PLEXIGLAS®

**PLEXIGLAS®**
Solid Sheet

# Environmental Product Declaration to ISO 14021

## 1 Summary

**Owner of environmental product declaration**
POLYVANTIS GmbH
Riedbahnstraße 70
64331 Weiterstadt
Germany

**Date of first issue**
November 2013

**Valid until**
unlimited

**Products examined**
PLEXIGLAS® solid sheets

**Scope of validity**
The Environmental Product Declaration applies to PLEXIGLAS® solid sheets:

- PLEXIGLAS® XT solid sheets
- PLEXIGLAS® GS solid sheets
- PLEXIGLAS® Satinice solid sheets (cast)

**Unit examined**
1 m² PLEXIGLAS® solid sheet

## 2 Product

### 2.1 Product Description

PLEXIGLAS® solid sheets are flat extruded or cast sheets with parallel surfaces, made from clear-transparent or colored polymethyl methacrylate (PMMA or acrylic) produced by Röhm GmbH (registered trademark PLEXIGLAS®).

The sheets are usually manufactured by means of one of two production processes. They are either extruded as continuous sheet from PMMA molding compound, or are cast in the casting process by mass polymerization from monomeric MMA in cells that usually consist of two glass sheets. During the casting process, the sheets acquire the same surface quality as that of the casting cell. They can therefore be high-gloss or have a matte velvet surface (PLEXIGLAS® Satinice).

PLEXIGLAS® solid sheets are available in different colors. With regard to their light transmission, a distinction is made between transparent, translucent (light-diffusing) and opaque (non-transparent) solid sheets.

The sheet geometry is the sum of the sheet width, sheet length and sheet height (thickness).

The extruded sheets are manufactured in accordance with DIN ISO 7823-2, the cast sheets in accordance with DIN ISO 7823-1. The solid sheets presented in this Environmental Product Declaration show the property profile that is typical of PLEXIGLAS®.

Among other things, they possess

- a crystal-clear appearance
- high light transmission
- low weight
- high impact strength
- ease of fabrication
- extremely high resistance to UV light and weathering.

In addition, PLEXIGLAS® solid sheets are available in other product grades such as grades with coatings that modify the product:

- matte surfaces
- textured surfaces
- scratch-resistant coating
- special blends to achieve special property profiles
- colors.

### 2.2 Application

PLEXIGLAS® is one of the world's highest-quality and most versatile plastics. It can take rough treatment and is easy to machine. PLEXIGLAS® sheets are therefore used for a variety of different applications, in the fields of mobility and transport, furniture construction, exhibition booths and store fixtures, sanitary ware, private applications in houses and gardens, but also in architecture and

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the commercial construction sector, industrial applications, and a wide range of lighting applications.

The quality and distribution of light and energy efficiency are key requirements in modern lighting technology. PLEXIGLAS® is the ideal material to meet these requirements. Its properties - unsurpassed transparency and brilliance, a variety of surfaces, ease of forming - meet the technical and design requirements of lighting engineers and illuminated advertising professionals, lighting manufacturers and architects.

Mechanical engineers, construction companies, vehicle manufacturers and builders of store fixtures all need to meet rising demands in their various fields. Protective equipment has to offer durable safety and security, while providing an appearance that harmonizes with the application. In the best of cases, design serves the purpose of security. That is why these professionals often opt for PLEXIGLAS®, for machine guards, glazing in the transportation and construction sector, for ice-rink barriers in ice hockey stadiums, or in security applications in stores.

Since the material is available in a variety of shapes and colors, and offers intelligent functionalities and ease of fabrication, this provides unlimited freedom of design for creative professionals in furniture construction, exhibition booths and store fixtures. PLEXIGLAS® is used as a display for product presentation, as a decorative element, in wall and ceiling design and for ambient lighting.

From huge commercial aircraft to small glider planes, the materials used in aircraft construction have always had to meet the most stringent requirements. They must withstand extreme temperature fluctuations, offer protection against UV radiation, be weather-resistant and tough, while weighing as little as possible. The demands to be met by aircraft continue to become ever more stringent. One important goal is to reduce fuel consumption by reducing weight. PLEXIGLAS® aircraft construction materials help to drive these developments. PLEXIGLAS® glazing can therefore be found both in passenger cabins and in the cockpit.

