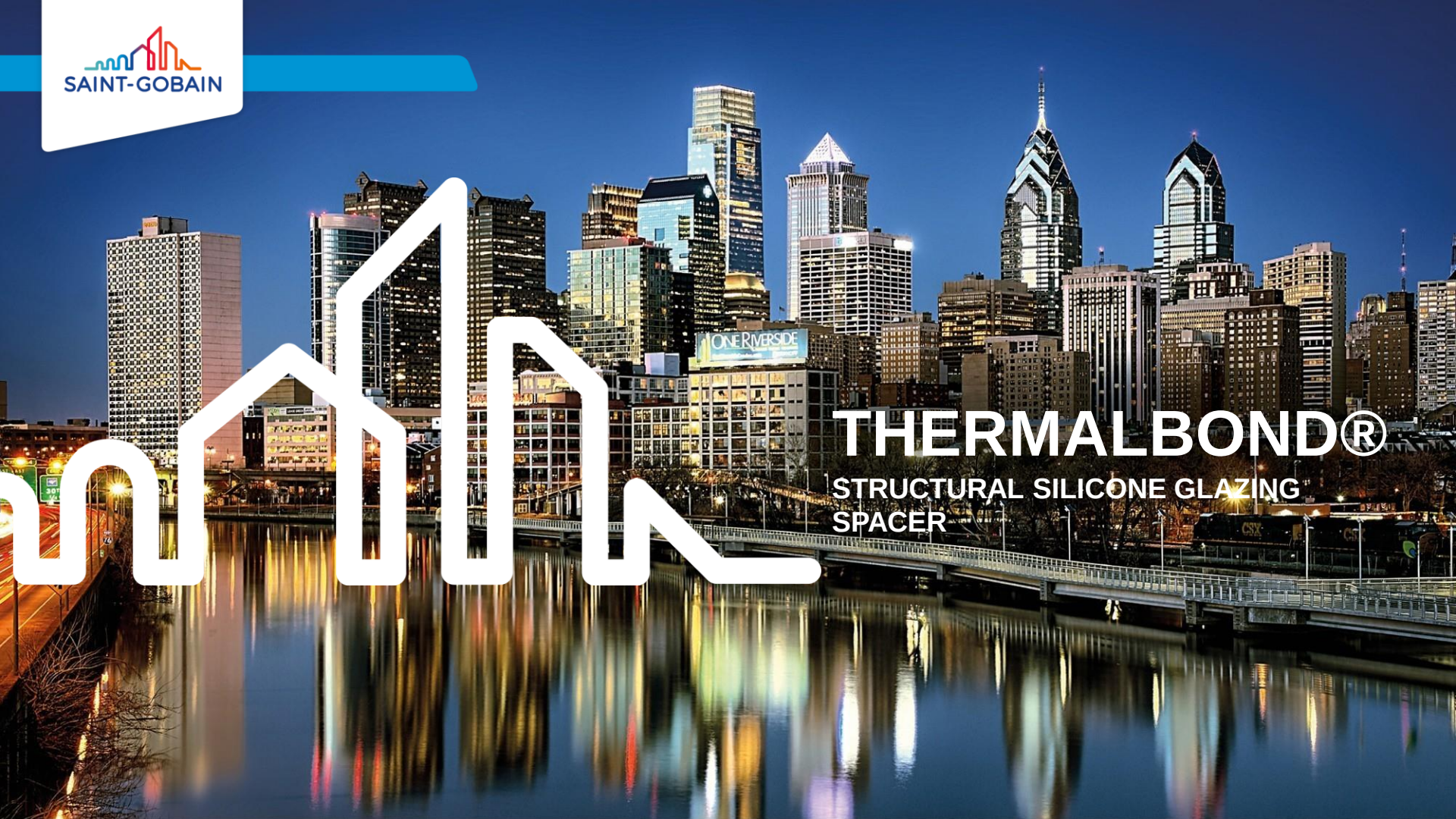


THERMALBOND®

STRUCTURAL SILICONE GLAZING SPACER

AGENDA

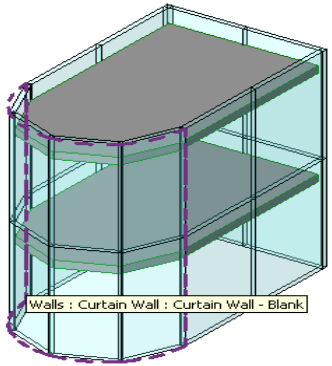
- Introduction to Saint-Gobain
- Curtainwalls & Structrual Silicone Glazing
- Product Portfolio
- Principles of Sustainability
- Distinct Advantage
- Projects
- Summary

