Ethos™ Modular Commercial Floor Coverings

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Primary Sponsor(s):	Tandus Flooring
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Recovered PVB Film from Safety Glass Recycling

Ethos™ Modular Commercial Floor Coverings

- ethos modular was formally introduced in November 2009 as an alternative floor covering and substitute for virgin PVC modular carpet. In the last two years, the production and sales of ethos modular increased 18 fold.
- The technology is not eligible for an academic or small business award.
- Applicable Focus Area 3: Designing/implementing products that are less hazardous than the products or technologies they replace.
- Ethos flooring was researched, developed, commercialized and produced in Dalton, Georgia. It is sold in the US and globally.

Abstract

For years, recyclers have recovered glass from recovered windshields and sold it into other markets. In contrast, most of the polymeric poly(vinyl butyral) (PVB) film recovered from used-car windshields and other safety glass has been sent to landfills or burned for energy. PVB provides shatterproof properties to safety glass and is a thermoplastic terpolymer of vinyl acetate, vinyl alcohol, and vinyl butyral.

Tandus Flooring is the first manufacturer to use the abundant PVB waste stream and recycle it into a high-performance carpet backing. Ethos™ secondary backing, made from PVB film reclaimed from windshields and other safety glass, is an alternative to other structured carpet backings such as poly (vinyl chloride) (PVC), ethylene–vinyl acetate (EVA), polyurethane, polyolefin, and bitumen. Producing ethos from recycled material reduces the energy and environmental impacts associated with extracting, harvesting, and transporting virgin raw materials.

Tandus evaluated PVB against ten other polymer-based materials using stringent performance and environmental criteria. In these tests, PVB was superior to the other polymers in material availability, recyclability, reduction of virgin resources, avoidance of hazardous emissions (e.g., dioxin), and elimination of chemicals of concern, such as, chlorine, fly ash, and phthalate plasticizers. In addition, ethos™ backing has extremely low environmental lifecycle impacts compared to other products and can be recycled in the company's patented closed-loop recycling process which recycles post consumer carpet and other manufacturing waste into new recycled content floor coverings.

Initially, Tandus successfully introduced a six-foot-wide ethos™ cushion backing to meet the needs of Kaiser Permanente who sought a high-performance, PVC-free soft surface flooring. More recently, the company introduced ethos™ modular, which has been commercially available since November 2009. Its production has increased by 18 fold in the last two years. Every square yard of ethos modular replaces approximately 5.25 pounds of PVC material. To-date, Tandus has recycled more than 10 million pounds of PVB into its flooring products – keeping it from being land filled and potentially replacing 52 million pounds of PVC.

Meeting the Scope of EPA's Green Chemistry Award

The Ethos product was developed as an alternative floor covering to traditional PVC modular carpet and is an environmentally preferred option to the PVC product it replaces. It exemplifies

source reduction in that it has reduced toxicity and environmental impacts compared to industry standard products, such as PVC.

- The ethos PVB backing is innovative and is the first of its kind in the carpet industry. The technology could also be adopted and utilized in other market sectors.
- The ethos technology is scientifically valid. The quality and performance of PVB in floor coverings has been commercially demonstrated and ethos modular products have been in production for two years.
- Ethos utilizes a recycled, discarded thermoplastic material, PVB, as a raw material and substitute for virgin materials, such as, PVC.
- Unlike PVC, PVB does not release persistent bioaccumulative toxins (PBTs), such as dioxin in its upstream manufacturing process.
- PVB does not require phthalate plasticizers for flexibility. In order to be produced as a flexible flooring material, virgin PVC must be produced using phthalate plasticizers, a potential health concern for children and a TSCA "chemical of concern."
- PVB avoids the use of mercury in its upstream processing. Although it is being phased out, some PVC is still manufactured using mercury cell technology.
- Unlike PVC, PVB does not generate hydrochloric acid (HCl) or dioxin emissions when burned in a fire.
- Ethos uses less energy to manufacture due to reduced processing performed at lower temperatures than PVC products.

Background

To meet the needs of its customers, Tandus Flooring developed ethos, an alternative and replacement floor covering for PVC floor coverings. The ethos carpet backing is produced from post consumer, recycled polyvinyl butyral (PVB) obtained from discarded windshield and safety glass. Tandus' Powerbond ethos cushion was developed specifically to meet the needs of health care provider, Kaiser Permanente. The high performance Powerbond product is a hybrid resilient flooring with a soft surface wear layer and PVB cushion backing that provides wall to wall moisture barrier properties. The Powerbond ethos product was designed for the health care and education markets and was produced using Tandus Floorings' existing equipment.

