreign bodies made of other materials such as **'widget' nitrogen balls** in beer cans, plastic caps and valve caps should only be used when necessary.

Aerosol cans with hydrocarbon-based propellants and spray cans with high residual contents are particularly problematic.

DECORATION AND OTHER COMPONENTS

Embossing does not have a negative impact on recycling.

Direct printing on the packaging should be carried out with **EuPIA** -compliant coatings and printing inks.

Non-compliant inks can reduce the quality of the secondary material.

PVC labels should be avoided, as they cause problems during processing in the recycling process

CLOSURE SYSTEM

Closure systems made of aluminium can be recycled together with the base material and are, therefore, to be preferred.

Plastic caps and valve caps should be designed in such a way that they can be separated before disposal or during the sorting process.

3.5.2 TINPLATE

MATERIAL

- Only ferromagnetic (alloy) metals should be used to prevent **contamination** in recycling.
- A lacquer coating does not interfere with the conventional recycling process

- In the recycling process of aerosol cans, an additional treatment step is required, which is why the design is rather disadvantageous.
- Aerosol cans with non-hydrocarbon-based propellants are preferable

- Aerosol cans with hydrocarbon-based propellants and spray cans with high residual contents are particularly problematic.

DECORATION AND OTHER COMPONENTS

- Embossing does not have a negative impact on recycling.
- Direct printing on the packaging should be done with **EuPIA**-compliant coatings and printing inks.
- Paper banderoles can also be used without any problems.

- Non-compliant inks can reduce the quality of the secondary material.
- **PVC** labels should be avoided as they can cause problems during processing in the recycling process.

CLOSURE SYSTEM

- In the best case, closures are also made of ferromagnetic (alloy) metals, as these can be recycled together with the base material.

- Plastic caps and valve caps should be designed in such a way that they can be separated before disposal or during the sorting process.

3.6 FOLDING BOX OUT OF PAPER/CARDBOARD/CARTON

MATERIAL

The fibres for the production come from coniferous and deciduous trees in the best case.

An uncoated and unlaminated version is preferable, especially to simplify the digestion of the fibre and to prevent **contamination**.

A one-sided plastic coating/**plastic laminate** can be recycled if the fibre content is > 95 %.

Mineral fillers such as kaolin, talc and calcium carbonate as well as titanium dioxide (white pigment) and starch can be used without hesitation as they do not interfere in the recycling process.

Fibres from alternative, non-woody plants such as hemp and cotton etc. are a material that can potentially interfere with paper recycling. In small quantities, however, these are not critical.

A one-sided plastic coating/plastic laminate can be used if required, if the fibre content remains between 95 % and 85 %.

The pulping of the fibres is also made more difficult by a plastic coating on both sides, wax coatings, siliconised paper and wet-strengthened fibre portions.

Similarly, one-sided plastic coatings/plastic laminates should be avoided if the fibre content is < 85 %.

DECORATION AND OTHER COMPONENTS

The printing shall be as minimal as possible and shall be carried out with **EuPIA**-compliant printing inks.

Adhesive components such as windows, labels and other plastic components should be avoided. They should be designed in such a way that they can be easily separated in the recycling process or by the consumer.

If the packaging is metallised, the metallisation should not cover more than 60% of the packaging surface.

Viewing windows and other plastic components that cannot be easily separated from the paper are interfering materials.

It is essential to avoid inks containing mineral oil, as these may contaminate the **secondary fibres.**

CLOSURE -SYSTEM

Paper tapes can be used as long as the **adhesive application** does not lead to the formation of problematic **stickies**[12].

In general, it is important to use adhesive applications that do not lead to the formation of problematic stickies in the recycling process[12].

When using staples and plastic adhesive tapes, care should be taken to ensure that they can be separated in the recycling process or in advance by end consumers.

3.7 COMPOSITE BEVERAGE CARTON

MATERIAL

- ✓ The layer structure should correspond to the standard composite system for **beverage cartons** for clear identification in the recycling stream[13] (**PE**-paper-PE or PE-paper-PE-aluminum-PE).
- ✓ Single- and double-sided plastic coatings do not cause any problems in the recycling process, as this is designed for the special processing of composite beverage cartons.
- ✓ Industry-standard **additives** in the paper content, such as kaolin, talc, calcium carbonate, titanium oxide and starch, can be used without any problems, but proportionally reduce the fiber yield in the recycling process.