### 2.3 Technical Data

| | PLEXIGLAS® GS | PLEXIGLAS® XT | PLEXIGLAS® Satinice |
|---|---|---|---|
| Product photo |  | | |
| Density (g/cm³) | 1.19 | 1.19 | 1.19 |
| Colors | Clear. White. Colored | Clear. White. Colored | Clear. White. Colored |
| Light transmittance TD65 (DIN 5036 ) [%] | Up to 92 | Up to 92 | Up to 92 |
| Coefficient of linear thermal expansion α [mm/m°C] | 0.07 | 0.07 | 0.07 |
| Possible expansion due to heat and humidity | 5 | 5 | 5 |
| Vicat softening temperature [°C] | 115 | 103 | 115 |
| Charpy impact strength | 15 | 15 | 15 |
| Elastic modulus Et (short-term value) [MPa] | 3300 | 3300 | 3300 |
| Max. service temperature [°C] | 80 | 70 | 80 |
| Forming temperature [°C] | 160 – 175 | 150 – 160 | 160 – 175 |

### 2.4 Marketing/Rules for Application

The solid sheets are manufactured in accordance with DIN ISO 7823-1&2.
The fire protection requirements depend on the field of application of the solid sheets.

### 2.5 Condition on Delivery

| | PLEXIGLAS® GS | PLEXIGLAS® XT | PLEXIGLAS® Satinice |
|---|---|---|---|
| Thickness [mm] | 2 – 250 | 1.5 – 25 | 2 – 20,<br>larger thicknesses possible |
| Widths [mm] | 2030 | 2050 | 2030 |
| Delivery lengths [mm] | 3050 | 3050,<br>special lengths available | |

### 2.6 Base Materials/Extenders

The PLEXIGLAS® grades described here consist of polymethyl methacrylate that may contain up to 20% of other constituents incorporated by polymerization (e.g. acrylate or methacrylate compounds). The basic chemical structure of PLEXIGLAS® contains no substances that are acutely toxic, carcinogenic, mutagenic or teratogenic. It is therefore neither harmful to health nor to the environment.

### 2.7 Manufacture

PLEXIGLAS® XT solid sheets are manufactured by extrusion. PLEXIGLAS® pellets are melted in a heated steel barrel and pressed through a forming tool by means of a screw that rotates inside the barrel.

PLEXIGLAS® solid sheets receive their final shape during subsequent calibration. After calibration, the extruded PLEXIGLAS® solid sheets are covered with masking film, cut to size and stacked on pallets.

PLEXIGLAS® GS solid sheets are manufactured by casting. Liquid monomer (MMA) is filled into a cell that forms the sheets. This cell usually consists of two glass sheets that are spaced by a flexible sealing profile.
The monomer normally polymerizes into a solid sheet inside the cell during a temperature-controlled process. Once polymerization is completed, the glass sheets and sealing profiles are removed. The cast PLEXIGLAS® solid sheets are then covered with masking film, cut to size and stacked on pallets.

The cast PLEXIGLAS® Satinice sold sheets are manufactured by means of the casting process described above, but using matte glass sheets.

### 2.8 Environmental and Health Aspects during Manufacture

The emissions (vapors) produced during manufacture are extracted and purified by biofilters. No wastewater or waste are produced during normal operation. As far as possible, production wastes are fed back into the production process.

The solid sheets are manufactured in accordance with DIN ISO 14001 and with occupational health and safety standard OHSAS 18001.

### 2.9 Product Fabrication

PLEXIGLAS® solid sheets are very easy to fabricate. They are suitable for all conventional plastics fabrication methods, such as:

**Machining:**
parting/sawing, drilling and milling

**Forming:**
thermoforming, cold bending

**Joining:**
bonding and screw fastening

**Surface treatment:**
polishing, coating, engraving, dulling

The corresponding technical regulations apply, in addition to the manufacturer's statements on assembly and fabrication.

## 2.10 Packaging

The solid sheets are supplied by the manufacturer on wooden pallets. Depending on the sheet format and thickness, each pallet contains between 5 and 60 solid sheets. The sheets are then packaged to individual order by distributors or fabricators. The solid sheets are protected on both sides by masking film applied at the factory.

## 2.11 Physical State

Owing to their chemical composition, PLEXIGLAS® solid sheets offer extremely high weather resistance. This means there is no need to apply a UV-protective coating.

