ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	POLYVANTIS GmbH
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-PLV-20240013-IBC1-EN
Issue date	09.01.2025
Valid to	08.01.2030

PLEXIGLAS® Boards and Panels

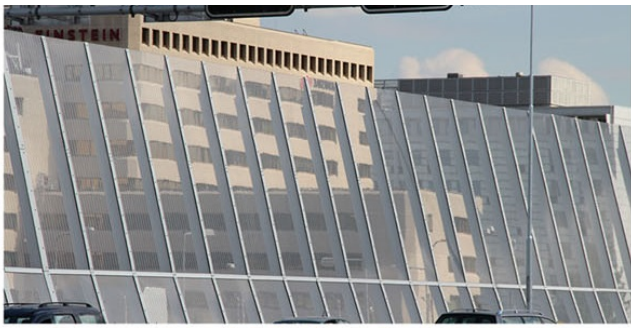
POLYVANTIS GmbH

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1. General Information

POLYVANTIS GmbH

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-PLV-20240013-IBC1-EN

This declaration is based on the product category rules:

Boards and panels made of plastic (interior and exterior applications), 01.06.2023
(PCR checked and approved by the SVR)

Issue date

09.01.2025

Valid to

08.01.2030

Dipl.-Ing. Hans Peters
(Chairman of Institut Bauen und Umwelt e.V.)

Florian Pronold
(Managing Director Institut Bauen und Umwelt e.V.)

PLEXIGLAS® Boards and Panels

Owner of the declaration

POLYVANTIS GmbH
Riedbahnstraße 70
64331 Weiterstadt
Germany

Declared product / declared unit

This environmental product declaration describes environmental impacts for the production of 1 kg of average PLEXIGLAS® sheets and panels.

Scope:

This environmental product declaration describes average PLEXIGLAS® sheets and panels produced by POLYVANTIS GmbH and covers the Weiterstadt/Wörth production group (DE).

The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

The EPD was created according to the specifications of EN 15804+A2. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025:2011
☐ internally ☒ externally

Matthias Schulz,
(Independent verifier)

2. Product

2.1 Product description/Product definition

1.1 PLEXIGLAS® is a registered trademark of Röhm GmbH.
PLEXIGLAS® sheets and panels are semi-finished products in sheet form made from clear-transparent or colored acrylic glass, with the chemical name polymethyl methacrylate, or PMMA.

A distinction is made depending on the production process, between PLEXIGLAS® GS and XT sheets/panels.
PLEXIGLAS® GS solid sheets are produced by a casting process, and PLEXIGLAS® XT solid sheets by an extrusion process (see also 2.6 'Production').
For an overview of typical trade names of PLEXIGLAS® products/product groups, see 2.2 'Application.'

In addition to the solid panels, sheets with internal flutes (multi-skin sheets) are produced in an extrusion process. These sheets are made up of two or more PLEXIGLAS® boards arranged in parallel and joined by evenly spaced upright PLEXIGLAS® ribs.

Extrusion is also used to create single-layer PLEXIGLAS® profiled sheets (corrugated sheets). These sheets are made by taking flat PLEXIGLAS® sheets and shaping them with a sinusoidal or trapezoidal cross-section.

The geometry of the sheets and panels is defined primarily by the width, length, and height (thickness) of the sheet.
Clear-transparent PLEXIGLAS® sheets and panels have a distinctive property profile.
Their characteristics include:

- crystal-clear optics
- high light transmittance
- low weight
- high break resistance
- easy processability
- extraordinarily high weathering- and UV-resistance

Moreover, PLEXIGLAS® sheets and panels are available in various colors. Regarding light transmittance, a distinction is made between transparent (clear), translucent (light-diffusing), and opaque (light-impermeable) sheets.
The surfaces of PLEXIGLAS® sheets and panels may be high-gloss, silk matte, or textured in other ways.
In addition to various colors and textured surfaces, PLEXIGLAS® sheets and panels are available in a number of different product variants.
Typical product finishes or modifications include, for example:

- hard coating for scratch resistance
- special mixes (blends), for example to achieve defined property profiles
- surface marking

PLEXIGLAS® sheets and panels with parallel faces have not so far been subject to EU harmonization legislation. The respective national provisions at the point of use apply for the use of these PLEXIGLAS® sheets and panels. Placing single-layer profiled PMMA panels on the market in the EU is governed by *Regulation (EU) No. 305/2011*. The product requires a Declaration of Performance (DoP) in accordance with *DIN EN 1013:2015-03, Light transmitting single skin profiled plastics sheets for internal and external roofs, walls and ceilings. - Requirements and test methods and a CE-mark*

2.2 Application

PLEXIGLAS® is an especially high-quality and versatile plastic. Sheets and panels made from this material are used in a wide variety of classic construction applications, indoors and outdoors, such as:

- transparent and non-transparent noise control
- large aquariums
- industrial construction applications, e.g. façades
- the furniture industry
- interior design
- exhibition booth and shop fitting
- illuminated signage
- bathroom and wellness
- private and industrial roofing

PLEXIGLAS® sheets and panels are also used in other applications such as:

- aircraft and helicopter glazing
- glazing for trucks, boats, and special-purpose vehicles
- the furniture industry
- the lighting industry

The PLEXIGLAS® sheets and panels used in these applications can often have the same composition, property profile, and basic format.
The specific application of the individual PLEXIGLAS® sheets and panels is often only decided on by the user and dealer/fabricator after they have been sold.

For these varied applications, POLYVANTIS GmbH offers different product families, including:

- PLEXIGLAS® GS
- PLEXIGLAS® XT
- PLEXIGLAS® Soundstop
- PLEXIGLAS® Heatstop
- PLEXIGLAS® Alltop
- PLEXIGLAS® Hi-Gloss
- PLEXIGLAS® LED
- PLEXIGLAS® Optical
- PLEXIGLAS® Resist
- PLEXIGLAS® Satinice
- PLEXIGLAS® Solar
- PLEXIGLAS® Textures
- PLEXIGLAS® proTerra *

* The environmental impact of this product variant is different from the LCA results stated in this environmental product declaration as it contains a significant portion of recycled PMMA.

Application rules / requirements

PLEXIGLAS® sheets and panels are manufactured in accordance with *ISO 7823-1, ISO 7823-2, ISO 12017, and EN 1013.* They are generally components of a system or design. Requirements on building systems or designs relating to

- mechanical strength and structural stability
- fire protection
- hygiene, health, environmental protection
- safety, accessibility
- noise control
- energy conservation, thermal insulation
- sustainable use of natural resources

depend on the application as well as the point of use of the systems and the designs.

2.3 Technical Data

The table below provides an overview of the typical technical characteristics of PLEXIGLAS® sheets and panels.

Further specific technical data is provided in the 'technical information' of the individual PLEXIGLAS® product groups.

Technical data

Name	Value	Unit
Thickness	1.5-250	mm
Gross density nach ISO 1183	1190	kg/m^3
Flexural strength nach ISO 178	69 - 115	N/mm^2
Permissible material tension	5-10	N/mm^2
Modulus of elasticity nach ISO 527-2/1B/1	1800-3300	N/mm^2
Shear modulus nach ISO 537	900-1700	N/mm^2
Minimal permissible cold bending radius	150-330xDicke	mm
Airborne sound reduction (bewertet) (für 10mm Massivpl.)	32	dB
Transmission factor nach DIN 5036-3	0-92	%
Total energy transmittance nach DIN EN 410 (für farblos,klar)	6-85	%
Coefficient of linear expansion	0.07-0.11	mm/(mK)
Coefficient of thermal expansion	70-110	$10^{-6}K^{-1}$
UV transmission	<1-90	%
Thermal conductivity nach DIN 52612	0.19	W/(mK)
Overall heat transfer coefficient	>1.5	W/(m²K)
Specific heat capacity	1.41-1.47	kJ/(kgK)
Specific heat capacity	1.41-1.47	kJ/kgK
Forming temperature	140-175	°C
Max. surface temperature	170-200	°C
Permanent operating temperature	70-80	°C
Reverse-forming temperature	>75->80	°C
Impact resistance Charpy, ISO 179/fu	15-kein Bruch	kJ/m²
Vicat softening point ISO 306, Methode B 50	97-115	°C

Performance values of PLEXIGLAS® panels and sheets in relation to their characteristics in accordance with the relevant technical regulations (not part of CE-marking).

2.4 Delivery status

PLEXIGLAS® sheets and panels are available in the following standard dimensions:

- Thickness: 1.5–250 mm
- Widths: 920–2050 mm, customized widths possible
- Lengths supplied: 2000 mm and above, customized widths possible

PLEXIGLAS® sheets and panels are normally masked with surface-protection film.
Depending on the depth of the distribution hierarchy, delivery may be on pallets (see also 2.9 'Packaging') or as single items. The design of the shipping pallets, which are generally made of wood, depends on the formats and weights of the PLEXIGLAS® sheets and panels.

The load varies according to the format and thickness of the sheets/panels, and is usually between 5 and 60 pieces of PLEXIGLAS® sheets/panels per pallet (normally 1000 kg gross weight).

2.5 Base materials/Ancillary materials

PLEXIGLAS® is the registered trademark of Röhm GmbH for acrylic glass (chemical name: polymethyl methacrylate, abbreviated to PMMA) in Europe, Asia, Africa, and Australia. Acrylic glass is an amorphous, glassy, thermoplastic polymer obtained by polymerization of the monomeric methacrylic acid methyl ester.