CURTAINWALLS & STRUCTURAL GLAZING

FOAMS & TAPES

SAINT-GOBAIN

WHAT IS A CURTAINWALL?



A Facade technology for cladding large buildings.

- Curtainwall systems do not carry any dead loads from the building structure.
- Designed to support their self-weight and transfer horizontal loads (wind) to the primary building structure.
- Curtainwall systems are typically “hung” from the building structure — from whence derives the “curtain” reference — and typically attached to the floor slabs.
- The primary functions of the curtainwall are to resist air and water infiltration and to provide a thermal barrier between inside and out.

TYPES OF CURTAINWALL

Architectural Panel Bonding & Sealing

Precast Concrete Sealing

Unitized Façade

Thermal –Break & Insulation

Vision Glass SSG

Window Wall

Curtain Wall Bonding & Leakage

Day-lighting:

- Vision Glass Glazing
- Window Wall sealing

Wall Panels: Outside

- Arch. Panel bonding & sealing
- Spandrel Panel sealing
- Precast Concrete

Wall Panels: Inside

- Thermal Break / Insulation

STRUCTURAL SILICONE GLAZING CURTAINWALL

A specific curtainwall system where:

- The glass or other panel material is secured to the exterior of a building using adhesive without mechanical fasteners or retainers
- The structural silicone takes the loads from the glass to it's perimeter support system and retention of the glass in the opening
- Can provide a complete flush exterior appearance with adjoining panels sealed with silicone to prevent water infiltration
- Limitless aesthetic opportunities for architects. All vision glass, colored or reflective glass, glass/spandrel panel combinations, etc.

STRUCTURAL SILICONE GLAZING CURTAINWALL

Traditional Window Wall
Projected frame around each opening

Structural Glazed System
Glass secured from back side

2 SIDED AND 4 SIDED GLAZED SYSTEMS

2 Sided SSG

The top and bottom edges of the glass are held in a conventional channel and the sides are bonded.

"Ribbon of Glass" effect

4 Sided SSG

All four sides of the glass are bonded to the frame.

"All Glass Building" effect

HISTORY OF STRUCTURAL SILICONE GLAZING

- 1976 – First 2 sided SSG with insulated glass units
- 1978 – First 4 sided SSG with insulated glass units
- **1979 – Thermalbond first used in SSG**
- 1980 – first SSG projects in Europe
- 1984 Dow Corning develops two-part SG sealant
- 1985 – **Thermalbond** V2200 Series introduced
- 1990 – Dow Corning introduces 995,one component SG sealant in US market
- 2004 – CE approval (mandatory for Europe Economic Area) of DC 895
- 2014 – **Thermalbond** Xpress, commercialized