## 2.12 Environmental and Health Aspects during Use

From the point of view of Röhm GmbH, the PLEXIGLAS® products described here can be used as a group of plastics in the fields of application in demand on the market in compliance with all the relevant health and safety aspects. Owing to their manufacturing process, the products contain no plasticizers, heavy metal salts or halogens, particularly chlorine. In addition, their basic chemical structure contains no nitrogen compounds or aromatic fractions such as bisphenol A. Additives are required in only very small quantities. Owing to its basic chemical structure, PLEXIGLAS® normally emits no toxic or cancerogenic, mutagenic, teratogenic or otherwise undesirable substances even above the softening temperature (around 100 degrees Celsius).

## 2.13 Typical Service Life

The service life of PLEXIGLAS® solid sheets depends on the application.

Service periods of up to 35 years are possible in exterior applications, such as patio roofs or light domes.

## 2.14 Unusual influences

**Fire**
Fire often spreads very rapidly and ignites other flammable materials. These often produce such large amounts of thick smoke that it is very difficult to see within seconds. Exit signs very quickly become obscured. Many materials also develop highly toxic gases. Both of these aspects are extremely dangerous and can be fatal within a very short time. Various technical publications describe that 80% of all fire deaths are due to smoke gases rather than flames. Fire can never be completely excluded, but it can be influenced by using suitable construction materials.

PLEXIGLAS® burns without hardly any smoke in accordance with DIN 4102. This prevents a loss of visibility due to thick smoke. The smoke gases emitted by PLEXIGLAS® are not acutely toxic as defined by DIN 53436 and are considered harmless as defined by this standard. This makes it possible to reduce the risk of toxic smoke inhalation. The smoke gases emitted by PLEXIGLAS® are non-corrosive in accordance with DIN VDE 0482-267. This makes it possible to reduce the risk of financial damage owing to aggressive smoke gases. Burning PLEXIGLAS® is easy to extinguish. Water is usually sufficient as an extinguishing agent.

Roof glazing made of PLEXIGLAS® opens up by melting in the event of fire and enable smoke and heat to escape. In terms of fire behavior, PLEXIGLAS® is rated in European Class E in line with DIN EN 13501. In Germany, PLEXIGLAS® meets the requirements of construction material class B2, normally flammable, with no burning droplets.

**Water**
Owing to its chemical composition,
PLEXIGLAS® does not react with water.

**Mechanical destruction**
Owing to their chemical structure, PLEXIGLAS® solid sheets are extremely resistant to normal mechanical influences during installation and use. PLEXIGLAS® solid sheets offer 11 times the impact strength of conventional float glass.

PLEXIGLAS® Resist solid sheets offer even higher impact strength due to their special impact modifiers.

### 2.15 End of Life

PLEXIGLAS® solid sheets can be completely recycled (material recovery). Unlike most other polymers, PMMA can be depolymerized into MMA again by heating. This makes it possible to process the material into PLEXIGLAS® and use it again. It should be noted that no comprehensive collection system has been in put in place for PLEXIGLAS® as yet. However, there are individual recycling plants that enable large-scale applications in particular to be economically recycled. No toxic emissions are produced during possible waste-to-energy operations.

### 2.16 Disposal

Disposal is performed either by countrywide disposal companies or via household waste. PLEXIGLAS® solid sheets are not classed as special waste.

### 2.17 Further Information

You can find further information on PLEXIGLAS® solid sheets at www.plexiglas.de.

## 3 LCA: Calculation Principles

The life cycle assessments based on the data stated here were performed in accordance with the specifications of standards DIN EN ISO 14040 and 14044. This ensured the conformity of the methods, database and calculations used in all impact categories. In line with the relevant standards, the LCA reports [Hegger 2010] [Evonik 2012] were certified by external experts (critical review).

In line with ISO 14044, the following points of the study were examined:

- Conformity with ISO 14040 and ISO 14044
- Assessment of the applied methods with regard to scientific and technical aspects
- Assessment of the data used
- Assessment of evaluation and interpretation of results, bearing in mind the
- objectives of the study and the known limitations
- Report

In the critical reviews, the following comments were made, among others:

- "The changes made in terms of updates correspond to the state of the art and are explained in a clear and critical way."
- "The data used, both those of the foreground and background system, are consistent and of high quality."
- "The final results in all impact categories are plausible and coherent."

The models used in the life cycle assessments for two production sites of Evonik Industries AG were combined for the purpose of drawing up this declaration, and updated to reflect the latest version (July 2013) of the software used by PE International (GaBi 6).