- ~ Non-wood plant fibres such as hemp, grass and cotton can reduce the fibre yield in the recycling process and should only be used if necessary.

- ✗ Special designs with additional outer coating that restrict sorting (e.g. metallised **PET** films) should be avoided.
- ✗ Wet-strengthened fibre components can make fibre digestion more difficult and should be avoided

DECORATION AND OTHER COMPONENTS

- ✓ Components made of **HDPE** or **PP** with easy separability do not restrict the recycling process.
- ✓ Printing should be done exclusively with **EuPIA**-compliant inks.

- ✗ Metallised surfaces or coatings that interfere with **NIR** detection can lead to problems in the sorting process and should be avoided.
- ✗ Paints containing mineral oil can lead to **contamination** of the **secondary fibres.**

CLOSURE SYSTEM

- ✓ Plastic closures (e.g. made of HDPE or PP) can be separated from the fibre content in the recycling process.

4. DESIGN RECOMMENDATIONS FOR PACKAGING TYPES (UNDER DEVELOPMENT)

In coordination with the Circular Packaging Design Guideline of the FH Campus Wien, work is underway to develop design recommendations for further packaging types. For the following packaging types, less specific recommendations are currently available, which is why only explicit recommendations or design criteria to be avoided are mentioned.

4.1 PAPER CANS/ ROUND TINS

It is recommended to keep the proportion of non-fibre materials as low as possible and, for example, to also form the base and lid from paper. If a fibre content of more than 95 % [14] is reached, it is recommended to check the recyclability and the possibility of recovery

In most cases, paper composite cans contain a barrier layer of aluminium and a composite with plastic. Therefore, in the usual case, this structure is not considered recyclable. If, in addition, there is a base or lid made of tinplate, these pass through the **magnetic separator** of the sorting plants into the metal processing and only the metal content is recycled. If the fibre content is less than 95% and the paper is coated on both sides, coated with wax/paraffin or impregnated, there are additional structural restrictions on recycling.

4.2 BUCKETS AND TUBS

Buckets should preferably be made of **mono-material**. Typically, buckets and tubs are made of **HDPE**, **PP** or tinplate. For design recommendations, see the material-specific information in the tables for trays and cups.

Metal handles should be avoided in plastic buckets and tubs, as these cause a high degree of sorting effort during manual sorting (larger containers) or end up in the metal fraction in automatic sorting (smaller containers).

4.3 CANISTERS

Canisters should preferably be made of mono-material. Typically, these are made of HDPE, PP or tinplate. The decoration and closures should be coordinated with the respective material-specific specifications in the tables for trays and cups.

The adhesion of non-water-soluble ingredients must be avoided.

4.4 BLISTER

In the best case, a recyclable blister packaging solution consists of **mono-materials** (e.g. plastic insert with plastic cover foil or full cardboard blister).

In the case of solid cardboard blisters, make sure that they are only coated on one side and the fibre content is >95 % [14]. The combination of plastic and paper in a blister pack should only be used if the components are easily separable.

Blisters made of **PET**, **PVC** and **PS** should be avoided as they are not recyclable or lead to unwanted **contamination.**
The combination or composition of metals and plastics should be avoided, as the individual materials cannot be recycled to a high quality.

4.5 PET TRAYS

If plastic trays are made of PET, mono-material (i.e. 100% PET) is considered to have good recycling properties. PET film or plastic film with a density of less than 1 g/m³ which can be separated in the process is suitable as a closure solution. If plastic labels are used, they should also have a density of less than 1 g/m³ and cover as small an area as possible so as not to impair material sorting.