1st Thermalbond SSG Project
Saks 5th Avenue Retrofit
Pittsburgh PA USA

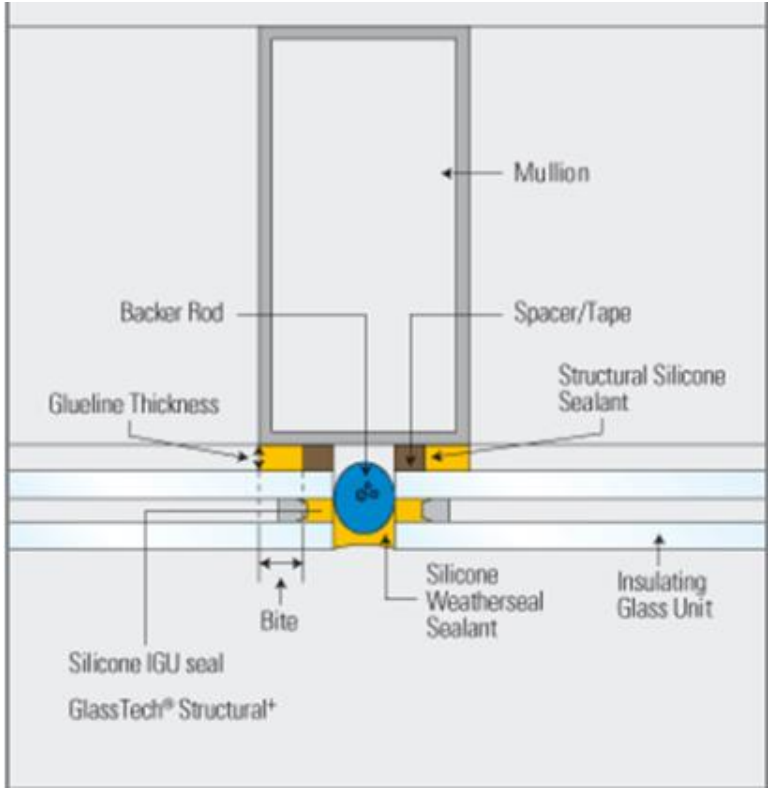
- Thermalbond V2100 Series
- PPG EFG 601 system

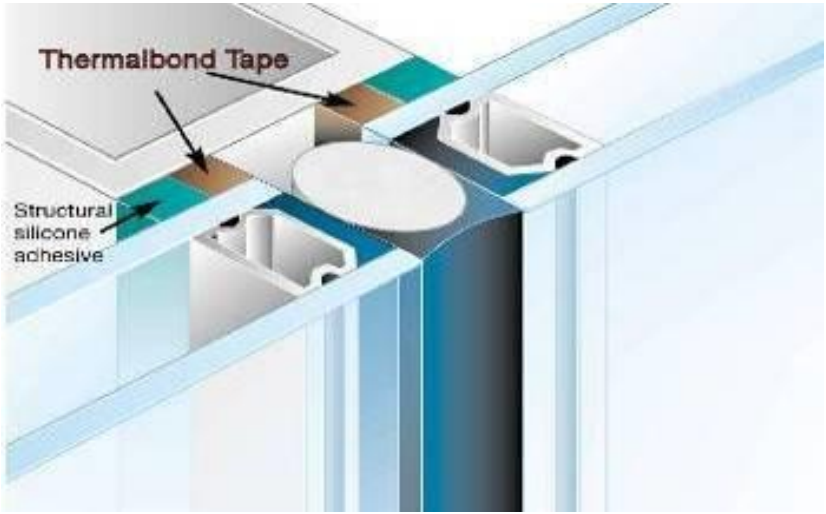
Before

After

SSG DESIGN AND COMPONENTS

Typical SSG Joint





SSG DESIGN AND COMPONENTS

Shop or Field Glazing?

On-site / Field Glazing

- Entire curtainwall erected at job site
- Glass (metal, stone, …) temporarily attached with mechanical fasteners
- Structural silicone applied – allowed to fully cure
- One-part (RTV) silicone commonly used (no mixing)
- After cure, fasteners removed, weather seal applied
- Higher risk of quality issues from adverse environmental issues

Glass applied at job site

SSG DESIGN AND COMPONENTS

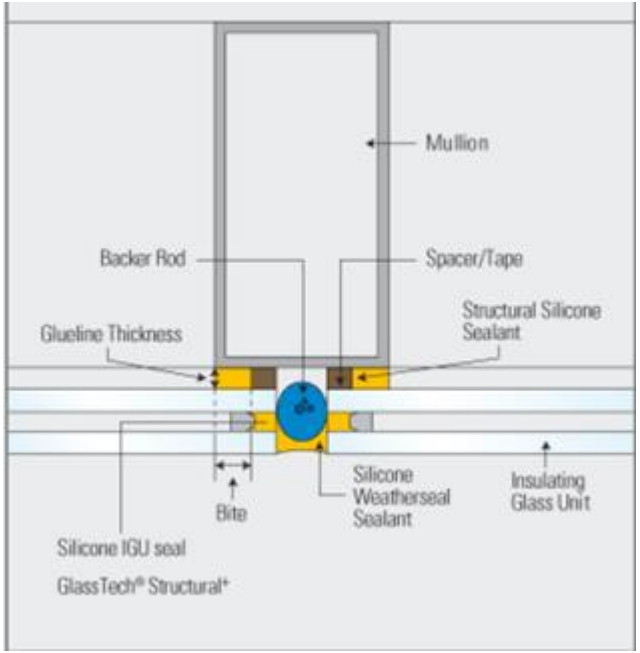
Shop or Field Glazing?

