

ENVIRONMENTAL PRODUCT DECLARATION

HANEX

ACRYLIC SOLID SURFACES



HYUNDAI

L & C

Hyundai Living & Culture is dedicated to protecting the environment and reducing our energy footprint by creating eco-friendly products that reflect the beauty of nature. From product research and development, to manufacturing and recycling, we take every step to safeguard the environment and protect its future for generations to come. As part of that effort, the Hyundai Department Store Group is a proud member of the U.S. Green Building Council, and we adhere to its Leadership in Energy and Environmental Design™ (LEED®) green building guidelines.

Hanex continually pushes the boundaries of what is possible in order to meet the demands of today's diverse applications. Hanex's goal is to enrich the lives of the people who encounter these spaces by understanding what really matters beyond aesthetics alone. With an exclusive manufacturing process using high-tech equipment, Hanex's next-generation products are meticulously crafted to withstand even the most rigorous treatment, making it the ideal material for residential and commercial applications.



ENVIRONMENTAL PRODUCT DECLARATION





HANEX
ACRYLIC SOLID SURFACES

According to ISO 14025

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.



PROGRAM OPERATOR	UL Environment	
DECLARATION HOLDER	Hyundai L & C Corporation	
DECLARATION NUMBER	4789966215.101.1	
DECLARED PRODUCT	HANEX Acrylic Solid Surfaces	
REFERENCE PCR	NSF PCR for Residential Countertops Extended per PCRExt 2021-103	
REFERENCE PCR STANDARD	<input checked="" type="checkbox"/> ISO 14025	
DATE OF ISSUE	July 1, 2021	
PERIOD OF VALIDITY	5 Years	
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications	
The PCR review was conducted by:	PCR Review Committee	
	ncss@nsf.org	
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL	 Grant R. Martin, UL Environment	
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	 James Mellentine, Thrive ESG	

ENVIRONMENTAL PRODUCT DECLARATION



HANEX
ACRYLIC SOLID SURFACES

According to ISO 14025

Company Information

Hyundai L&C is one of the world's leading manufacturers of premium building materials and an industry leader in the market of Acrylic Solid Surface. Hyundai L&C being a total interior enterprise of Hyundai Department Store Group has grown as a representative enterprise in Korea specializing in building materials since its foundation in 1965.

It runs the business of various building materials including high-class interior stones and various surface finishing materials based on eco-friendly interior film manufacturing technology, trendy style wallpapers and flooring materials, and up to windows & doors of grade 1 energy saving technology. It is strengthening the status as the 'total living interior enterprise' by providing one-stop services from counseling to delivery, construction and after-sales service through operation of directly managed interior store. Under the belief that simple imitation achieves nothing, Hyundai L&C's strong global network, excellent human resources, and leading technologies will create the new living culture of the future.

Product Information

Description of Product

Hanex is an acrylic solid surface material that is resistant to stains and chemicals and can be molded in a variety of designs with unique combinations of acrylic resin and natural materials. It is an ideal material for residential and commercial applications because of its beauty, durability, aesthetics, design flexibility, and color choices.

Hanex Solid Surfaces are made with a composition of Methyl Methacrylate (MMA) and Poly Methyl Methacrylate (PMMA) resin filled with Alumina Trihydrate (ATH) and other specialized formats to give them timeless beauty and quality. Hanex sheets are made using DBCU (Double Belt Casting Unit) process and SBCU (Single Belt Casting Unit) process to produce superior products.

Table 1 Material Composition

Chemical Name	CAS No.	Content (%)
Poly Methyl Methacrylate (PMMA)	9011-14-7	10
Aluminium Trihydrate	21645-51-2	60
Methyl Methacrylate	80-62-6	25
Copolymer Colorants	-	< 5

Application of Product

Hanex Solid Surfaces is an ideal hygienic material for kitchens and baths due to its resistance to heat, moisture,

Environment



ENVIRONMENTAL PRODUCT DECLARATION



HANEX
ACRYLIC SOLID SURFACES

According to ISO 14025

pollutants, bacteria, and other harmful agents. With a wide selection of colors and design applications, Hanex Solid Surfaces can transform any space into a beautiful environment. The unlimited design flexibility of Hanex Solid Surfaces makes it a perfect material for commercial applications. Many commercial builders are using solid surfaces in hospitals, restaurants, hotels, schools, banks, and other areas because of all the advantages a solid surface has to offer.



