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AGREEMENT

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Plastics - Recycled plastics - Characterization of polyvinyl butyral (PVB) recyclates

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European foreword

This CEN Workshop Agreement (CWA 18174:2025) has been developed in accordance with the CEN-CENELEC Guide 29 "CEN/CENELEC Workshop Agreements – A rapid way to standardization" and with the relevant provisions of CEN/CENELEC Internal Regulations – Part 2. It was approved by the Workshop CEN "Plastics - Recycled plastics - Characterization of polyvinyl butyral (PVB) recyclates" consisting of representatives of interested parties on 2024-11-26, the constitution of which was supported by CEN following the public call for participation made on 2024-03-04. However, this CEN Workshop Agreement does not necessarily include all relevant stakeholders.

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Introduction

Recycling plastic waste, by mechanical recycling, is one type of material recovery process intended to save resources (virgin raw materials, water, and energy), while minimizing harmful emissions into air, water and soil. The environmental impact of recycling is assessed over the whole life cycle of the recycling system (from the waste generation point to the disposal of final residues). To ensure that recycling constitutes the best environmental option for treating the available waste, some prerequisites should preferably be met:

— recycling scheme being contemplated should generate lower environmental impacts than alternative recovery options;

— existing or potential market outlets should be identified that will secure a sustainable industrial recycling operation;

— collection and sorting schemes should be properly designed to deliver recyclable plastics waste fractions fitting reasonably well with the available recycling technologies and with the (changing) needs of the identified market outlets, preferably at minimum costs to society.

During their use phase, products are temporarily out of industrial control. Consequently, at the end user stage, it is often impossible to trace back each individual product and whether it has been used correctly through its life cycle.

This document has been produced in accordance with the guidance produced by CEN on Environmental Aspects and in accordance with CEN/TR 15353.

NOTE CEN/TR 15353 considers the general environmental aspects, which are specific to the recycling process.

1 Scope

This document specifies the main characteristics and associated test methods for assessing of polyvinyl butyral (PVB) recyclates intended for use in the production of semi-finished/finished products.

It is intended to support parties involved in the use of PVB obtained by mechanical recycling (rPVB) to agree on specifications for specific and generic applications.

This document is applicable without prejudice to any existing legislation.

This document does not cover the characterization of plastic waste, which is covered by EN 15347-1 [1], neither traceability topics which are covered by EN 15343.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CEN/TR 15353, *Plastics — Recycled plastics — Guidelines for the development of standards for recycled plastics*

DIN 53236, *Colouring materials — Conditions of measurement and evaluation for the determination of colour differences for paint coatings, similar coatings and plastics*

EN 15343, *Plastics — Recycled plastics — Plastics recycling traceability and assessment of conformity and recycled content*

EN 17615, *Plastics — Environmental Aspects — Vocabulary*

EN ISO 105-A03, *Textiles — Tests for colour fastness — Part A03: Grey scale for assessing staining*

EN ISO 178, *Plastics — Determination of flexural properties*

EN ISO 472:2013, *Plastics — Vocabulary*

EN ISO 489, *Plastics — Determination of refractive index*

EN ISO 527-1, Plastics — Determination of tensile properties — Part 1: General principle*s*

EN ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

EN ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

EN ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

EN ISO 3451-1:2019, *Plastics — Determination of ash — Part 1: General methods (ISO 3451-1:2019)*

EN ISO 11357-2, *Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature and step height*

EN ISO 11358-1, *Plastics — Thermogravimetry (TG) of polymers — Part 1: General principles*

EN ISO 15512, *Plastics – Determination of water content*

EN ISO/CIE 11664-4, *Colorimetry — Part 4: CIE 1976 L*a*b* colour space*

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 12418-2:2012, *Plastics — Post-consumer poly(ethylene terephthalate) (PET) bottle recyclates — Part 2: Preparation of test specimens and determination of properties*

ISO 14782, *Plastics — Determination of haze for transparent materials*

ISO 17223, *Plastics — Determination of yellowness index and change in yellowness index*

ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*

ASTM E313, *Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates*

ASTM E1252, *Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 472, CEN/TR 15353 and EN 17615 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

3.1
post-consumer
descriptive term covering material, generated by the end-users of products, that has fulfilled its intended purpose or can no longer be used (including material returned from within the distribution chain)

Note 1 to entry: The term “post-use” is sometimes used synonymously.