### 3.1 Declared Unit

For this examination, the manufacture of 1 $m^2$ PLEXIGLAS® solid sheet (GS and XT) from 100% polymethyl methacrylate with a thickness of 8 mm is defined as the functional unit. At this thickness, 1 $m^2$ weighs 9.52 kg.

### 3.2 System Boundary

Cradle-to-grave is the system boundary of the system examined here. To calculate the life cycle assessment, consideration is given to the modules A1 (provision of feedstocks), A2 (transportation of feedstocks to the factory), A3 (production including packaging, energy provision and production processes).

The raw materials are examined up to the elementary flows. No consideration is given to the construction of the production lines or the infrastructure required for transportation. Nor is consideration given to the effort involved in developing the product or of the input and output flows for administration. Real data from the production lines, e.g. from the central accounting system, were used for capturing the production data.

### 3.3 Estimates and Assumptions

There were no assumptions about uncontrolled emissions during manufacture. Such assumptions are therefore not considered here.

### 3.4 Cut-off Rules

Some of the extenders used to produce the feedstock MMA were ignored in the model because they are used in negligible quantities (amounting to less than 0.5% of mass).

### 3.5 Background Data

The background data on power supply, feedstocks, transportation and disposal mainly come from PE International's GaBi 6 database and are available as generic data.

The established methodology of the Institute of Environmental Sciences at the University of Leiden (CML), the Netherlands, was used to assess the results of the life cycle inventories, using characterization factors dating from November 2010.

### 3.6 Data Quality

The average production data were determined over the reference years, if not otherwise available. The feedstock data and (by-) product quantities were taken from the SAP system at the plant sites and are therefore extremely accurate. The feedstock yield may, however, vary in actual operation owing to load changes. Some uncertainties are due to the facility network and feedstocks that are procured externally. The values used here may, however, be considered as secured over the temporal average. We refer to the documentation in the databases with regard to the cut-off criteria for the background data [GaBi 6 2013].

### 3.7 Period under Review

The data are based on production data for 2007 and 2011, with updates from 2012. The background data were updated at the time of modeling (GaBi 6, service pack 22, as at: July 2013).

### 3.8 Allocation

A co-product is produced during production of the feedstock methyl methacrylate. This is not required for further production, but is used in other applications. A value allocation was made in this context. Mass allocation was used for other by-products that are utilized.

### 3.9 Comparability

In this case, 1 $m^2$ of PLEXIGLAS® solid sheet (GS and XT) was selected as the declared unit. The results for 1 kg of material are also stated.

In principle, the data from this Environmental Product Declaration can only be compared or assessed in relation to data from other declarations, for example, if all the data sets to be compared were drawn up by means of comparable criteria/specifications, and the context of the application or the product-specific performance characteristics were taken into account.

## 4 LCA Scenarios and Further Technical Information

After their use, PLEXIGLAS® solid sheets are either recycled (material recovery) or converted to energy (e.g. in a waste-fed heating and power plant). For large-scale applications of PLEXIGLAS®, it can be assumed that the majority is recycled (material recovery), because the recycling company pays for the return of the used material in line with its market value. This possibly recycling leads to advantages in the LCA as compared with other similar materials. In this declaration, the environmental impacts of the end-of-life are not quantified owing to the examination framework and the non-defined application.

# 5 LCA Results

Statement of system boundaries (X = contained in LCA; NDM = non-declared module)

| Production stage | | | Construction stage | | Service stage | | | | | | | Disposal stage | | | | Credits from disposal stage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feedstock supply | Transportation | Manufacture | Transportation to construction site | Installation in the building | Use/Application | Maintenance | Repair | Replacement[1)] | Renewal[1)] | Use of energy for operating the building | Use of water for operating the building | Dismantling/Demolition | Transportation | Waste treatment and recycling | Disposal at landfill | Credit from C3: Waste treatment and recycling |
| A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | B7 | C1 | C2 | C3 | C4 | D |
| X | X | X | NDM | NDM | NDM | NDM | NDM | NDM | NDM | NDM | NDM | NDM | NDM | NDM | NDM | NDM |

[1)] The stages of replacement (B4) and renewal (B5) are usually irrelevant at product level because they refer to future applications in the life cycle of the building. For reasons of clarity, these two stages were therefore deleted from the following tables.