Manufacturing Location

Hanex is manufactured in both Republic of Korea and the United States. During the raw material acquisition and construction stage, the data was collected only from the Sejong Plant which located in Korea. However, the results include the worldwide transport and disposal after the construction stage.

Characteristics of Product

- Thermal Stability: The resistance without change in color and shape when heat is applied to the material from an

Environment



ENVIRONMENTAL PRODUCT DECLARATION



HANEX

ACRYLIC SOLID SURFACES

According to ISO 14025

outside source, including direct and/or indirect heat source. Hanex Solid Surfaces has been tested and passed the following tests:

- Heat Resistance
- Hot Water Resistance
- Weatherability
- UV Stability
- Flame Resistance
- **Chemical Resistance:** The resistance to certain acid, alkali and organic solvent without change in color and composition. Hanex Solid Surfaces has been tested under the strictest guidelines.
- **Maintenance/Repairability:** Unlike other surfacing materials which are produced by laminating or coating, Hanex is nonporous and solid through the entire material. These features make Hanex Solid Surfaces virtually maintenance free and fully repairable.
- **Seamless Design:** Sheets can be bonded together with inconspicuous seams. Smooth integration allows large areas without joints.
- **Recyclable:** Hanex is an eco-friendly material, as it is renewable and can be used again in its production process.
- **No Radon Detected:** Hanex is a safe product with no first-class carcinogen radon detected.
- **Anti-Bacteria:** Hanex is capable of withstanding the spread of other harmful germs and bacteria.
- **Translucent:** Various thickness of Hanes exhibit a special translucency when exposed to light.
- **Thermoform:** Sheets can be thermoformed to create curves of shapes of any designs.
- Other Product Benefits:
 - Stain resistant
 - Mildew resistant
 - Class A fire rating
 - Nonporous
 - Repairable
 - Custom edge details
 - Industry's best warranty
 - Durable

Table 2. Technical specifications for Hanex (engineered stone)

Characteristic	Value	Unit
Primary Material Thickness	12 (1/2")	mm (inch)
sheet/slab length	2500~3680 (98~144")	mm (inch)
sheet/slab width	760 (30")	mm (inch)
primary material weight	20.4 (1.27)	kg/m ² (lb/ft ²)
Underlayment Included	None	
Underlayment Type	None	



ENVIRONMENTAL PRODUCT DECLARATION



HANEX
ACRYLIC SOLID SURFACES

According to ISO 14025

VOC Emissions Test Method	<p>UL 2818 - 2013 Gold Standard for Chemical Emissions for Building Materials, Finishes and Furnishings. Building products and interior finishes are determined compliant in accordance with California Department of Public Health (CDPH) Standard Method V1.2-2017 using an Office and Classroom Environment. Product tested in accordance with UL 2821 test method to show compliance to emission limits on UL 2818. Section 7.1 and 7.2.</p> <p>GREENGUARD - Indoor Air Quality Certified Building materials are determined compliant in accordance with an Office environment with an air change of 0.68 hr⁻¹ and a loading of 3.20 m². Products tested in accordance with UL 2821 test method to show compliance to emission limits in UL 2818, Section 7.1.</p>
Other Characteristics	<p>GREENGUARD Gold certification ANSI/NSF 51-2012 Food equipment materials</p>

Table 3. Additional technical specifications for Hanex (engineered stone)