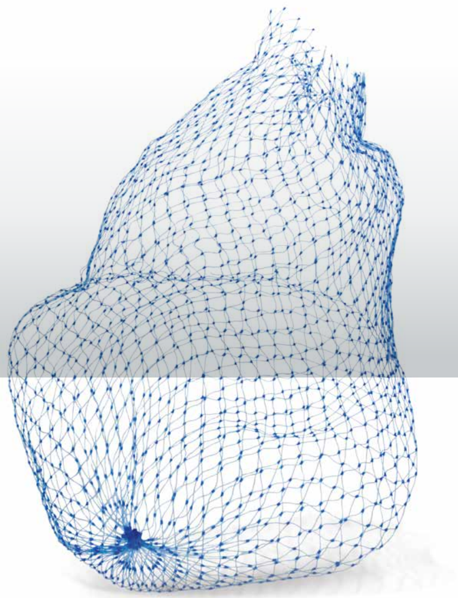
To ensure a high recyclate quality, no multilayer materials should be used for PET trays. The modification of PET (e.g. **PET-G**, **C-PET**, expanded PET (LDPET)) also leads to problems in the recycling of thermoformed PET. Composites with other plastics, e.g. **PE**, **PLA**, **PVC**, **PS** and a PET CJSC structure should, therefore, be avoided. Likewise, **suction inserts** can lead to problems in the recycling process of PET trays, especially if they are firmly bonded. Labels with a density > 1 g/m³, paper labels containing **Bisphenol A** or non-wet-strength paper labels should be avoided.[16]

4.6 PET FILMS

Only in individual cases can **PET** films be positively classified as part of a recyclable **packaging system**, for example, as a flexible closure on PET trays according to the recommendations of Petcore Europe

Currently, PET films for **flexible packaging** are not recycled due to material and quantity restrictions, which is why no recommendations for the design can be defined at present.

4.7 NETS



Nets can be made of different materials and in many cases consist of **PE**, **EPS** or cellulose. The recyclability, therefore, depends on the base material and is also related to the technical conditions in the sorting plant, as small-format nets in particular are in danger of being rejected.
If nets are used, it is important to use materials that are as widely available as possible and also have a recycling structure (e.g. PE). In addition, closures, clips and markings (e.g. labels, banderoles) should be made of the same material as the net.

Metal clips and detachable small parts should be avoided, as well as other details made of incompatible materials (cf. material-specific information in the tables for **flexible packaging**).

4.8 PLASTIC FOLDING BOX

Folding boxes made of plastic are often made of **PET** or **PP**,; the material-specific specifications can be found in the tables for trays and cups. **Applied adhesives** and labels must be adapted to the base material and direct printing should be kept to a minimum.

4.9 WOODEN PACKAGING

Auxiliaries made of other materials such as metal clips and adhering plastic parts are to be avoided. Insofar as wooden packaging is collected, only inferior quality can be recovered due to the material-specific properties.[17]

4.10 FIBRE FORM

A fibre composite that is only partially wet-strengthened enables the fibre components to be reopened. **Applied adhesives**[5] must not lead to problematic **stickies** and labels should ideally also be made of paper.

Strong moisture proofing[15] can lead to a reduction in recyclability.

4.11 BAG-IN-BOX

Bag-in-box packaging consists of a combination of flexible packaging and a folding box (mainly made of corrugated board). Material-specific design criteria can be found in the tables for **flexible packaging** and folding boxes, as well as flexible packaging made of **PE**. The recyclability of bag-in-box packaging is strongly dependent on whether the final consumer separates the components of the packaging and disposes of them separately. If the packaging is properly separated and disposed of, it can be assumed that the fibre part of the cardboard and the inner film (depending on the material used) are recyclable (provided they comply with the recommendations for recyclable design).

Non-adhesive small parts and combinations of non-compatible plastics should be refrained from (see material-specific information for flexible packaging).

5. NOTES/GLOSSARY

1 Exceptions currently exist through the requirements of the European **PET** Bottle Platform (**EPBP**, 2019) for personal and household care products, provided that packaging with a plastic **sleeve** with double perforation is permitted and information on separation is provided (regulation applies until 2022). In addition, an exception can be made if it can be proven by means of empirical studies that the individual **packaging components** are separated by the users to a high percentage.

2 If the decoration covers more than 50% of the packaging surface, the sortability of the packaging material must be proven, in order to be considered recyclable.

3 In the case of transparent base material, discolouration may occur.

4 The approval of the quantity content and design of an **EVOH** barrier may differ depending on the type of packaging and must not exceed a certain value. Specific information is provided by RecyClass at: https://recyclass.eu/de/uber-recyclass/richtlinien- fuer-recyclingorientiertes-produktdesign/ bereitgestellt

5 Information on the recyclability of adhesives is currently being revised and will be published in a forthcoming version of the FH Campus Wien - Circular Packaging Design Guideline.