### Results of LCA Environmental Impacts 1 m²

| | | PLEXIGLAS® GS solid sheet per m² (9,52 kg) | | PLEXIGLAS® XT solid sheet per m² (9,52 kg) | |
|---|---|---|---|---|---|
| | | Production/m² | Production/kg | Production/m² | Production/kg |
| **Parameter** | **Unit** | **A1-A3** | **A1-A3** | **A1-A3** | **A1-A3** |
| GWP | [kg $CO_2$-equiv.] | 40.21 | 4.22 | 39.73 | 4.17 |
| ODP | [kg CFC11-equiv.] | $12.82 \times 10^{-9}$ | $1.35 \times 10^{-9}$ | $9.36 \times 10^{-9}$ | $0.98 \times 10^{-9}$ |
| AP | [kg $SO_2$-equiv.] | $98.5 \times 10^{-3}$ | $10.4 \times 10^{-3}$ | $96.9 \times 10^{-3}$ | $10.2 \times 10^{-3}$ |
| EP | [kg $PO_4^3$-equiv.] | $8.82 \times 10^{-3}$ | $0.93 \times 10^{-3}$ | $8.63 \times 10^{-3}$ | $0.91 \times 10^{-3}$ |
| TOFP | [kg Ethen equiv.] | $10.3 \times 10^{-3}$ | $1.08 \times 10^{-3}$ | $10.2 \times 10^{-3}$ | $1.07 \times 10^{-3}$ |
| ADPE | [kg Sb equiv.] | $6.69 \times 10^{-6}$ | $0.70 \times 10^{-6}$ | $6.22 \times 10^{-6}$ | $0.65 \times 10^{-6}$ |
| ADPF | [MJ] | 922.31 | 96.88 | 895.23 | 94.03 |

**Legend**

GWP = Global warming potential; ODP = Ozone depletion potential; AP =Acidification potential of soils and water; EP =Eutrophication potential; TOFP = Tropospheric ozone formation potential; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil fuels

## Results of LCA Environmental Use of Resources for 1 m²

| | | PLEXIGLAS® GS solid sheet per m² (9,52 kg) | | PLEXIGLAS® XT solid sheet per m² (9,52 kg) | |
|---|---|---|---|---|---|
| | | Production/m² | Production/kg | Production/m² | Production/kg |
| **Parameter** | **Unit** | **A1-A3** | **A1-A3** | **A1-A3** | **A1-A3** |
| PERE | [MJ] | 23.3 | 2.4 | 16.7 | 1.8 |
| PERM | [MJ] | 0 | 0 | 0 | 0 |
| PERT | [MJ] | 23.3 | 2.4 | 16.7 | 1.8 |
| PENRE | [MJ] | 1000 | 105 | 974 | 102 |
| PENRM | [MJ] | 0 | 0 | 0 | 0 |
| PENRT | [MJ] | 1000 | 105 | 974 | 102 |
| FW | [m³] | 21.1 | 2.2 | 15.4 | 1.6 |

**Legend**

PERE = Use of renewable primary energy; PERM = Use of renewable primary energy resources as raw materials; PERT = Total renewable primary energy; PENRE = Use of non-renewable primary energy; PENRM = Use of non-renewable primary energy resources as raw materials; PENRT = Total non-renewable primary energy; SM = Use of secondary materials; RSF = Use of renewable secondary fuels; NRSF = Non-renewable secondary fuels; FW = Use of freshwater resources; energy sources are stated as net values.

## Results of LCA Output Flows and Waste Categories for 1 m²

| | | PLEXIGLAS® GS per m² (9,52 kg) | | PLEXIGLAS® XT per m² (9,52 kg) | |
|---|---|---|---|---|---|
| | | Production/m² | Production/kg | Production/m² | Production/kg |
| **Parameter** | **Unit** | **A1-A3** | **A1-A3** | **A1-A3** | **A1-A3** |
| HWD | [kg] | 0.0033 | 0.0003 | 0.0059 | 0.0006 |
| NHWD | [kg] | 52.3 | 5.5 | 43.3 | 4.5 |
| MFR | [kg] | * | * | * | * |
| MER | [kg] | * | * | * | * |
| EE [therm] | [MJ] | * | * | * | * |
| EE [electr.] | [MJ] | * | * | * | * |

**Legend**

HWD = Hazardous waste disposal; NHWD = Non-hazardous waste disposal; RWD = Radioactive waste disposal; CRU = Components for reutilization; MFR = Material for recycling; MER = Material for energy recovery; EE = Exported energy per type; * The energy and feedstocks recovered in the manufacturing processes and during feedstock production cannot be explicitly captured, but are included in the result.