Factory / Shop Glazing

- Units are pre-assembled in a factory environment
- Structural silicone glazing done in factory – pre-glazed
- Each unit can be one or more panes, larger units sometimes called “ladders”
- Usually called “Unitized System” or “Panel System”
- After curing, units are transported to job site and attached to building core with mechanical fasteners
- Weather seal applied.
- Lower risk of quality issues as all glazing done in controlled environment

SSG DESIGN AND COMPONENTS

What are the functions of the spacer?



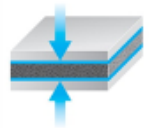
MUST HAVE:

- ✓ Provide a consistent gap between the glass and metal frame while the silicone cures

- ✓ Compatibility with the structural silicone for the life of the system

NICE TO HAVE:

- ✓ Provide adhesion between the glass and metal to stabilize the system while the silicone cures.



- ✓ Allow moisture to pass through to assist silicone curing (one part silicones)

SSG SPACER TAPE OPTIONS

Tapes

- **PUR open cell**

- **PVC closed cell**

- **PE closed cell**

- **EVA closed cell**

Extruded Profiles

- **Silicone**

- **SCR**
  Silicone compatible rubber

Each have benefits, limitations and risks

SSG SPACER TAPE OPTIONS

Spacer property / attribute comparison chart

	PUR Tapes open cell	PVC Tapes closed cell	PE Tapes closed cell	EVA 'sticks' closed cell	Silicone profiles	SCR* profiles
Silicone compatability (long term proven)						
Spacer function (no load deformation)						
Open Cell (allow 1K Si curing)						
Adhesion property						
Location assured						
No stretch during installation						
Allow easy glass positioning						
Easy to handle configuration						
Low chance of silicone seeping into site line						
Wide range of dimensions (with low moq)						

OKAY
CONCERN
RISK

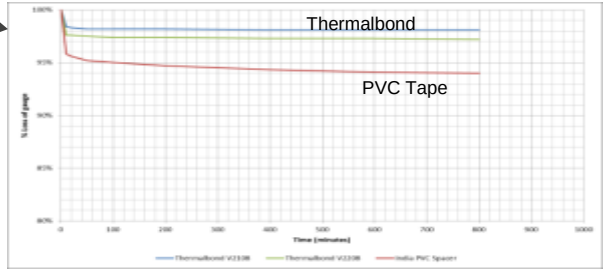
PRODUCT PORTFOLIO

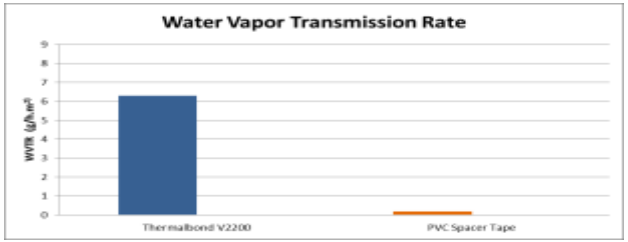
SAINT-GOBAIN

THERMALBOND KEY FEATURES/FUNCTIONS

Thermalbond – the standard for over 34 years

- ✓ **Semi rigid Foam Spacer to maintain joint between glass and frame**
  - No ‘deformation creep’ from glass loading
- ✓ **Compatible with structural silicone adhesives**
  - Long time approvals with all major silicone mfgs.
- ✓ **Adhesive on 2 sides for positioning and securing of panels**
  - Stabilizes glass during curing cycle
  - Prevents silicone from overflowing into vision area
- ✓ **Adhesive one side configuration available – NEW**
  - Self wound easy to apply roll configuration
- ✓ **Open Cell foam core structure**
  - Vapor permeable to allow rapid curing of silicone
- ✓ **Wide range of dimensions – gauges and widths**
  - Utilize with any joint design
- ✓ **High density film branded liner**
  - Easy to remove
  - Avoid counterfeits