The majority of the PLEXIGLAS® semi-finished product variants described may contain up to around 2% of added components such as fillers, pigments, etc. Acrylate or methacrylate compounds may be present in larger quantities.

1) 'The product contains substances included in the ECHA Candidate List of Substances of Very High Concern for Authorisation (SVHC) (date June 14, 2023) above 0.1% by mass: No.'

2) 'The product contains other CMR substances of category 1A or 1B that are not on the candidate list above 0.1% by mass in at least one subassembly: No.'

3) 'The construction product has had biocidal products added to it or has been treated with biocidal products (making it a treated article under the terms of Biocidal Products Regulation (EU) No. 528/2012): No.'

2.6 Manufacture

PLEXIGLAS® GS panels/solid sheets are produced by casting, with the liquid monomer (MMA) being filled into a shaping chamber. The chamber typically consists of two glass plates separated by a flexible sealing gasket. The height of the gasket is the major determinant of the subsequent sheet thickness. The polymerization of the monomers in the chamber into a solid sheet generally occurs by a temperature- or initiator-controlled process.
PLEXIGLAS® GS solid sheets with a textured surface are produced by the use of appropriately textured glass plates.

After polymerization is complete, the glass plates and gaskets are removed from the PLEXIGLAS® GS sheet. The cast PLEXIGLAS® GS solid sheets are then masked with protective film, cut to size, and stacked on pallets.

PLEXIGLAS® XT panels/solid sheets are produced in an extrusion process. PLEXIGLAS® granulate or molding compound is fused in a heated steel cylinder and extruded through a forming die by means of a rotating screw conveyor in the cylinder.

The PLEXIGLAS® XT solid sheets attain their final form and surface in a subsequent calibration process, generally in a multi-roll calender. In multi-roll calenders the surface of the temperature-controlled rollers determines the sheet surface, and the roller gap of the outlet defines the thickness of the panels or sheets.

After calibration the extruded PLEXIGLAS® XT solid sheets are masked with protective films, cut to size, and stacked on pallets.

PLEXIGLAS® multi-skin sheets are produced in an extrusion process, like PLEXIGLAS® XT panels/solid sheets. The shaping tool (orifice) forms the basic geometry of the multi-skin sheets. The sheets are given their final form in a vacuum calibration unit. Like PLEXIGLAS® XT solid sheets, the extruded PLEXIGLAS® XT multi-skin sheets are masked with protective films, packaged, and stacked on pallets.

PLEXIGLAS® corrugated sheets are produced in an extrusion process, like PLEXIGLAS® XT panels/solid sheets. After exiting the tool (orifice), the flat melted PMMA material is first calibrated and then processed in a station that creates the corrugated geometry. After they have been given their final shape, the PLEXIGLAS® profile sheets are cut to size and stacked on pallets.

2.7 Environment and health during manufacturing

Gas emissions arising during production of PLEXIGLAS® sheets and panels are removed by suction and disposed of by appropriate methods, such as off-gas cleaning in biofilters or thermal aftertreatment. In normal operation only very small quantities of wastewater are generated, which are treated in an appropriate process.
Production wastes are minimized and where possible fed back into the production process (see also 2.14 'Re-use phase').

The production of PLEXIGLAS® sheets and panels at both sites of the Weiterstadt/Wörth production group is in compliance with *ISO 9001, ISO 50001, and ISO 14001*.

2.8 Product processing/Installation

PLEXIGLAS® sheets and panels are very easily processed. They are suitable for all common methods for processing of plastics, such as:

- sawing (separating)
- drilling
- milling

forming, including:

- thermoforming
- cold curving

joining, including:

- bonding
- screw unions

surface treatment, including:

- polishing
- coating
- engraving
- matting

mounting, installation, etc.

- clamping
- screw unions

For all processing and installation methods, the following apply: recommendations for processing of PLEXIGLAS®, the usual technical rules for the application, if available, and instructions of the manufacturers of the tools and accessories for processing and fitting of PLEXIGLAS® sheets and panels.

2.9 Packaging

In general, PLEXIGLAS® sheets and panels are provided with protective films applied on both sides. These serve mainly for protection against mechanical damage and soiling during transport and handling.

Protective films on PLEXIGLAS® sheets and panels are usually made of polyethylene (PE-LD) unless the product description explicitly states otherwise. Accordingly, they are recyclable without any problem (see also 2.15 'Disposal').

PLEXIGLAS® sheets and panels are supplied on shipping pallets.

After leaving the production facility the PLEXIGLAS® sheets and panels are order picked by dealers or fabricators.