[SOURCE: EN ISO 472:2013, 2.1700]

3.2
pre-consumer
descriptive term covering material diverted during a manufacturing process

Note 1 to entry: This term excludes re-utilized material, such as rework, regrind or scrap that has been generated in a given process and is capable or being reclaimed within that same process.

Note 2 to entry: The term “post-industrial material” is sometime used synonymously.

[SOURCE: EN ISO 472:2013, 2.1701]

4 Symbols and abbreviations

For the purposes of this document, the symbols and abbreviations related to recyclates are given in EN ISO 1043-1 [2].

NOTE Additionally to the abbreviation “rPVB”, “PVB-R” or “R-PVB” or “PVB (REC)” are used as well.

5 Characterization of PVB recyclates

A single batch is the quantity of recyclate that has homogenous characteristics within the specified tolerances.

The characteristics of PVB recyclates, which shall be met for every batch of PVB are shown in Table 1, and divided into two types:

— mandatory characteristics (M) required to characterize PVB recyclates in general and required for all applications;

— optional characteristics (O) needed to characterize PVB recyclates according to customer specifications and applications.

NOTE PVB or PVB-containing plastic wastes for recycling can contain different PVB types such as acoustic and non-acoustic PVB. Further variations are seen in the form of the added plasticizer (type and amount). The properties and performance of recyclates derived from such wastes will depend on the relative proportions of the PVB types and the plasticizers.

These characteristics shall be assessed by using the test methods given in Table 1.

When the PVB recyclate is intended for the use in laminated glass applications, the following optional characteristics are mandatory and shall be reported: colour, glass transition temperature, haze, light transmittance.

Additional tests may be carried out by agreement between the customer and the supplier and results shall be reported.

A certificate of analysis giving the test results for each batch of recyclate shall be provided by the supplier to the customer upon request.

Where several methods are listed in Table 1, the certificate of analysis shall specify the method used for each measured parameter.

The customer may require some additional information on recyclate composition from the recycler in order to facilitate the legally compliant use of the recyclate. In addition to the physical and chemical characteristics specified in Table 1, each batch shall be accompanied by an information stating:

— product name;

— intended (suitable) application(s).

Table 1 — Characterization of PVB recyclates

Characteristic	Unit	Test method	PVB recyclate	Comment
Ash content	%	EN ISO 3451-1: 2019, Method A	M	The amount of PVB (in g) used to determine the ash content shall be stated in the report. Ash content can be used to indirectly determine the glass and metal content of the PVB recyclate.
Colour by visual inspection		Visual inspection	M	ISO 105-A02 and/or EN ISO 105-A03 may be used

Characteristic	Unit	Test method	PVB recyclate	Comment
Impurities		Based on ISO 12418-2:2012, Annex A	M	Depending on the original use and the recycling process different impurities can be present (e.g. glass, metals, calcium carbonate). Additional tests may be agreed between the interested parties depending on the impurities present in the recyclate. Report the size range of the visually detected impurities using a ruler.
Original application (i.e. which product was the PVB in before being processed to a recyclate) and material history		Supplier to declare	M	e.g. pre-consumer, post-consumer, automotive windshields, buildings, acoustic PVB, non-acoustic PVB, unknown original application
Presence of polymers other than PVB	Present / Not present	ASTM E1252	M	Any usable techniques of infrared spectrometry (FTIR) may be used. Both parties acknowledge that this is an estimation or range and cannot be applied to all recyclates in case of FTIR.
Plasticizer content	%	EN ISO 11358-1	M	
Residual moisture content	%	EN ISO 15512	M	
Yellowness index		ASTM E313 or ISO 17223	M	YI should be measured on foil and/or laminated glass/PVB/glass stack and can be used to indirectly determine degradation level. (i) For measurement on a foil: results should be reported with the PVB-foil thickness and foil processing method. (ii) For measurement on a laminated glass/PVB/glass stack: results should be reported together with lamination conditions, PVB foil thickness, glass thickness, utilized glass type, and foil processing method.
Adhesion to glass	N/cm	To be agreed between the interested parties.	O	