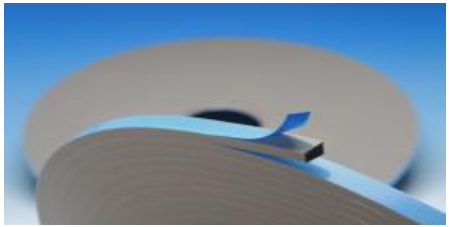




THERMALBOND KEY FEATURES/FUNCTIONS

Thermalbond – the standard for over 34 years

- ✓ **Light GREY color with UV stable adhesive**
  - better match to silicones
- ✓ **Hand tools for application**
  - Simple applicators to facilitate placement
  - Tool to position offset from edge

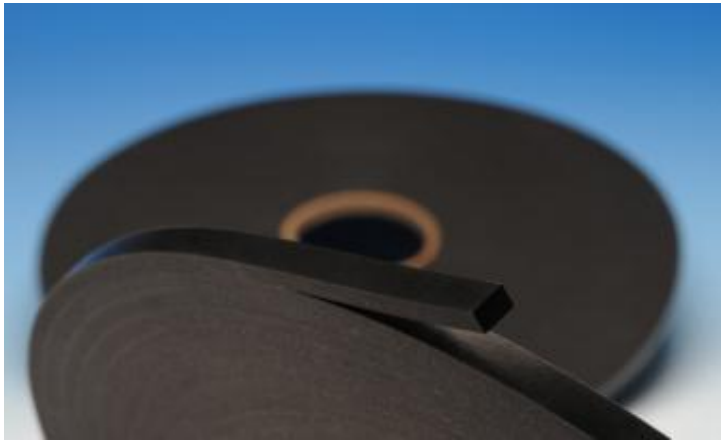


- ✓ **Global manufacturing**
  - Manufactured in US and China today, Europe soon
  - Solid manufacturing contingency plan
- ✓ **Local Converting**
  - Saint-Gobain facilities maintain stocks for local business
  - Converting (slit to width) locally for fast service of custom roll configurations
- ✓ **Technical Service support**
  - Engineers available in all regions for customer support
- ✓ **Saint-Gobain company**
  - Support and comfort of knowing there is strong, responsible corporation behind every sale

THERMALBOND XPRESS

More about Thermalbond Xpress
From the proven Thermalbond brand

- Same foam core as Thermalbond
- Same adhesive formulation as Thermalbond
- Adhesive one side configuration
- Formulated “release” coating on non adhesive side
- Matte finish provides clean visual thru glass
- Liner less construction with self wound rolls
- Available in V2100 and V2200 Grade



THERMALBOND XPRESS

More about Thermalbond Xpress

Designed to:

> Replace silicone compatible rubber profiles where no adhesive on glass side is desired