Additional Characteristic	Value	Test Standard
Specific Gravity	1.7	ASTM D792-08
Rockwell Hardness	90	ASTM D785-08
Tensile Strength	43.8 MPa	ASTM D638-10
Tensile Modulus of Elasticity	12.6 GPa	
Flexural Strength	58.8 MPa	ASTM D790-10
Flexural Modulus of Elasticity	10.6 GPa	
Izod Impact Strength	16 J/m	ASTM D256-10
Water Absorption	0.036 % (24hr Immersion)	ASTM D570-98
Density	1.7 g/cm ²	ASTM D792-08
Heat Resistance Test	No Defects	JIS K 6902 : 2008
Hot Water Resistance Test	No Defects	
Deflection Temperature Under (1.82MPa)	115 °C	ASTM D648-07
Thermal Expansion	3.93 x 10 ⁻⁵ 1/°C	JIS K 6911 : 2006
Compressive Strength	118 MPa	ISO 604 : 2002



ENVIRONMENTAL PRODUCT DECLARATION



HANEX
ACRYLIC SOLID SURFACES

According to ISO 14025

Light Resistance	No Effect	NEMA LD3 3.03
Boiling Water	No Effect	NEMA LD3 3.05
Ball Impact Resistance	No Fracture on 3 Impacts	NEMA LD3 3.08
Resistance to Impact by Large Diameter Ball	Max Impact Height : 2m	ISO 4586-2
Point Impact Resistance	No Cracks or Chips	ANSI Z124.3 4.3
Stain Resistance Test	Pass	ANSI Z124.3 5.2
Wear and Cleanability Test	Pass	ANSI Z124.3 5.3
Cigarette Test	Pass	ANSI Z124.3 5.4
European Railway Standard for Fire Safety	R1, HL3	EN 45545
Resistance to Bacteria	No Growth	EN 45545
Resistance to Fungi	No Growth	ASTM G21
European Classification Standard	B-s1, d0	EN 13501-1
Façade Panel	ETA (European Technical Assessment)	DIBT
Weatherability (1,000 hr) - Special Color Only	No Visual Change	ASTM G155

Modelling of Life Cycle Assessment

The analysis represents the weighted average of Hanex from the Sejong plant, based on production and sales volume in 2020. The whole LCA process was conducted according to ISO 14044.

Reference PCR

This LCA study was conducted according to the requirements in the Product Category Rule (PCR) for Environmental Product Declarations “PCR for Residential Countertops” published by NSF International and valid through September 17, 2021.

Functional Unit

The functional unit is one square meter (10.76 square ft) of countertop for a period of 10 years in residential use. The



ENVIRONMENTAL PRODUCT DECLARATION



HANEX
ACRYLIC SOLID SURFACES

According to ISO 14025

functional unit includes a front edge and a backsplash.

Table 4 Characteristics of Hanex per functional unit

Characteristic	Value	Unit
Functional Unit	1	m ²
Service Life	10	years
Weight	20.4	kg

System Boundary

The figure 1 describes the system boundary of Hanex for the LCA report.