6 Deviating findings must be examined on a case-by-case basis.

7 Discolouration may occur in the case of transparent base material

8 If the decoration covers more than 50% of the packaging surface, the sortability of the packaging must be proven by means of a sorting test, in order to be considered recyclable.

9 Exact limits for the **PP** content are currently under discussion.

10 The permitted mass percentage and design of an EVOH barrier varies depending on the type of packaging, and should not exceed a certain value. Specific information is provided by RecyClass at: https://recyclass.eu/de/uber-recyclass/richtlinien-fuer- recyclingorientiertes-produktdesign/ bereitgestellt.

11 For example, the sorting is not affected if the metallisation is applied in an intermediate layer of the laminate structure.

12 Specific adhesive requirements and recommendations are currently being worked on in a separate working group at the FH Campus Wien 'Focus Group Recycling-Ready Adhesives'.

13 However, the sorting process may differ depending on the plant.

14 The limits for the minimum fibre content may vary due to current country-specific requirements (e.g. minimum 80 % fibre content in Austria). Information on the technical recyclability of paper packaging is published by Cepi - Confederation of European Paper Industries: https://www.twosides.info/UK/cepi-publish-paper-based-packaging-recyclability- guidelines/

15 Information on wet solvents is currently being revised. Due to the ongoing updates of the FH Campus Wien – Circular Packaging Design Guideline, the classification of recyclability may differ.

16 Further information and ongoing developments on thermoformed PET packaging are being prepared by Petcore Europe and are available online.

17 This does not apply to packaging for special transports and heavy loads, which are subject to separate transport safety regulations.

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AA blocker

Acetaldehyde blocker is an additive in plastics technology that prevents the transfer of acetaldehyde, a taste-active substance, from **PET** into the food, by binding it.

Additive

Additives are substances that are added to products in small quantities in order to achieve (or improve) certain properties. In the case of plastics, this happens during **compounding.** Examples of additives are plasticisers, dyes, fillers and stabilisers.

Adhesive application

Adhesive application describes the way in which an adhesive is applied.

Al_2O_3

Aluminium oxide is used to coat plastics in order to improve the barrier properties. For this purpose, aluminium is vapour-deposited onto the substrate in extremely thin layers.
This can be applied to film packaging, as well as **rigid packaging.**

Batch coding

A batch describes the quantity of a product that was produced or packaged under the same conditions. By means of the corresponding batch code or batch number, which is affixed to the packaging, this batch can be determined and it is possible to trace back to when the product was produced and packaged.

Best-before date

The best-before date indicates the time until which the manufacturer guarantees that the food will retain its specific properties, for example, smell or taste, if stored correctly.

Bisphenol A

Bisphenol A (BPA) is a substance which is used, among other things, as a plasticiser in the production of plastics and which is considered to be potentially hazardous to health due to its hormone-active effect in the human body. Examples for the use of Bisphenol A are coatings on thermal paper, for example (e.g. cash register receipts) or interior coating of food cans.

BOPP

BOPP is a biaxially (longitudinally and transversely) stretched polypropylene. The purpose of stretching is to increase strength and transparency.

$CaCO^3$

Calcium carbonate (limestone) is a mineral filler in plastics technology.

Carbon black

Carbon black is a pigment in the form of virtually pure elemental carbon with very small particles that is used to colour various **polymers.**

Carbon plasma coating

This carbon plasma coating process is used, among other things, to improve the barrier properties of plastics.

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Coding

Printing applied directly to the primary packaging during the packaging or filling process, in most cases for batch numbers and **best-before dates** (to be distinguished from direct printing processes such as offset, flexo, screen or digital printing).

Compounding

Compounding is a preparation process in which the properties of a plastic are modified by the admixture of **additives** (various additives such as fillers, dyes, reinforcing materials, etc.). It usually involves melting, dispersing, mixing, degassing and extruding and is generally used to optimise the material properties.

Contamination

Contamination refers to the pollution or contamination of a substance by pollutants or interfering substances.

C-PET

C-PET is a designation for the material quality of **PET** (crystalline PET). In contrast to amorphous PET (A-PET), C-PET has higher strength and stiffness, but lower impact strength and transparency.

Degree of printing

The degree of printing describes the ratio of the printed area to the total area.