> Facilitate glass positioning – coating allows glass to slide over surface

> Use in clear glass applications where aesthetics thru glass is important

Works great for glass floors and steps

THERMALBOND PRODUCT LINE

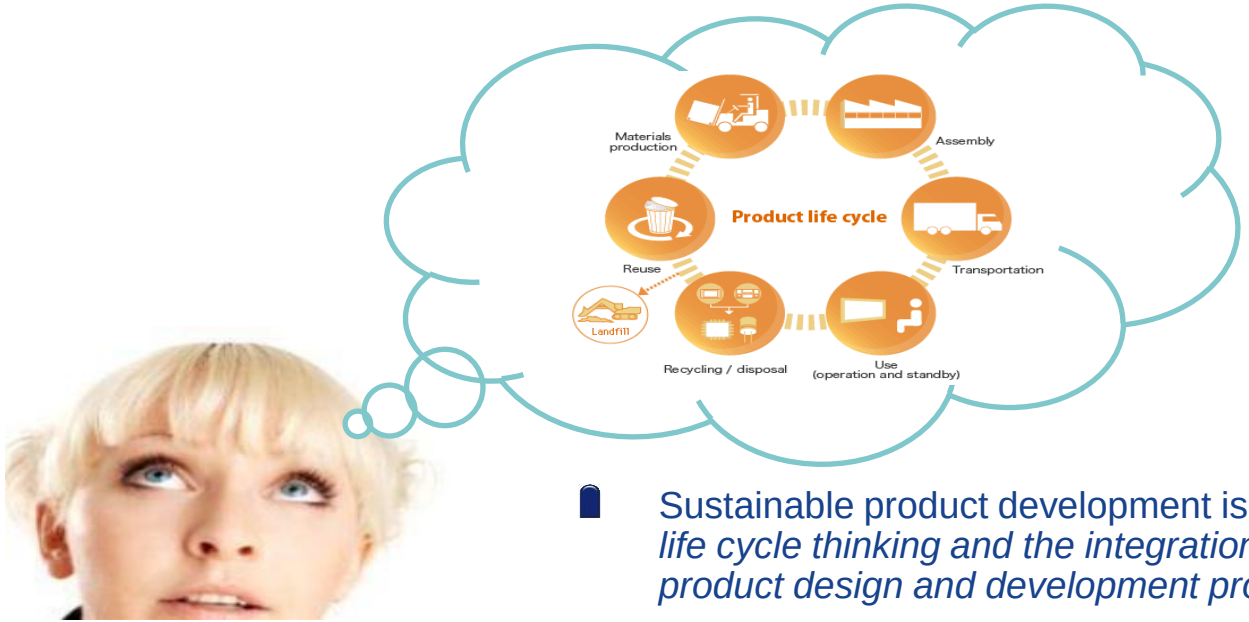
	V2100	V2200
Adhesive 2 Sides		
Black	**Yes:** ⅛ " – ½" (3.2 – 12.7 mm)	**Yes:** ⅛ " – ⅜" (3.2 – 9.5 mm)
Dark Grey (original)	**Yes:** ⅛ " – ½" (minimum order qty)	na
Light Grey (G272)	**Yes:** ¼ " – ⅜" (6.3 – 9.5 mm)	**Yes:** 3/16" – ⅜" (4.8 – 9.5 mm)
Adhesive 1 Side (with poly liner)		
Black	**Yes:** ⅛ " – ½" (minimum order qty)	na
Dark Grey (original)	na	na
Light Grey (G272)	na	na
XPRESS (adhesive 1 side, no liner)		
Black	**Yes:** ⅛ " – ¼ " (3.2 – 6.3 mm)	**Yes:** ⅛ " – ⅜" (3.2 – 9.5 mm)
Dark Grey (original)	na	na
Light Grey (G272)	na	na

THERMALBOND® SERIES

PRINCIPLES OF SUSTAINABILITY

SAINT-GOBAIN

PRINCIPLES OF SUSTAINABILITY



- Sustainable product development is characterized by the concept of *life cycle thinking and the integration of sustainability into the product design and development process*.
- Customers will require Saint-Gobain to meet Sustainable Supply Chain requirements.
- Competitors will utilize Sustainable Product Development to gain competitive advantage.

PRINCIPLES OF SUSTAINABILITY

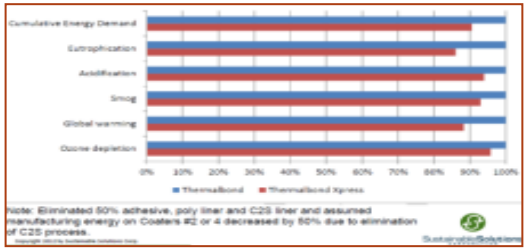
Saint-Gobain's Corporate Social Responsibility Policy

1. **Invent sustainable buildings**
2. **Limit our environmental impact**
3. Encourage employees' professional growth
4. Support local community development
5. Take action across the value chain

PRINCIPLES OF SUSTAINABILITY

An industry first cradle to grave Life Cycle Assessment was conducted on Thermalbond. Third party verified in accordance to ISO 14040 and 14044

And ….. no other spacer tape has these credentials!