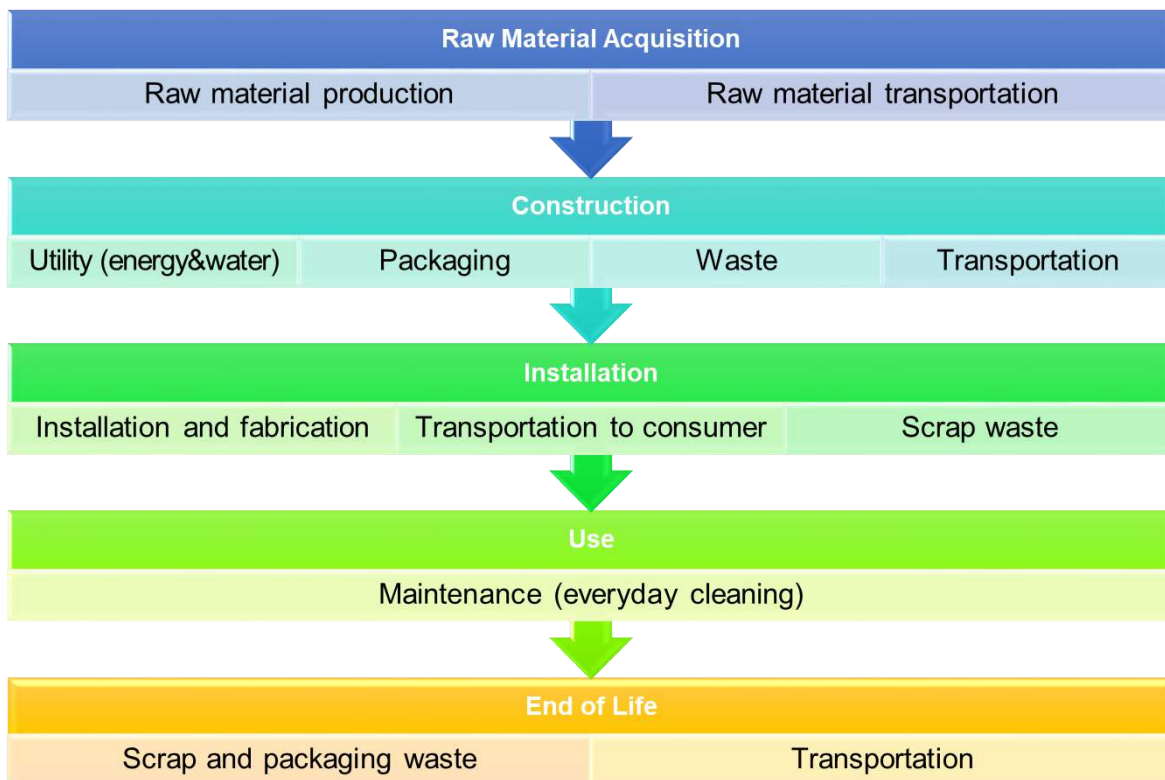


Figure 1 System Boundary of Hyundai L&C Hanex

- Material acquisition and pre-processing: This stage includes the material extraction from nature, pre-processing, intermediate processing, and the transportation within and between all processing stages and ends when the material



ENVIRONMENTAL PRODUCT DECLARATION



HANEX

ACRYLIC SOLID SURFACES

According to ISO 14025

reaches the gate of the construction facility. The stage also considers the transportation of the raw materials to the construction site.

- Countertop construction: The stage starts with the product components entering the construction gate and ends with the final countertop leaving the construction gate. This stage is intended to be “gate-to-gate”. The construction stage includes production processes such as material and energy use, inbound transport of semi-finished products, waste and scrap, and packaging materials.
- Installation: The stage starts from the gate of facility and ends when the product is arrived and installed to the final consumer. During the distribution stage, all the domestic and foreign transport via truck and container ship was considered. The fabrication scenario including cutting, sanding and securing the surface with adhesive is based on the fabrication manual of Hanex solid surfaces. Since the countertops are customized by the fabricator, a 10% scrap rate is assumed.
- Use and maintenance stage: The stage refers to Care & Maintenance Information from the fabrication manual of Hanex solid surfaces. It includes everyday cleaning with tap water and soap over 10-year reference service life. No sealing or grouting is needed.
- End-of-life stage: The stage includes the disposal of the product and packaging, a 90% scrap rate. The product scrap is not typically recycled or reused at the end of life. In the absence of primary data, it is modeled as 80% landfill and 20% incineration according to the latest US EPA WARM model.

※ The LCA study took into account all the transport of waste materials.

Cut-off Rules

To avoid the need to calculate trivial inputs and outputs in the system, cut-off criteria was applied as follows;

- Mass and energy flows that consist of less than 1% may be omitted from the inventory analysis
- Cumulative omitted mass or energy flows shall not exceed 5%.
- Mass or energy flows that contribute more than 10% to an impact category shall be included.

According to the cut-off criteria, excluded Inputs are additional agents for antifoaming, cross-linking, coupling and dispersing and decorative elements such as pattern chips, glitters and colorings. Hanex products have different color, pattern and design for each collection but those differences does not affect the major results of LCA.