2.10 Condition of use

PLEXIGLAS® sheets and panels are robust, resilient, and highly scratch-resistant and are easily machined with the usual tools. Due to their chemical structure they have good resistance to dilute acids and alkalis.

They are also extraordinarily UV stable and resistant to weathering and aging.
For this reason, as far as we are currently aware, PLEXIGLAS® sheets and panels retain their material composition and environmentally relevant inherent material characteristics, even after prolonged use in the standard applications (indoors and outdoors).

The UV-protection coatings that are necessary in many plastics are therefore not needed for PLEXIGLAS® sheets or panels, for example in long-term exterior applications.

2.11 Environment and health during use

PLEXIGLAS® sheets and panels are produced in such a way as to contain no plasticizers, heavy metal salts, or halogens, and in particular no chlorine.
In their basic chemical structure, moreover, they have no nitrogen linkages, nor what are known as aromatic constituents.

According to current knowledge PLEXIGLAS® sheets and panels, on the basis of their chemical structure, normally release no toxic, carcinogenic, mutagenic, or reprotoxic substances, or other substances with similar undesired effects, in relevant quantities, even above the softening temperature (in the region of 100 degrees Celsius).

PLEXIGLAS® sheets and panels are solid polymer products and therefore do not fall under the scope of the *VOC Regulation*. They do not emit ingredients to air, water, or soil.

2.12 Reference service life

The useful life of PLEXIGLAS® sheets and panels is determined by the particular application.
It varies between, for example, a few days for applications in trade-show booths to several decades for applications in the construction industry with a longer period of use.

In the view of POLYVANTIS GmbH, useful lives of up to 30 years or more are possible for outdoor applications such as noise barriers and industrial or residential roofing.

2.13 Extraordinary effects

Fire

The fire behavior of PLEXIGLAS® sheets and panels is classified under European Class E in accordance with *EN 13501*.

According to *EN 13501*, there is no supplementary classification of dripping behavior and smoke-gas generation for Class 'E' building materials:

- Class: E
- Flaming droplets: no data
- Smoke-gas generation: no data

In Germany, PLEXIGLAS® sheets and panels satisfy the requirements of building material class B2: normal flammability, without burning droplets, in accordance with *DIN 4102.*

In addition to the categorization in fire class E *(EN 13501)* and building material class B2 *(DIN 4102)*, other properties including those relating to the formation of smoke, acute fume toxicity, corrosiveness of fumes are characteristic of PLEXIGLAS® sheets and panels because of their chemical composition.

Detailed information is available at www.plexiglas.de

Water
Due to the chemical composition of PLEXIGLAS® sheets and panels, they do not react with water.
PLEXIGLAS® sheets and panels are therefore suitable for applications in contact with water, such as:

- glazing for large aquariums
- viewing windows for underwater vehicles and similar

Mechanical destruction
Due to their chemical structure, PLEXIGLAS® sheets and panels are resistant to the usual mechanical influences in installation and during use.

2.14 Re-use phase
At the end of their life cycle, PLEXIGLAS® sheets and panels, cleanly separated, can be conveyed at various recycling stages to a thermal recycling facility for energy recovery, or alternatively to physical or chemical recycling.

Recycling stages
Primary recycling
This describes the recycling loop of, e.g., PLEXIGLAS® scrap as long as the products have not yet left the production facility. POLYVANTIS GmbH has for many years been feeding all scrap generated in this way immediately into a recycling loop (physical recycling, see below); this means that PLEXIGLAS® XT sheets and panels are ground, re-granulated, and re-used in specialty products.

PLEXIGLAS® GS solid sheets can be fed to chemical recycling (see below).

Secondary recycling
PLEXIGLAS® scrap can undergo secondary recycling to form post-industrial recycled material (PIR).

Tertiary recycling
Tertiary recycling can be used for PLEXIGLAS® products to create post-consumer recycled material (PCR).

Thermal recovery
Thermal recovery is possible for PLEXIGLAS® sheets and panels.

2.15 Disposal
For secondary and tertiary recycling (see also 2.14 'Re-use phase') POLYVANTIS GmbH has also entered into an agreement with specialist waste-disposal firms to connect customers' plants to a controlled recycling loop for PLEXIGLAS® semi-finished products.
Recycling through such a recyclable materials firm is tantamount to an already functioning return system.

Waste code in accordance with European Waste Catalogue: 07 02 13 'Plastic waste'

Recycling information on masking films of PLEXIGLAS® sheets and panels:
Recycling triangle: Sheet 07 PMMA
Recycling triangle: Masking 04 PE-LD

2.16 Further information
EC safety data sheets are available for all PLEXIGLAS® sheets and panels through the sales department of POLYVANTIS GmbH.