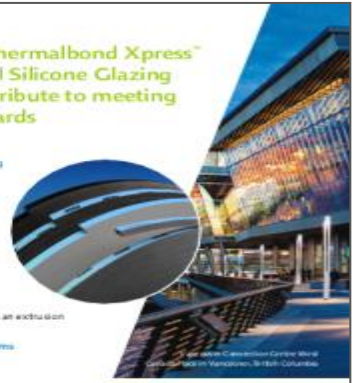
Did you know ?

- ✓ Thermalbond improves the U value of a window assembly.
- ✓ Thermalbond has better thermal performance than silicone gaskets
- ✓ Our factory has made Thermalbond more environmentally friendly with energy and water savings initiatives.
- ✓ Thermalbond Xpress improves on the “green” product initiative thanks to the liner-less configuration and unique manufacturing process.
- ✓ Detailed LCA data is available to fabricators to support their EPD /LCA process.
- ✓ LEED credits can be earned by using Thermalbond Spacer Tapes (New Construction, Core and Shell, Commercial Interiors, and more)
- ✓ All data has been validated by an independent third party review (Sustainable Solutions Corp.).

PRINCIPLES OF SUSTAINABILITY

NORTON
SAINT-GOBAIN

Thermalbond® and Thermalbond Xpress™ Spacers for Structural Silicone Glazing by Saint-Gobain contribute to meeting green building standards

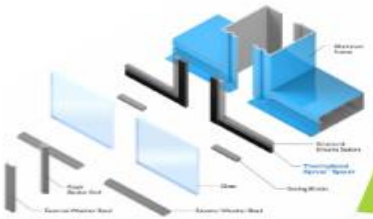


Thermalbond® (also known as Norton® tape) for structural glazing of curtain walls can reduce thermal conductivity and improve a building's energy efficiency.

- Deters heat transfer
- Reduces the U-value
- Aids in easy fabrication
- Reduces waste and disposal impacts
- High-strength polyurethane foam
- Maintains uniform spacing between glass and frame
- Compatible with structural silicones
- Low thermal conductivity
- Thermalbond Xpress™ has no liner; can reduce the amount of aluminum in an extrusion

Preventing heat transfer can help reduce the load on HVAC systems and also help earn points in the following LEED rating systems:

- LEED for New Construction (LEED-NC)
- LEED for Core and Shell (LEED-CS)
- LEED for Commercial Interiors (LEED-CI)
- LEED for Retail: New Construction (LEED for Retail: NC)
- LEED for Retail: Commercial Interiors (LEED for Retail: CI)
- LEED for Schools
- LEED for Healthcare
- LEED Canada: New Construction (LEED Canada NC)



Sustainability at the Granville, NY manufacturing facility:

- Committed to sustainable manufacturing and operations, with goals to reduce waste and increase energy efficiency.
- Initiated an internal sustainability program with goals to reduce waste and increase energy efficiency.
- Focus on improving sustainability of products using life cycle analysis to understand and reduce environmental impact.
- Hosts community education nights where Granville personnel inform the local community about various aspects of the plant's manufacturing process.
- Committed to supporting local agriculture and open space, maintains a long-term lease on 25 acres of facility property with a local farmer.
- Takes pride in employee safety, awarded the Saint-Gobain Millionaire's award in 2010 for achieving a million hours worked without a lost-time accident.
- ISO 14001 and OHSAS 18001 certified.

ThermalBond® Spacer Tapes LEED Credit Contributions — Leed-NC, LEED-CS, LEED for Retail: NC, LEED for Schools, LEED Canada NC, LEED for Healthcare