Allocation Rules

Allocation was conducted based on a mass basis and production amount of Hanex compared to the other products produced in the Sejong plant, Seoul.

Calculation Rules and Data Quality Requirements

ENVIRONMENTAL PRODUCT DECLARATION



HANEX

ACRYLIC SOLID SURFACES

According to ISO 14025

SimaPro ver.9.1, a LCA modeling software program, was used for life cycle assessment. In the absence of primary data, secondary datasets were used from Ecoinvent version 3.

For the data quality assessment, the following requirements are considered;

- Time related coverage: Primary data from on-site was collected during the fiscal year of 2020
- Geographical coverage: Primary data was collected from the Sejong plant, Republic of Korea.
- Technology coverage: Primary data was collected from Single Belt Casting Unit (SBCU) and Double Belt Casting Unit (DBCUC) in the Sejong plant.
- Source of the data: All input and output data was collected in the enterprise resources planning (ERP) system.
- Uncertainty of the Information: The relative uncertainty associated with this study has been minimized. However, there are few assumptions and limitations as mentioned below. The production location is only limited to Sejong city in Republic of Korea. The geography of the secondary data for the construction stage is rest of world (RoW) instead of Republic of Korea due to the applicable range of LCI data. That from the use stage to the end-of-life stage is US (the United States of America) as the most selling country of Hanex is the USA. There are also some scenarios for the use stage and transportation overall adapted in the study stated in the assumptions and limitations.

The data used in this study meets all data quality requirements as outlined in the PCR. Secondary data was evaluated with regard to precision, completeness, consistency, reproducibility, representativeness and uncertainty. The above indicators were considered in accordance with ISO 14044.

Life Cycle Impact Assessment (LCIA) Method

IPCC 2013 GWP 100 was used for global warming potential (GWP). For other impact categories, US TRACI 2.1 ver. 1.05 and CML baseline v3.06 were used.

Assumptions and limitations

The following assumptions and limitations are adapted.

- Geography of secondary data: The geography of secondary data is based on the rest of world (RoW).
- Distribution transport distance: The transport distance from facilities to selling agents was calculated as weighted average of more than 90% sales volume.
- Product thickness: The thickness of Hanex is unified as 12mm, the standard thickness. The production with the different thickness is calculated to the standard thickness based on the production volume.
- Waste treatment: According to the PCR, The waste treatment of Hanex during the installation and end-of-life stage follows the most current version of the US EPA WARM model. All waste treatment after construction is considered as happened in the United States, the country with the largest export volume. The average municipal solid waste disposition is 80% landfill and 20% incineration. According to the WARM model, the average transport distance at the end of life is 32 kilometers (20 miles). A 10% scrap rate is used during the installation stage.
- Production site: The LCA results represent the average production of Hanex at the Sejong Plant in Republic of Korea, not from the other countries.

ENVIRONMENTAL PRODUCT DECLARATION



HANEX
ACRYLIC SOLID SURFACES

According to ISO 14025

Life Cycle Assessment Results

Life cycle assessment results of Hanex are presented per the functional unit. The analysis represents the weighted average of Hanex from the Sejong plant, based on the production and sales volume in 2020. The LCIA results are relative expressions and do not predict impacts on category endpoints, the exceedance of thresholds, safety margins or risks.

Life Cycle Inventory Results

Table 5 Material resources results of Hanex per functional unit

Inventory	Material Acquisition	Construction	Install	Use	Disposal	Total
Material resources (kg)						
Virgin renewable resources	0.00E+00	0.00E+00	0.00E+00	1.10E+02	0.00E+00	1.10E+02
Recycled resources	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Virgin non-renewable resources	2.53E+01	1.10E+00	3.50E-01	2.91E+00	0.00E+00	1.39E+02