Tandus wanted to offer ethos as a modular carpet to meet the needs of other commercial market sectors that prefer a modular product. The performance requirements of modular products make them more difficult to produce because the structure requires extra stabilization. Ethos modular could not be produced on existing equipment; therefore, Tandus spent several years researching and developing its innovative product composition and invested nine million dollars to install a new manufacturing line to produce the modular product. Tandus also fine tuned and improved the products' environmental footprint during the last two years of commercial production. For example, post consumer PVB was substituted for virgin and pre consumer materials and the total weight of the product was reduced by 30% without sacrificing quality and performance.

While the production volume of Powerbond ethos cushion has remained fairly constant, the sales and production of ethos modular has increased by 18 fold (1700%) since it was introduced in late 2009. The production volume of ethos modular in 2011 was more than twice that of Powerbond ethos cushion and continued growth is expected.

Production (square yards)	2009	2010	2011
Ethos modular	28,617	224,176	523,131

Composition of Ethos Products

All other components being equal, the general composition of the precoat and secondary backing of virgin PVC and ethos PVB products are outlined below. The precoat is the "tie layer" that binds the tufted yarn composite and secondary backing.

Virgin PVC:

precoat and backing	%
Latex	8.5%
Filler*	58.0%
PVC	16.5%
phthalate plasticizer	16.0%
misc.**	1.0%

ethos modular:

precoat and backing	%
post consumer PVB	43.0%
Filler*	54.1%
misc.**	3.0%

*fillers utilized can be calcium carbonate, ATH, fly ash or a combination of these.

**misc. = surfactants, thickeners, process aids, etc.

The ethos composition is more environmentally preferred because it substitutes post consumer recycled PVB polymer for PVC and phthalate plasticizer. In addition, the ethos PVB product is 30% lighter in weight. As a result, the ethos modular product is 2.4 pounds per square yard lighter than the PVC product and every square yard of ethos modular avoids the use of approximately 5.25 pounds of PVC material. A 10,000 yd2 project using ethos would replace approximately 52,500 lbs (or 26 tons) of PVC. To-date, Tandus has utilized more than 10 million pounds of PVB into its flooring products – keeping it from being land filled and potentially replacing 52 million pounds of PVC.

Tandus Floorings' ethos products are unique in that they utilize post consumer recycled polymer as the matrix of the backing. All the PVB utilized in the ethos product is post consumer content. Unlike other products, recycled PVB can also be incorporated into the ethos precoat without the use of synthetic latex. Latex is utilized in most carpet precoats and recycled content cannot be incorporated because it makes the latex compound unstable. In addition, other carpet manufacturers typically use virgin polymers, such as, PVC or polyolefin as the secondary backing matrix and utilize fly ash to incorporate recycled content into the product. The environmental attributes and use of fly ash is controversial and some customer groups prefer to purchase products that don't contain fly ash due to health and environmental concerns. For this reason, Tandus Flooring does not utilize fly ash in ethos products.

Recycled Content

The post consumer recycled content in secondary backing of Powerbond ethos is 76% and in ethos modular is 50% -- among the highest in the industry. The overall recycled content in ethos products is shown below.

Recycled Content	Overall Recycled Content	Post Consumer Content	NSF 140 Certification	Warranty
Powerbond® ethos™ cushion	37 to 63%	Min 36%	Platinum	25 yr
ethos™ modular	26 to 50%	Min 26%	Platinum	15 yr

The following list describes some of the attributes and benefits of ethos products:

- Products contain high post consumer recycled content.
- Ethos is equivalent in cost to alternative flooring products.
- Products are fully recyclable back into new floor coverings in Tandus Floorings' take back and closed-loop recycling process for carpet. The company has recycled over 200 million pounds of carpet and waste material to-date.
- Ethos keeps a waste material (PVB film) from being landfilled/incinerated and uses that valuable material to produce durable, long lasting floor coverings.
- Ethos has low VOC emissions; meets industry 01350 and Green Label Plus IAQ requirements complying with CHPS and LEED criterias.
- Ethos is durable with a long life resulting in less frequent replacement.

Embodied Energy Results

Tandus Floorings' use of recycled material prevents going back to the "well-head" to obtain virgin material for the production of its products. As a result, Tandus ethos products have lower embodied energy because the use of virgin materials is minimized. The embodied energy of ethos modular is 70% lower and Powerbond ethos cushion is 84% lower than industry standard, virgin PVC modular carpet. The lower environmental impact results are attributed to the difference in chemistry and the fact that recycled polymer is utilized instead of virgin PVC polymer. This is shown in the table below from LCA results in BEES 4.0 software[1].