De-inking

De-inking (ink removal) is the process of removing ink from waste paper. The most important step in this mechanical and chemical process is so-called flotation. During flotation, the previously shredded paper is freed from the ink particles in a water bath together with chemicals and by adding air. The ink particles with the chemicals attach themselves to the air bubbles and float upwards in the water mixture, where they can be skimmed off and removed.

Directive on waste (2008/98/EC)

Directive 2008/98/EC of 19 November 2008 on waste – the Waste Framework Directive – is a European Community Directive and sets the legal framework for Member States' waste legislation. Link:
https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A32008L0098

Eddy current separator

The eddy current separator is used in the sorting of packaging waste and serves to separate non-magnetic but electrically conductive substances such as aluminium and copper from a material stream. In the eddy current s eparator, these substances are repelled due to a complex electromagnetic process.

EPBP

European **PET** Bottle Platform is a voluntary initiative launched by the European Federation of Bottled Waters (EFBW), the European Association of Plastic Recycling and Recovery Organizations (EPRO), Petcore Europe, Plastics Recyclers Europe (PRE) and the Union of European Beverages Association (UNESDA).

EPS

EPS (extruded polystyrene) is a tough solid foam produced by the chemical extrusion of polystyrene and is mainly known under the trade name Styrofoam.

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EU Circular Economy Package

The Circular Economy Package of the EU that entered into force in July 2018 includes provisions for enhancing circular approaches to raw materials at the European level. It sets new legally binding targets for waste recycling and landfill reduction across Europe with specific deadlines.

EU Packaging and Packaging Waste Directive (94/62/EC)

The EU Packaging and Packaging Waste Directive is a Europe-wide directive that serves to ensure the uniform, environmentally sound and health-friendly nature of packaging and packaging waste.
Link: https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A31994L0062

EuPIA

EuPIA is the European Printing Ink Association. It is part of the European Confederation of the Paint, Printing Ink and Artists' Colours Industry (CEPE). https://www.eupia.org/index.php?id=1

EU Plastics Strategy

The EU Plastics Strategy is a strategy paper for plastics that accompanies the Circular Economy Package: A European Strategy for Plastics in a Circular Economy ('EU Plastics Strategy'). This focuses on increasing the recycling rates for all packaging materials, and on intensifying extended producer responsibility schemes, as well as limitations on marketing individual plastic articles.

EVA

Ethylene vinyl acetate (EVA) refers to a group of copolymers formed by the polymerisation of ethylene and vinyl acetate. EVA is available as a film material, for example, but the processing possibilities are diverse and similar to those of **LDPE**.

EVOH

Ethylene vinyl alcohol copolymer (EVOH) is used in the packaging sector as a barrier plastic. It can either be extruded or laminated as a thin layer onto cardboard or plastic. EVOH composites are mostly used where there are increased barrier requirements such as e.g. for meat or sausage packaging.

Flexible packaging

Packaging which significantly changes shape during its intended use, under a low load. For example pouches and bags. Definition in accordance with ÖNORM A 5405: 2009 06 15

Foaming agent

Foaming agents are used to give the basic mass of a plastic a low density by means of chemical blowing agents.

Full emptying capability

Full emptying capability refers to the suitability of a packaging with regard to the intended removal of the contents by end consumers.

HDPE, LDPE, MDPE, LLDPE

Based on the different densities, a distinction is made between 4 main types of polyethylene (**PE**):
HDPE - high-density polyethylene: Polyethylene with high-density.
MDPE - medium-density polyethylene: Polyethylene with medium density.
LDPE - low-density polyethylene: Polyethylene with low density.
LLDPE - linear, low-density polyethylene.

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Ink jet

Ink jet is a printing process in which the printed image is produced by the targeted firing or deflection of ink droplets.

In-mould label

A printed label is placed in the mould immediately before injection moulding, thermoforming or blow moulding without adding adhesion promoters. The label thus becomes an integral part of the finished product.

Landfill Directive (1999/31/EC)

The EU Landfill Directive (1999/31/EC) creates uniform standards for landfills or for the disposal of waste in Europe.
Link: https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:01999L0031- 20111213&from=DE
DIN EN ISO 14021
The International Standard specifies requirements for environmental supplier declarations including statements, symbols and graphic representations for products. It also specifies selected terms frequently used in environmental statements and provides guidance on their application.