## 6 LCA: Interpretation

The LCA results of the solid sheets examined here in categories A1 to A3 are very similar due to the use of the same feedstocks. Approx. 98% of the primary energy requirement for PLEXIGLAS® solid sheets is accounted for by non-renewable primary energy.

The proportion of non-hazardous waste accounts for the largest share of waste disposal. Almost 99% is due to dumping caused by feedstock extraction.

The major share (> 50%) of emissions in the categories examined for the manufacture of PLEXIGLAS® solid sheets (that are of relevance to the stated impact categories) results from the feedstocks used. The combustion processes during manufacture constitute another influencing factor.

One exception is the ODP, only approx. 20% of which is due to feedstocks during the production process, since this gives rise to relevant emissions, particularly during combustion processes.

Transportation plays a subordinate role in all impact categories.

The stability and validity of the results were examined by means of sensitivity analyses of the relevant influencing parameters and allocations. Deviations for manufacture are in the single-digit percentage range.

## 7 Classification of Results

As shown by the analysis of the environmental impacts of PLEXIGLAS® GS, Satinice and XT sheets, the specific emissions for the examined sheets are more or less identical. It is therefore advisable to select and decide how to use the chosen PLEXIGLAS® GS, Satinice and XT sheets based on functional or esthetic considerations, since there is hardly any difference in their environmental impacts.

The customer can then further classify the results depending on the specific application, bearing in mind the service life. The results of this declaration can be used as a basis for this.

## 8 Literature

**CML 2001**
Institute of Environmental Sciences at the University of Leiden URL: http://cml.leiden.edu/research/industrialecology/researchprojects/finished/new-dutch-lca-guide.html,
called up on September 3, 2012

**DIN EN ISO 1183**
Plastics – Methods for determining the density of non-cellular plastics

**DIN 5036**
Radiometric and photometric properties of materials

**DIN EN 410**
Glass in building – Determination of luminous and solar characteristics of glazing

**EN ISO 12017**
Plastics – Poly(methyl methacrylate) double- and triple-skin sheets – Test methods

**DIN 4102**
Fire behaviour of building materials and building components

**DIN 53436**
Generation of thermal decomposition products from materials in an air stream for toxicological testing

**DIN EN 13501**
Fire classification of construction products and building elements

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

**DIN 14040, 14044**
International Organization for Standardization: ISO Standards 14040 ff. “Environmental management – Life cycle assessment – Principles and framework”

**DIN VDE 0482-267**
Common test methods for cables under fire conditions – Tests on gases evolved during combustion of material from cables

**Evonik 2012**
Evonik Industries AG, F. Böss, B. H. Schlüter, Life Cycle Assessment of methyl methacrylate sheet production at the Evonik plant site Wesseling, September 2012 and Aktualisierung des LCI-Modells zur Herstellung von MMA im Evonik-Werk Worms Ergänzungen zur Ökobilanzierung PLEXIGLAS® Ökobilanzierung verschiedener PLEXIGLAS® Produkte Abschlussbericht (April 2010)

**GaBi 6 2013**
GaBi 6: Software und Datenbank zur Ganzheitlichen Bilanzierung. LBP, University of Stuttgart and PE International, 2013

**Hegger 2010**
Prof. M. Hegger, J. Hartwig, Department of Design and Energy Efficient Building, Department of Architecture, Technische Universität Darmstadt "Ökobilanzierung PLEXIGLAS® - Ökobilanzierung verschiedener PLEXIGLAS® Produkte Abschlussbericht 2010"

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**Ökobau.dat 2010**
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**PCR 2011, Part A**
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**PCR 2011, Teil B Tafeln und Platten aus Kunststoff (Part B Plastic Panels and Sheets)**
Institut Bauen und Umwelt e.V., Königswinter (Ed.): Produktkategorienregeln für Bauprodukte aus dem Programm für Umwelt-Produktdeklarationen des Instituts Bauen und Umwelt (IBU) Teil A: Anforderungen an die EPD für Tafeln und Platten aus Kunststoff. 2011-10 (www.bau-umwelt.de)

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