Further information on PLEXIGLAS® sheets and panels, including their applications, is available from:
www.plexiglas.de www.plexiglas-shop.com

3. LCA: Calculation rules

3.1 Declared Unit
For the present investigation, the production of 1 kg of PLEXIGLAS® sheets and panels is considered for cast as well as extruded sheets. The declared unit was chosen on the basis of the wide variability of the sheet thicknesses and the different geometries of the corrugated and multi-skin sheets.

Declared unit

Name	Value	Unit
Gross density	1190	kg/m^3
Declared unit	1	kg

The data used as a basis for the mean values related to the mass produced in 2021 at the Weiterstadt and Wörth sites. This approach is deemed representative as the products undergo similar manufacturing steps at the two plants. The production processes are technologically identical and have similar levels of efficiency in terms of energy consumption and scrap rates. Both sites are located in Germany and are therefore geographically representative. This means that the declared unit can be converted to a specific product on the basis of a mass-based scaling factor.

3.2 System boundary
This is an EPD of the cradle to gate type with options, modules C1–C4, and module D (A1–A3 + C + D and additional modules).
Modules A1, A2, A3, A5, C1, C2, C3, C3/1, D, and D1 were considered for calculation of the life cycle assessment.

Product stage (A1–A3): The product stage comprises:

- Module A1: Provision of the precursors
- Module A2: Transport of the precursors to the site
- Module A3: Production including packaging, provision of energy, and production processes

The **construction process stage** of the structure **(A5)** comprises:

- Module A5: Disposal of packaging

The **end-of-life stage (C1–C4)** comprises:

- Module C1: Manual removal
- Module C2: Truck, 50 km
- Module C3: 100% scenario, thermal recovery
- Module C3/1: 100% scenario, material recovery
- Module C4: no expenditure

The benefits and loads beyond the system boundaries (D) comprise:

- Module D: Energy substitution from A5 and C3

- Module D/1: Material substitution from A3 and C3/1 depending on application of net flow calculation

3.3 Estimates and assumptions

Pigments are used in colored panels. Roughly one third of the production output is colored. This means that the average mass percent of pigments is 0.32% across the entire production output. As this amount is so low, the pigments are estimated with the raw material PMMA molding compound.

3.4 Cut-off criteria

The assessment takes into account all available data from the production process, i.e. all raw materials used and the power consumption on the basis of the most suitable LCI data records available. This means that material and energy flows are considered even if they make up less than 1% of the mass or energy.

The production of capital goods, systems, and infrastructure needed for manufacture is not taken into account in this study. Similarly, the developmental expenses for the product, input and output streams for administration, transport processes for the packaging materials, and ancillary materials were not considered.

3.5 Background data

Data from Sphera's *LCA FE and MLC database* (GaBi) 2023.1 was used as background data. For two primary products, POLYVANTIS provided specific MLC data records for calculation purposes: monomeric MMA for GS products and PMMA molding compounds for XT products.
The data records are based on manufacturer data from the Worms site.

3.6 Data quality

The raw material and production data come from the SAP system of the POLYVANTIS GmbH sites and accordingly has a high level of precision. However, raw material utilization in actual operation may vary due to load fluctuations. Some uncertainties arise from, e.g., data availability for externally procured raw materials. The values used here can, however, be considered reliable as averages over time. The data is from the reference year 2021.

For the background data, region-specific data from the database of the company Sphere (*LCA FE and MLC database* (GaBi), *CUP 2023.1*) were used. This data is representative of the years 2017–2022. For the cut-off criteria for the background data, see the documentation for the databases *LCA FE and MLC.*A *TÜV certificate* has been issued for the LCA methodology used for the two data records generated by POLYVANTIS (see 3.5). This certificate is available from the certificate database of TÜV Rheinland (labeled 'Roehm GmbH') at: https://www.certipedia.com.

3.7 Period under review

The production data refer to the reference year 2021.
The background data is taken from the latest available MLC database CUP 2023.1 *(LCA FE and MLC).*

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: Germany

3.9 Allocation

No coproducts are generated in the production of PLEXIGLAS® sheets and panels, so no allocation is necessary. At the Wörth site, corrugated sheet is the only product included in the data collection. Tube products, which are also produced, are not taken into account. The energy expenditure for the extruders cannot be allocated directly. Apart from this, expenses for production operation (heating oil, water, electricity) were allocated at a rate of 50%.
All related incineration processes are mapped on the basis of the partial flows (separated by material) for the incineration process, in accordance with the specific composition of the incinerated material. An R1 value of >0.6 is assumed for the waste incineration plant.
The environmental impact of the incineration of the packaging and the products in the end-of-life scenario is allocated to the system (A5); the resulting credits for thermal and electric energy are specified in Module D. The credits for thermal and electrical energy are calculated on the basis of European framework conditions.