Life cycle of packaging

The life cycle begins with the extraction of raw materials and ends with the recycling of the packaging.

Liner

The term liner is used in many ways in the packaging sector, for example, to designate different types of paper in corrugated cardboard production (kraft liner, test liner). In the context of closures, the term refers to seals.

Littering

Littering is when small amounts of municipal waste are thrown away or left without using the existing disposal sites. Definition in accordance with the Swiss Federal Office for the Environment (BAFU)

Magnetic separator

Magnetic separation is a technique for separating and sorting waste. Over-conveyor band magnets or magnetic drums remove ferromagnetic material (mainly ferrous materials) from material streams transported by a conveyor belt.

Material recycling

Material recycling looks to exploit material properties when recovering waste or for previously used products, and to manufacture using these secondary raw materials. This covers material (mechanical) and raw material (chemical) recycling.

Material-specific structure (composite beverage carton)

The typical, material-specific standard structure or packaging material composition for composite beverage cartons is as follows:

Composite beverage cartons for fresh products	Aseptic composite beverage cartons for longer lasting products
- **PE interior coating** - PE bonding layer - Cardboard - Printing - PE outer coating	- PE interior coating - PE bonding layer - Aluminium film - PE bonding layer - Cardboard - Printing - PE outer coating
The mass proportion of the components is approximately 80 % cardboard and 20 % **PE**.	The mass proportion of the components is approximately 75 % cardboard, 20 % PE and 5 % aluminium.

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Microplastics

Microplastics are generally defined as small plastic particles, but there is currently no globally valid definition – including a size limit. According to the Austrian and German Federal Environmental Agency, microplastics are 'solid, water-insoluble plastic particles that are five millimetres and smaller'. Microplastics are formed over time from larger pieces of plastic through abrasion and erosion, e.g. from tyre wear, the washing of synthetic textiles or the decomposition of plastic waste in the sea.

Mono-material packaging

The components of the packaging are mainly made from one packaging material or at least from the main material of a packaging material group. One example is blister packaging, in which the thermoformed lower part and the cover film consist of polypropylene.

Multilayer/composite materials

The combination of several packaging materials which cannot be separated by hand and none of which has a mass proportion of more than 95 %. (Definition in accordance with the German Packaging Act)

Nanoparticles

Nanoparticles are small particles with a characteristic dimension in the size range from 1 to approx. 100 nm, which are used as **additives** in plastics to produce novel mechanical, optical or chemical properties.

NF metals

Abbreviation for non-ferrous metals. This includes all metals except iron as well as metal alloys in which iron is not the main element or does not exceed 50 %. Examples are copper, aluminium and brass.

NIAS

Food contact materials and articles may contain non-intentionally added substances (NIAS) that migrate into the food under certain circumstances. These are not substances introduced for technical reasons, but by-products, degradation products and **contaminants**. They can be chemical syntheses of raw materials, or also be produced during the transport or recycling of packaging.

NIR

Near-infrared refers to a light spectrum in a range that is not visible to humans of between 760 and 2,500 nm. NIR spectrometers are used in the recycling process to detect and sort plastics and are based on the principle of the transmission and reflection of radiation.

Non bleeding colours

Ink 'bleeding' refers to the spreading of inks or dyes into unwanted areas. If bleeding inks are used on packaging and are recycled, this can either affect the quality of the recyclate and/or contaminate the wash water.

OPP

Polypropylene is a uni-axially (longitudinally) stretched polypropylene. It is often used as a packaging material for bags.

Optical brighteners

Optical brighteners are **additives** that are used to achieve a higher degree of whiteness or to compensate for a residual colour cast. They are chemical compounds with fluorescent properties that are introduced into the plastic and absorb invisible ultraviolet radiation and re-emit it as visible longer-wave radiation.

Oxo-degradable plastic

Oxo-degradable plastic is plastic that contains certain additives (e.g. magan) that cause the plastic to break down into microparticles or chemically degrade through oxidation. This presents an issue in that this type of plastic does not biodegrade sufficiently and thus contributes to the pollution of the environment by **microplastics** or has a negative impact on the recycling of conventional plastics, if the articles are sent for recycling.

Oxygen absorber

Oxygen absorbers are **additives** that bind the (residual) oxygen in the packaging by means of a chemical reaction, in order to protect oxidation-sensitive food ingredients.