Characteristic	Unit	Test method	PVB recyclate	Comment
Colour by colorimetry	L, a, b values	EN ISO/CIE 11664-4, DIN 53236	O	Indication of L, a, b values is relevant to several applications. These should be measured on foil and/or laminated glass/PVB/glass stack, with parameters for observer 10°, illumination source D65 type and in transmission mode. (i) For measurement on a foil: results should be reported with the PVB-foil thickness, and foil processing method. (ii) For measurement on a laminated glass/PVB/glass stack: results should be reported together with lamination conditions, PVB foil thickness, glass thickness, utilized glass type, and foil processing method.
Elasticity modulus		EN ISO 178	O	
Flexural modulus	MPa	EN ISO 178	O	
Flowability			O	e.g. loose, sticky
Glass transition temperature	°C	EN ISO 11357-2	O	Indirect measurement for plasticizer content which lowers the glass transition temperature of PVB. The scanned temperature range shall start by at least -20 °C.
Haze		ASTM D1003 or ISO 14782	O	Haze is mandatory for laminated glass application and should be measured on laminated glass/PVB/glass stack. Results should be reported together with lamination conditions, PVB foil thickness, glass thickness, utilized glass type, and foil processing method.

Characteristic	Unit	Test method	PVB recyclate	Comment
Light transmittance	%	ASTM D1003 with illuminant A/2° or C/2°	O	Light transmittance is mandatory for laminated glass application and should be measured on foil and/or laminated glass/PVB/glass stack. (i) For measurement on foil: results should be reported with PVB foil thickness and foil processing method (ii) For measurement on a laminated glass/PVB/glass stack: results should be reported together with lamination conditions, PVB foil thickness, glass thickness, utilized glass type, and foil processing method.
Melt filtration mesh size	µm	Mesh size	O	For granules produced by extrusion
Melt mass-flow rate	g/10 min	EN ISO 1133-1	O	Relevant for extrusion process only
Refractive index		EN ISO 489	O	Preferably, the refractive index should be measured at 20°C or 25°C.
Tensile stress at yield	MPa	EN ISO 527-1 EN ISO 527-2 EN ISO 527-3	O	
Tensile strain at break	%	EN ISO 527-1 EN ISO 527-2 EN ISO 527-3	O	
Thermal conductivity			O	Relevant for PV applications

6 Quality assurance

In order that the customer can have confidence in the quality of the recyclates, the supplier/recycler shall maintain records of the quality controls carried out by the supplier/recycler.

NOTE A quality management system certified to EN ISO 9001 [3] can be a suitable guarantee of consistent recyclate quality but not the recycled content.

The specification and the standard deviation or range of values within and between batches of material shall be agreed between the supplier and the customer.

Where a statement of recycled content, or the previous history of the material, is requested, documentary evidence shall be provided. These records should be available to the customer on request.

Where a recyclate has been produced via a melt process, the supplier may choose to state the level of filtration applied during that process. This will determine the maximum size of any non-melting contaminants present in the recyclate. The statement of filtration level shall include details of the filter. Recyclates which have not passed through a melt process cannot be specified in the same way, and the supplier may state this.

Traceability shall be ensured according to EN 15343, that describes a qualified recycling process and gives details of traceability and the assessment of recycled content. The calculation of the recycled content shall follow EN 15343.

Bibliography

[1] EN 15347-1, *Plastics — Sorted plastics wastes — Part 1: General characterization*

[2] EN ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

[3] EN ISO 9001, *Quality management systems — Requirements*