Table 6 Inventory results of Hanex per functional unit

Inventory	Material Acquisition	Construction	Install	Use	Disposal	Total
Energy type and usages (MJ)						
Primary energy demand	1.30E+03	2.14E+02	5.48E+01	9.78E+01	8.39E+00	1.67E+03
Fossil fuel based energy	1.22E+03	1.93E+02	5.09E+01	3.10E+01	7.79E+00	1.50E+03
Nuclear energy	7.11E+01	2.00E+01	1.61E+00	2.27E+00	1.66E-01	9.52E+01
Biomass energy	5.05E+00	2.59E-01	7.71E-01	6.32E+01	3.72E-02	6.94E+01
Wind, Solar, Geothermal energy	0.00E+00	8.30E-01	7.15E-01	1.35E-01	3.17E-01	2.00E+00
Hydro energy	6.70E+00	4.70E-01	8.41E-01	1.08E+00	8.18E-02	9.17E+00
Emissions to air (kg)						
SO _x	3.21E-04	1.26E-06	1.02E-06	6.12E-06	2.09E-06	3.31E-04



ENVIRONMENTAL PRODUCT DECLARATION



HANEX

ACRYLIC SOLID SURFACES

According to ISO 14025

NO _x	1.62E-01	1.49E-02	3.31E-02	1.07E-02	4.27E-03	2.25E-01
CO ₂ *	6.14E+01	4.51E+00	3.01E+00	2.29E+00	9.01E+00	8.03E+01
Methane	2.99E-03	1.99E-03	1.15E-03	2.27E-08	1.42E-04	6.27E-03
N ₂ O	3.69E-04	2.23E-04	1.38E-04	2.09E-03	3.53E-04	3.17E-03
CO*	1.02E-01	3.94E-03	3.78E-03	5.68E-03	1.24E-03	1.17E-01
Emissions to water (kg)						
Phosphates	2.56E-02	7.91E-03	1.18E-03	3.50E-03	1.63E-04	3.84E-02
Nitrates	3.73E-03	4.44E-03	1.35E-03	1.53E-01	8.89E-03	1.71E-01
Dioxin	1.19E-17	7.39E-19	1.99E-17	1.16E-17	1.10E-18	4.53E-17
heavy metals, arsenic	3.99E-04	2.12E-05	6.62E-06	9.61E-06	3.31E-05	4.70E-04
heavy metals, lead	3.35E-04	1.38E-03	8.38E-04	2.03E-04	7.18E-03	9.94E-03
heavy metals, mercury	2.44E-06	3.11E-06	1.50E-06	7.30E-07	1.18E-05	1.96E-05
heavy metals, cadmium	1.08E-05	2.38E-04	1.27E-04	5.69E-06	1.13E-03	1.52E-03
heavy metals, chromium	1.58E-06	9.20E-07	6.41E-07	6.28E-06	1.40E-07	9.56E-06
Water consumption (kg)						
Water Input	1.48E+01	7.76E-01	1.74E+00	1.15E+01	5.78E-01	2.94E+01
Waste management (kg)						
Incineration with energy recovery	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Incineration without energy recovery	0.00E+00	0.00E+00	4.08E-01	0.00E+00	3.67E+00	4.08E+00
Landfill (non-hazardous solid waste)	0.00E+00	2.46E+00	1.63E+00	0.00E+00	1.47E+01	1.88E+01
Hazardous waste	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Landfill avoidance (recycling)	0.00E+00	3.78E+00	0.00E+00	0.00E+00	0.00E+00	3.78E+00

*The source of carbon dioxide and carbon monoxide is fossil.