PA

Polyamide is a plastic based on peptide bonds, i.e. it is chemically related to protein molecules. It is characterised by a high degree of toughness and strength, as well as good barrier properties. A well-known representative of this material is nylon. In the packaging sector, PA is mainly used in the form of films.

PA additive

The PA additive of **PET**(PET - PA Blend) serves to increase the light and oxygen barrier. However, it can cause the material to be detected as potentially interfering by NIR identification.

Packaging components/packaging aids

Packaging usually consists of several components. These can be divided into packaging materials and packaging aids and consist of different packaging materials. A packaging material is understood to be the component which forms the main part of the packaging and encloses or holds together the packaged goods (contents). This is the basis. This can be, for example, a bottle, a tray or a bag. Packaging aids are components that permit supplementary functions such as closing, labelling, handling and removal.
These include staples, sealing foils, adhesive tapes, labels, banderoles, **sleeves,** closures, pull-on tapes and cushioning materials. Together, basic packaging and packaging aids form the packaging.

Packaging system

The packaging system comprises the primary packaging (which envelops the product itself), secondary packaging (for grouping primary packaging) and tertiary packaging (transport unit).

PC

Polycarbonate is a transparent plastic with very high strength that is used for kitchen utensils, drinking bottles and microwave dishes. However, because of the **bisphenol A** it contains (suspected hormone activity), its use in the food sector is declining.

PGA

Is a biopolymer-based plastic derived from polyglycolic acid (PGA), which is originally used in medical technology, but can also potentially be used as a substitute for conventional plastics (e.g. **PS**, PP).

PE

Polyethylene is one of the most widely used plastics and is resistant to oils, greases and alcohols, as well as diluted acids and alkalis. It is also very resistant to cold and can be welded. It is also produced in different qualities (see **HDPE**, **LDPE**, **MDPE**). Depending on the quality/ type, PE is used in, among other things, freezer bags and carrier bags and as an inner coating on composite beverage cartons.

PET

Polyethylene terephthalate is a usually transparent plastic, which is particularly stable and has good barrier properties. **PET** sometimes has a high aroma density and good lipid resistance. It is mainly used for the production of bottles for carbonated drinks, but also for salad trays, clear cups and film production.

PETG

Is a PET modified with glycol, which is characterised, above all, by a high viscosity and is used in injection moulding, extrusion and blow moulding. Due to its great sealing properties, PETG is also used in multilayer films (PET-GAG).

PET-GAG structure

Refers to a three-layer film in which the outer layers consist of PET-G (glycol-modified PET) and the inner layer of the less expensive PET-A (amorphous PET). The material is good barrier properties and can also be sealed. Recycled material can also be used for the inner layer.

PE-X

PE-X means 'cross-linked polyethylene' and represents a non-meltable and, therefore, thermally more resilient plastic.

PLA

(Polylactic acid) is a plastic that is obtained from renewable raw materials (starch) and may also be biodegradable. It is a clear plastic which is characterised by a good aroma barrier. PLA is mainly used for the production of films, but also as a coating for paper cups and for the production of fibres.

Plastic granulate

Is the common delivery form of thermoplastics for the plastics processing industry. The plastic is heated/melted in extruders, formed into strands via nozzles, cut into sections a few millimetres long and cooled. The resulting granulate can be easily transported as bulk material.

Plastic laminate

Generally, a material or product consisting of two or more layers bonded together in a flat manner is referred to as a laminate. These layers can consist of the same or different materials. In the case of plastic laminate, different plastics are bonded to each other over their entire surface, whereby e.g. **multilaye**r films can be produced.

PO

Designates the plastic group of polyolefins (PO). The most important representatives include polyethylene (PE) and polypropylene (PP).

Polymer

Plastics consist of polymers. Polymers are chemical compounds consisting of chain or branched molecules (macromolecules), which in turn consist of a large number of identical or similar units, the so-called monomers. They can have linear, branched or cross-linked structures. Polymers are classified – according to the degree of cross-linking of the macromolecules – into thermoplastics, **thermosets** and elastomers.

POM

Polyoxymethylene (POM) is a colourless thermoplastic with high rigidity. The material is mainly processed into moulded parts by injection moulding or also by extrusion blow moulding, and is used in the packaging sector, e.g. for spray bottles.