3.10 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account. The background database used is *LCA FE and MLC.*

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

Information on the description of the biogenic carbon content at the gate

In the re-use phase, the product undergoes thermal (C3) or material (C3/1) recovery.

Name	Value	Unit
Biogenic carbon content in product	-	kg C
Biogenic carbon content in accompanying packaging	0.028	kg C

Note: 1 kg of biogenic carbon is equivalent to 44/12 kg of CO_2.

Construction installation (A5)

Module A5 comprises the disposal of the packaging materials wooden pallets and PE film. Thermal recovery is assumed.

Name	Value	Unit
Packaging, PE film	0.03	kg
Packaging, wooden pallet	0.07	kg

End-of-life stage (C1–C4)

In the re-use phase, the product undergoes thermal (C3) or material (C3/1) recovery.

Name	Value	Unit
Collected separately waste type PMMA	1	kg
Recycling	1	kg
Energy recovery	1	kg

Future re-use, recycling or energy recovery potentials (D), relevant scenario details

Impacts and credits resulting from the recovery are declared in

Module D or D/1.
The impacts and credits from thermal recovery of the packaging (A5) are also listed in Module D.

5. LCA: Results

The environmental results of the LCA for 1 kg PLEXIGLAS® sheets and panels are declared below. C3 and D cover the scenario of thermal recovery (EoL1).
C3/1 and D/1 specify the values for material recovery (EoL2). Module C4 has no impact for either scenario.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	X	MND	MND	MNR	MNR	MNR	MND	MND	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 kg PLEXIGLAS® Tafeln und Platten

Parameter	Unit	A1-A3	A5	C1	C2	C3	C3/1	C4	D	D/1
GWP-total	kg CO_2 eq	4.62E+00	2.01E-01	0	4.06E-03	2.2E+00	2.36E-01	0	-9.95E-01	-3.2E+00
GWP-fossil	kg CO_2 eq	4.7E+00	9.59E-02	0	3.94E-03	2.2E+00	2.36E-01	0	-9.94E-01	-3.28E+00
GWP-biogenic	kg CO_2 eq	-8.49E-02	1.05E-01	0	8.07E-05	1.07E-04	1.88E-04	0	-1.02E-03	8.33E-02
GWP-luluc	kg CO_2 eq	1.56E-03	5.35E-07	0	3.59E-05	2.9E-06	2.04E-06	0	-1.13E-04	-1.25E-03
ODP	kg CFC11 eq	1.39E-09	1.57E-14	0	5.04E-16	1.47E-13	3.12E-13	0	-7.8E-11	-1.53E-09
AP	mol H^+ eq	1.4E-02	2.79E-05	0	4.94E-06	2.31E-04	5.75E-05	0	-1.32E-03	-6.22E-03
EP-freshwater	kg P eq	1.26E-05	4.24E-09	0	1.42E-08	3.48E-08	6.37E-08	0	-1.89E-06	-1.07E-05
EP-marine	kg N eq	2.95E-03	7.3E-06	0	1.67E-06	6.22E-05	1.45E-05	0	-3.56E-04	-1.1E-03
EP-terrestrial	mol N eq	2.89E-02	1.21E-04	0	2.01E-05	1.11E-03	1.97E-04	0	-3.71E-03	-9.56E-03
POCP	kg NMVOC eq	8.48E-03	2.05E-05	0	4.25E-06	1.76E-04	3.96E-05	0	-1.01E-03	-3.51E-03
ADPE	kg Sb eq	5.96E-07	1.47E-10	0	2.55E-10	1.37E-09	2.64E-09	0	-8.46E-08	-5.18E-07
ADPF	MJ	1.01E+02	3.97E-02	0	5.28E-02	3.71E-01	3.77E-01	0	-1.87E+01	-7.33E+01
WDP	m^3 world eq deprived	3.18E+00	2.12E-02	0	4.68E-05	2.16E-01	2.52E-02	0	-1.99E-01	-2.63E+00

GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential)

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 kg PLEXIGLAS® Tafeln und Platten

Parameter	Unit	A1-A3	A5	C1	C2	C3	C3/1	C4	D	D/1
PERE	MJ	6.21E+00	1.06E+00	0	3.84E-03	9.42E-02	2.12E-01	0	-4.77E+00	-5.86E+00
PERM	MJ	1.05E+00	-1.05E+00	0	0	0	0	0	0	0
PERT	MJ	7.26E+00	9.96E-03	0	3.84E-03	9.42E-02	2.12E-01	0	-4.77E+00	-5.86E+00
PENRE	MJ	7.58E+01	1.33E+00	0	5.3E-02	2.44E+01	2.44E+01	0	-1.87E+01	-7.33E+01
PENRM	MJ	2.53E+01	-1.29E+00	0	0	-2.4E+01	-2.4E+01	0	0	0
PENRT	MJ	1.01E+02	3.97E-02	0	5.3E-02	3.71E-01	3.77E-01	0	-1.87E+01	-7.33E+01
SM	kg	0	0	0	0	0	0	0	4.06E-02	8.73E-01
RSF	MJ	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0
FW	m^3	7.05E-02	4.97E-04	0	4.21E-06	5.06E-03	6.7E-04	0	-7.02E-03	-7.46E-02

PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 kg PLEXIGLAS® Tafeln und Platten

Parameter	Unit	A1-A3	A5	C1	C2	C3	C3/1	C4	D	D/1
HWD	kg	2.56E-04	8.96E-13	0	1.64E-13	8.47E-12	-2.57E-11	0	-9.54E-06	-2.05E-04
NHWD	kg	7.39E-02	2.61E-03	0	8.08E-06	1.1E-02	1.35E-03	0	-8.43E-03	-1.86E-02
RWD	kg	1.25E-03	2.29E-06	0	9.92E-08	2.23E-05	5.62E-05	0	-1.19E-03	-7.23E-04
CRU	kg	0	0	0	0	0	0	0	0	0
MFR	kg	4.88E-02	0	0	0	0	1E+00	0	0	0
MER	kg	0	0	0	0	0	0	0	0	0

EEE	MJ	1.45E-01	3.59E-01	0	0	3.47E+00	3.47E-01	0	0	0
EET	MJ	3.37E-01	6.42E-01	0	0	6.2E+00	6.2E-01	0	0	0

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional: 1 kg PLEXIGLAS® Tafeln und Platten

Parameter	Unit	A1-A3	A5	C1	C2	C3	C3/1	C4	D	D/1
PM	Disease incidence	9.67E-08	1.79E-10	0	3.65E-11	1.26E-09	4.16E-10	0	-1.07E-08	-4.19E-08
IR	kBq U235 eq	1.17E-01	3.67E-04	0	1.48E-05	3.61E-03	9.34E-03	0	-1.96E-01	-9.07E-02
ETP-fw	CTUe	3.57E+01	1.86E-02	0	3.75E-02	1.65E-01	1.66E-01	0	-4.6E+00	-2.75E+01
HTP-c	CTUh	1.26E-09	1.82E-12	0	7.67E-13	1.39E-11	6.38E-12	0	-2.14E-10	-9.61E-10
HTP-nc	CTUh	5.16E-08	9.89E-11	0	4.09E-11	4.29E-10	1.66E-10	0	-7E-09	-3.71E-08
SQP	SQP	2.59E+01	1.22E-02	0	2.21E-02	1.17E-01	1.45E-01	0	-3.48E+00	-1.1E+01

PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index

Limitation notice 1—applies to the indicator 'potential human exposure efficiency relative to U235.'

This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure, nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon, and from some construction materials is also not measured by this indicator.

Limitation notice 2—applies to the indicators: 'abiotic depletion potential for non-fossil resources,'

'abiotic depletion potential for fossil resources,' 'water (user) deprivation potential),' 'potential comparative toxic unit for ecosystems,' 'potential comparative toxic unit for humans—cancer effects,'
'potential comparative toxic unit for humans—non-cancer effects,' 'potential soil quality index.'
The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

6. LCA: Interpretation

The table of results shows that the product stage (A1–A3) dominates the product system in relation to most environmental impact indicators. The other life cycle modules, such as installation, packaging disposal, and transport, have little significance for the environmental results. Product recovery is relevant in the re-use phase, however. There are major differences depending on the type of recovery. Thermal recovery (EoL1) creates relevant contributions in C3 and leads to potential credits of minor importance in D. Material recovery, on the other hand, leads to significant credits, although preparation in C3/1 has minor environment impacts.

In the product stage (A1–A3) the primary products PMMA molding compound and monomeric MMA are highly relevant for the environmental impact. In addition, energy usage has an influence up to 15% depending on the environmental indicator. Transport processes, ancillary materials, water, and packaging materials are mainly of marginal importance. Two exceptions in this context are wooden packaging, with regard to biogenic global warming potential, and wastewater treatment, with regard to eutrophication potential (fresh water).
Interpretation based on the terminology of ISO 14040 and EN ISO 14044: most important, significant influence
(contribution >50 %; very important, relevant influence
(contribution 25–50%); fairly important, some influence
(contribution 10–25%); little importance, minor influence
(contribution 2.5–10%); not important, negligible influence
(contribution <2.5%).

Variability of the LCA results
PMMA molding compounds and monomeric MMA make up 98–100% of the product recipe. Accordingly, the amount of fluctuation in the recipe for the declared products is low. Because of the high environmental influence of these primary products, a deviation of max. 2% can be expected in the environment impacts.
The energy consumption, as the second relevant impact factor, closely correlates with the extruded/cast mass, although the shaping of the panel, which creates the different products, barely causes any additional or reduced expenditure. Only marginal deviations are to be expected in the environmental impacts in this regard.