Embodied Energy

	Total Primary* Energy (MJ/sq ft)	Feedstock Energy** (MJ/sq ft)	Fuel Energy*** (MJ/sq ft)
Industry Average (Generic) PVC modular tile	**110.1**	44.2	65.9
ethos Modular	**33.0**	9.6	23.4
Powerbond® ethos cushion	**16.8**	4.9	11.9

*****Total Primary Energy = Feedstock Energy + Fuel Energy

******Feedstock Energy: the calorific value of the polymers in the carpet

*******Fuel energy - energy to manufacture and transport the raw material and product and energy for installation

[1] BEES (Building for Environmental and Economic Sustainability) is a Life Cycle Analysis (LCA) database featuring over 230 building products developed by National Institute of Standards and Technology (NIST). BEES Version 4.0 was published in May 2007. BEES 4.0 and can be downloaded at http://www.epa.gov/opptintr/epp/tools/bees.htm.

Life Cycle Analysis

Generic modular carpet with virgin PVC backing (e.g. "industry average" carpet) was compared with Tandus' ethos products using BEES 4.0 LCA software. In the BEES software, lower values correspond to lower environmental impacts. The ethos products had significantly lower environmental impacts than virgin PVC and other commercial carpets in the following categories: Ecological Toxicity, Eutrophication, Fossil Fuel Depletion, Global Warming, Human Health and Water Intake. The BEES overall performance score was 8.3 times lower for Powerbond ethos and 4.3 times lower for ethos modular than the industry average PVC modular carpet.

BEES 4.0 Overall Performance

Category	Powerbond ethos cushion	Virgin PVC carpet tile (low VOC glue)	Ethos modular
Economic Performance 0%	0.0	0.0	0.0
Environmental Performance 100%	8.9	74.1	17.1
Sum	**8.9**	**74.1**	**17.1**

BEES 4.0 Overall Environmental Performance

Category	Powerbond ethos cushion	Virgin PVC carpet tile (low VOC glue)	Ethos modular
Acidification 5%	0.0000	0.0000	0.0000
Crit. Air Pollutants 6%	0.0000	0.0002	0.0001
Ecolog. Toxicity 11%	0.0004	0.0018	0.0007
Eutrophication 5%	0.0001	0.0011	0.0002
Fossil Fuel Depl. 5%	0.0003	0.0019	0.0006
Global Warming 16%	0.0006	0.0033	0.0012
Habitat Alteration 16%	0.0000	0.0000	0.0000
Human Health 11%	0.0011	0.0125	0.0020
Indoor Air 11%	0.0000	0.0003	0.0000
Ozone Depletion 5%	0.0000	0.0000	0.0000
Smog 6%	0.0002	0.0010	0.0004
Water Intake 3%	0.0001	0.0013	0.0002
Sum	**0.0028**	**0.0234**	**0.0054**

Notes:

1. Parameters were used in the analysis were 100% Environmental Performance; EPA Scientific Advisory Board weighting of environmental impacts; 1000-mile distance.
2. BEES examines carpet over a 50-year period. Powerbond ethos cushion with its 25 year warranty would be replaced twice whereas ethos modular with a 15 year warranty would be replaced 4 times. The life of the product as determined by the warranty period accounts for the difference in life cycle impact results between the two ethos products.
3. Although Tandus products can be purchased as carbon neutral (e.g. where the green house gas emissions over the entire life cycle are off set), the carbon neutral option was not chosen in this analysis.

CHEMISTRY

Virgin PVB (Polyvinylbutyral) Production

PVB (polyvinylbutyral) is a "terpolymer" of vinyl acetate (x), vinyl alcohol (y) and vinyl butyral and a specialty resin used in the manufacture of automotive windshields and other safety glass. By incorporating a layer of PVB between two layers of flat glass increases the damage-resistance of the glass. The chemical process for producing virgin PVB is shown below.