ENVIRONMENTAL PRODUCT DECLARATION



HANEX
ACRYLIC SOLID SURFACES

According to ISO 14025

Life Cycle Impact Assessment Results

Table 6 Characterization results of Hanex per functional unit

Inventory		Material Acquisition	Construction	Install	Use	Disposal	Total
IPCC 2013 GWP 100							
Global Warming	kg CO ₂ -eq.	7.59E+01	1.01E+01	4.54E+00	7.20E+00	1.04E+01	1.08E+02
TRACI 2.1 v.1.05							
Acidification	kg SO ₂ -eq.	4.00E-01	1.80E-02	4.12E-02	3.09E-02	3.92E-03	4.94E-01
Photochemical Ozone Creation (Smog)	kg O ₃ -eq.	4.09E+00	1.33E+00	8.26E-01	2.89E-01	1.07E-01	6.64E+00
Eutrophication	kg N-eq.	1.23E-01	6.09E-02	2.64E-02	5.06E-02	1.93E-01	4.54E-01
Ozone Layer Depletion	kg CFC ₁₁ -eq.	1.70E-06	6.70E-07	9.26E-07	4.90E-07	7.37E-08	3.86E-06
Abiotic resource Depletion	MJ surplus	1.63E+02	2.32E+01	6.46E+00	2.76E+00	1.02E+00	1.97E+02
CML-IA baseline v3.06							
Abiotic resource Depletion	kg Sb-eq.	2.19E-04	9.16E-06	2.05E-05	2.03E-04	4.61E-06	4.56E-04
Abiotic fossil Depletion	MJ	1.12E+03	1.75E+02	4.75E+01	2.88E+01	7.28E+00	1.38E+03
Global Warming	kg CO ₂ -eq.	7.48E+01	1.00E+01	4.51E+00	7.18E+00	1.03E+01	1.07E+02
Ozone Layer Depletion	kg CFC ₁₁ -eq.	1.49E-06	5.34E-07	8.53E-07	4.45E-07	5.78E-08	3.38E-06
Photochemical oxidation	kg C ₂ H ₄ -eq.	2.60E-02	7.67E-04	1.37E-03	4.01E-03	3.09E-04	3.24E-02
Acidification	kg SO ₂ -eq.	4.19E-01	1.53E-02	3.77E-02	2.80E-02	3.06E-03	5.03E-01
Eutrophication	kg PO ₄ -eq.	6.83E-02	2.53E-02	1.37E-02	2.52E-02	7.14E-02	2.04E-01



ENVIRONMENTAL PRODUCT DECLARATION



HANEX

ACRYLIC SOLID SURFACES

According to ISO 14025

Other Environmental Information and independent verification

Hanex is highly regarded in the environment-friendly materials market with various environmental related certifications such as NSF, Greenguard. From recycling 100% of the water used in the production process, to installing air purification systems and collecting and removing all dust within our plants, we strive to ensure a healthy workplace and promote an eco-conscious approach to product development and waste management.



Please visit the following link to find our sustainability efforts, <https://hyundainc.athena.dev-applied3.com/sustainability>.

References

- ISO 14025:2006 Environmental labels and declarations — Type III environmental declarations — Principles and procedures
- ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework
- ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines
- Product Category Rule for Environmental Product Declaration – PCR for Residential Countertops. NSF International. Valid through September 17, 2021
- Fabrication Manual for Hanex Solid Surfaces, 2018 https://hyundaincusa.com/uploads/documents/hanex_solid_surfaces_fabrication_manual.pdf
- Hanex Product Specification, http://www.hanex.com/common/php/download.php?file=/board/DOCUMENTS/o_1emovdga19na12ul1kc51ua4o9qa.pdf&num=241
- Hanex MSDS, Retrieved from https://hyundaincusa.com/uploads/documents/hanex_solid_surfaces_msds_us_version_1-1.pdf
- Hanex Product Catalogue, <https://s3.amazonaws.com/online.pubhtml5.com/jqns/lzwo/index.html#p=1>
- EPA, Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI)
- Leiden University CML IA Characterisation Factors
- US EPA Waste Reduction Model (WARM)3
- World Business Council for Sustainable Development's Global Water Tool
- World Resources Institute (WRI) Draft Product Life Cycle Accounting and Reporting Standard
- LCI Databases: Ecoinvent 3
- LCI Databases: USLCI
- LCI Databases: Agri-footprint
- UL General Program Instructions, v.2.5 March 2020



ENVIRONMENTAL PRODUCT DECLARATION



HANEX
ACRYLIC SOLID SURFACES

According to ISO 14025

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