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PP

Polypropylene is a plastic similar to chemical polyethylene, but is stronger and more temperature-resistant. It has good barrier properties against lipids and moisture and is also one of the most widely used plastics for food packaging. Examples include bottle caps, trays and films.

Primary raw materials

Primary raw materials are natural resources that come from primary extraction. They are unprocessed – apart from the steps necessary to extract them.

PS

Polystyrene is a plastic with relatively high gas and water vapour permeability that is very dimensionally stable and clear. It can be injection moulded, thermoformed or foamed depending on the intended use in processing. Typical applications are yoghurt pots, plastic cutlery and CD cases.

PTN

Polytrimethylene napthalate (PTN) is a **polymer** that is supposed to increase the barrier properties of **PET** by mixing/alloying with PET (by co-polymerisation).

PVC

Polyvinyl chloride is a plastic with a very wide range of applications, especially in the non-food sector. It is usually very hard and brittle and becomes more malleable through the addition of plasticisers. PVC is used, for example, as shrink film in transport or for the production of pipes. In contact with food, however, there is a risk that the added plasticisers will pass into the food.

PVDC

Polyvinylidene chloride is an effective barrier and coating plastic against oxygen, carbon dioxide and water vapour. PVDC can be used in various applications, for example, as a barrier film, coating, bottle seal or shrink film.

Rigid packaging

Packaging that does not change its shape and form under load when used as intended. For example, glass bottles. Definition in accordance with ÖNORM A 5405: 2009 06 15

Secondary fibres

See primary raw materials and secondary raw materials

Secondary raw materials

Secondary raw materials are obtained by reprocessing primary raw materials. They are, therefore, materials that are used a second or repeated time.

SiOx

Silicon oxide is used to coat plastics in order to improve their barrier properties. It is applied in extremely thin layers by means of plasma coating. Colloquially, it is often referred to as 'glass coating'.

Sleeve

A sleeve is a tubular label made of shrinkable plastic which is pulled over the body of the packaging material from above and tightly joined by shrinking.

Stickies

Stickies is a term for adhesive components that result from the raw material of recovered paper and can potentially lead to **contamination** in the recycled paper. Definition based on Blechschmidt (2013) – Pocketbook of Paper Technology

Suction liner

Absorbent liners are absorbent liners used in food packaging to absorb escaping liquids from the food (e.g. meat juice from fresh meat) and to prevent the food from lying in the escaping liquid for a longer period of time (increasing product quality).

Sustainability

Sustainability or sustainable development means meeting the needs of the present in a way that does not limit the opportunities of future generations. It is important to consider the three dimensions of sustainability – economic efficiency, social justice and ecological sustainability – on an equal footing.

Thermoset

Thermosets are polymers that can no longer be deformed after they have cured.

TPE

Thermoplastic elastomers (TPE) are plastics that behave like classic elastomers at room temperature, but become deformable when heat is applied. They, therefore, combine the elastic properties of rubber with the easy processability of thermoplastics and can be repeatedly melted.

UV stabilisers

UV stabilisers are **additives** that are added to plastics to protect them against ageing caused by UV radiation (break-up of the **polymer,** chains) and are used, for example, to prevent cracking and colour loss.

Waste hierarchy

The five-stage waste hierarchy regulated in the Closed Substance Cycle Waste Management Act lays down a fundamental order of priority for waste treatment and recovery measures: 1. Avoidance, 2. Preparation for reuse, 3. Recycling, 4. Other recovery, in particular, energy recovery and backfilling, 5. Removal

Wet processing

Wet processing has the task of dissolving the waste paper into the individual fibres through the action of water and under mechanical stress (agitator, rotary drum).

'Widget' nitrogen balls

The term 'widget' is used to describe approx. 3 cm large, hollow plastic balls filled with nitrogen, which are used to create foam in beer can packaging. As soon as the can is opened, the nitrogen contained escapes through a predetermined breaking point in the ball and foam is formed.

Wood-containing paper

Refers to the wood pulp content in paper. Wood-containing papers contain more than 5 % wood pulp in the total fibre mass. Wood pulp, which is obtained mechanically, contains more lignin than pulp, which is obtained chemically. This is why wood-containing papers also tend to yellow more.

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