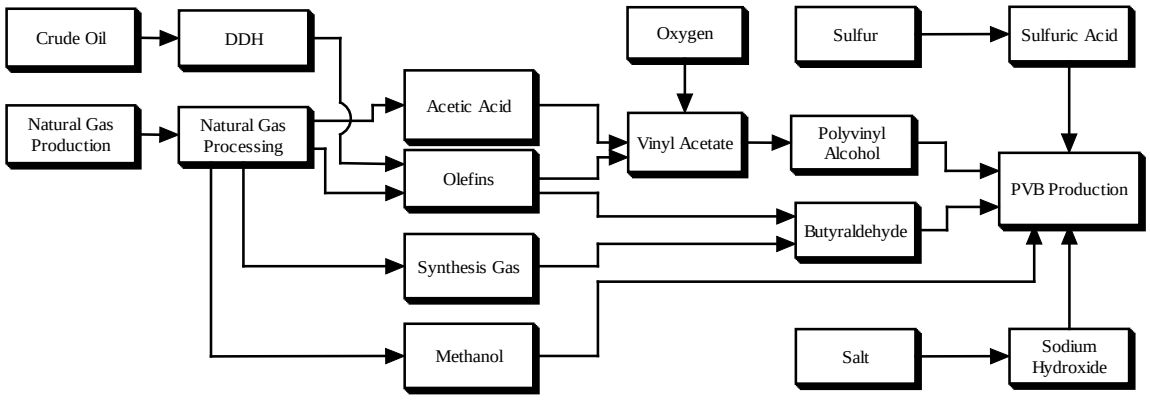


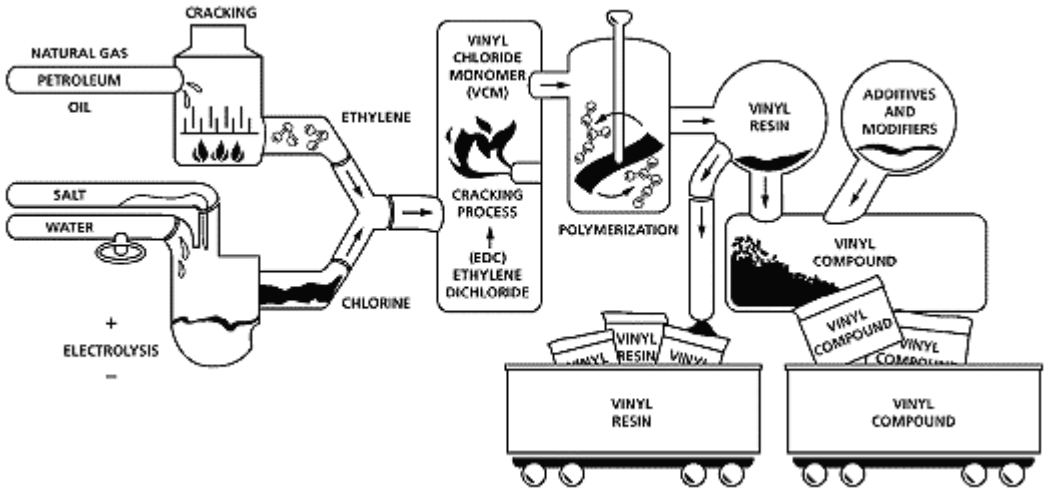
Figure B-1: Flow diagram for the production of PVB (Polyvinylbutyral)

Tandus Flooring utilizes recovered post consumer PVB in the production of its ethos backings. The process to recover PVB from post consumer auto windshields and safety glass involves removing unwanted trash from the windshields and glass, grinding the material, separating the PVB film from the glass and drying the PVB polymer pieces. To produce the ethos precoat, ground PVB is incorporated into a water-based dispersion which is applied to the tufted yarn composite in processing and heated to evaporate the water. The ethos secondary backing is produced by extruding ground PVB polymer.

PVC (Polyvinyl chloride) Production

The process to make virgin PVC starts at the wellhead. PVC is made by combining ethylene (derived from petroleum, natural gas or coal) and chlorine derived from common salt. The resulting product, ethylene dichloride (EDC) is transformed into a gas called vinyl chloride monomer (VCM), a carcinogenic gas. A final step called "polymerization" converts the monomer into vinyl polymer -- a fine-grained, white powder or resin known as PVC. The vinyl resin is mixed with phthalate plasticizer, filler and additives and is processed. A very small amount of dioxin, a persistent bio accumulative toxic compound, is emitted during the production of PVC. Polyvinylbutyral (PVB) it is not produced with nor does it contain chlorine. As a result, dioxin is not associated with the life cycle of polyvinylbutyral.

PVC (Polyvinyl chloride) Production



Tandus Flooring spent many years researching alternative polymers and in the development of its ethos products. None of the other polymer systems evaluated met all the required performance and environmental requirements necessary for a commercial carpet backing. Ethos products made with recovered PVB have lower environmental impact as shown by LCA analysis than virgin PVC and other commercially available backing systems. The high-recycled content products are durable and long lasting and can be recyclable into new floor coverings at the end of their life. Tandus is confident in its investment which has resulted in the growth and market-wide acceptance of its ethos product lines.

Dalton, Ga.-based Tandus (www.tandus.com) creates floor covering solutions that enhance spaces for learning, working, healing and living through inspired design, leading-edge technology, unprecedented achievement toward sustainability and an absolute commitment to continued leadership. For more than 40 years, Tandus has examined ways to become a better corporate citizen and environmental steward – and has taken actions that resulted in demonstrable, meaningful, quantifiable results.