7. Requisite evidence

POLYVANTIS GmbH manufacturer declaration:
Extruded and cast PLEXIGLAS® products are solid polymer products/articles and they therefore do not fall under the scope of the VOC Regulation.

8. References

EN 15804
EN 15804:2012+A2:2019+AC:2021, Sustainability of construction works - Environmental Product Declarations - Core rules for the product category of construction products.

ISO 14025
EN ISO 14025:2011, Environmental labels and declarations - Type III environmental declarations - Principles and procedures.

IBU 2021
General Instructions for the EPD Programme of Institut Bauen und Umwelt e.V., Version 2.0, Berlin: Institut Bauen und Umwelt e.V., 2021; http://www.ibu-epd.com

Regulation (EU) No. 305/2011
Regulation of the European Parliament and of the Council of 9 March 2011 laying down harmonized conditions for the marketing of construction products

ISO 1183
DIN EN ISO 1183-1:2019, Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pycnometer method and titration method

ISO 537
ISO 537:1980-03, Plastics - Testing with the torsion pendulum Off. document withdrawn

ISO 178
ISO 178:2010 + Amd.1:2013, Plastics - Determination of flexural properties

ISO 179-1
DIN ENISO 17-1:2010, Plastics - Determination of Charpy impact properties - Part 1: Non-instrumented impact test

DIN 5036-3
Radiometric and photometric properties of materials; methods of measurement for photometric and spectral radiometric characteristics

DIN 52612
Testing of thermal insulating materials; determination of thermal conductivity by the guarded hot plate apparatus; conversion of the measured values for building applications

ISO 306
DIN EN ISO 306:2013, Plastics - Thermoplastic materials - Determination of Vicat softening temperature (VST)

EN 410
DIN EN 410, Glass in building - Determination of luminous and solar characteristics of glazing

DIN 4102
Fire behavior of building materials and elements

EN 13501
Fire classification of construction products and building elements

ISO 527-1
DIN EN ISO 527-1:2012, Plastics - Determination of tensile properties - Part 1: General principles

ISO 527-2
DIN EN ISO 527-2:2012, Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics

ISO 7823-1
ISO 7823-1:2003, Plastics - Poly(methyl methacrylate) sheets - Types, dimensions and characteristics - Part 1: Cast sheets

ISO 7823-2
DIN EN ISO 7823-2:2003, Plastics - Poly(methyl methacrylate) sheets - Types, dimensions and characteristics - Part 2: extruded sheets

ISO 12017
DIN EN ISO 12017:2021, Plastics - Poly(methyl methacrylate) double- and triple-skin sheets - Test methods

EN 1013
DIN EN 1013:2015-03, Light transmitting single skin profiled plastics sheets for internal and external roofs, walls and ceilings - Requirements and test methods

ISO 9001
DIN EN ISO 9001:2015, Quality management systems - Requirements

ISO 14001
DIN EN ISO 14001:2015, Environmental management systems - Requirements with guidance for use

EN 14021
DIN EN 14025, Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling)

ISO 14040
DIN EN ISO 14040: 2009-11: Environmental management - Life cycle assessment - Principles and framework

ISO 14044
DIN EN ISO 14044: 2006-10: Environmental management - Life cycle assessment - Requirements and guidelines

DIN 14040
International Organization for Standardization: Standards ISO 14040 ff. Environmental management - Life cycle assessment - Principles and framework
DIN 14044

ISO 50001
DIN EN ISO 50001, Energy management systems - Requirements with guidance for use

LCA FE and MLC
MLC database documentation for the software system LCA FE and databases (formerly GaBi); LBP (University of Stuttgart) and Sphera Solutions GmbH, Leinfelden-Echterdingen, 2023, Sphera. CUP2023.1

PCR Part A
Product Category Rules for Building-Related Products and Services, Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report, Institut Bauen und Umwelt e.V., www.ibu-epd.com, Version 1.4, 2024

PCR: sheets and panels made of plastic
Product Category Rules for Building-Related Products and Services, Part B: Requirements on the EPD for boards and

panels made of plastic, 06/2023

VOC Regulation
VOC Regulation, EU Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

TÜV report
LCA certificate, TÜV Rheinland, confirmation of compliance of the LCA methodology of Röhm GmbH with international state-of-the-art standards, science, and technology.
https://www.certipedia.com

ECHA or candidate list
The REACH Regulation provides for a list of substances of very high concern (SVHC).
This list is referred to as a candidate list and is maintained and published by the European Chemicals Agency (ECHA).
https://echa.europa.eu

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