LEED Credit	ThermalBond® Contribution	Possible Points Per LEED Rating System
Energy & Atmosphere		
EA Prerequisite 2 Minimum Energy Performance	ThermalBond®'s high strength polyurethane foam substrate has a low thermal conductivity, which deters heat transfer from an outside space into your building envelope. Preventing this heat transfer can help reduce the load on HVAC systems and satisfy ANSI/ASHRAE 90.1-2007 requirements.	Required in all Rating systems
EA Credit 1 Optimize Energy Performance	ThermalBond®'s high strength polyurethane foam substrate has a low thermal conductivity, which deters heat transfer from an outside space into your building envelope. Preventing this heat transfer can help reduce the load on HVAC systems and satisfy ANSI/ASHRAE 90.1-2007 requirements.	LEED-NC, LEED for Schools, LEED for Retail: NC: 1-19 Points LEED-CS: 1-21 Points LEED for Healthcare: 1-24 Points
Indoor Environmental Quality		
IEQ Credit 7 or 7.1 Thermal Comfort	ThermalBond®'s high strength polyurethane foam substrate has a low thermal conductivity, which deters heat transfer from an outside space into your building envelope. By preventing this heat transfer, ThermalBond can help your building satisfy ANSI/ASHRAE 55-2004 requirements.	All Rating Systems: 1 Point

ThermalBond® Spacer Tapes LEED Credit Contributions — LEED-CI, LEED for Retail: CI

LEED Credit	ThermalBond® Contribution	Possible Points
Energy & Atmosphere		
EA Prerequisite 2 Minimum Energy Performance	ThermalBond®'s high strength polyurethane foam substrate has a low thermal conductivity, which deters heat transfer from an outside space into your building envelope. Preventing this heat transfer can help reduce the load on HVAC systems and satisfy ANSI/ASHRAE 90.1-2007 requirements.	Required in all Rating systems
EA Credit 1.3 Optimize Energy Performance: HVAC	ThermalBond®'s high strength polyurethane foam substrate has a low thermal conductivity, which deters heat transfer from an outside space into your building envelope. Preventing this heat transfer can help reduce the load on HVAC systems and satisfy ANSI/ASHRAE 90.1-2007 requirements.	5-10 Points
Indoor Environmental Quality		
EQ Credit 7 or 7.1 Thermal Comfort	ThermalBond®'s high strength polyurethane foam substrate has a low thermal conductivity, which deters heat transfer from an outside space into your building envelope. By preventing this heat transfer, ThermalBond can help your building satisfy ANSI/ASHRAE 55-2004 requirements.	1 Point

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ENERGY STAR AWARD 2012
SUSTAINED EXCELLENCE

SAINT-GOBAIN

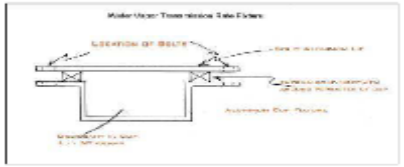
DISTINCT ADVANTAGE

SAINT-GOBAIN

THERMALBOND DISTINCT ADVANTAGE

Anyone can claim their product is better than the competition

The difference is we conduct testing to demonstrate the technical advantage we can offer

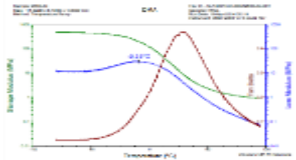


Our Technical Service group conducts ongoing comparative testing to understand the different spacer options

Table 2: General properties

Sample	Nature	Hardness Value (Shore A)	Hardness STDEV (Shore A)	Density Value (kg/m³)	Density STDEV (kg/m³)
3M	PU	43[1]	2	474[1]	49
V2100	PU	38[1]	2	519[1]	37
V2200	PU	34[1]	4	412[1]	16
Dow	PU	44	# N/A	519	# N/A
EVA SEA	EVA	52[1]	1	203[1]	15
EVA CH SHIMY	EVA	28	# N/A	129	# N/A
Lohmann	EVA	26	# N/A	122	# N/A
Ganka	PVC	58[1]	3	406[1]	23
Bow	PVC	56	# N/A	356	# N/A
SGT 3200	PVC	34	# N/A	400	# N/A
ADHERE 635 ST	PVC	44	# N/A	300	# N/A
TB PVC CHX 1	PVC	52	# N/A	317	# N/A

We analyze the results and quantitatively show how Thermalbond compares to the competitive options.



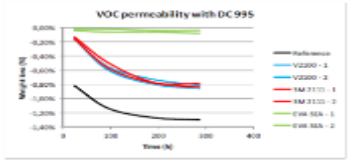
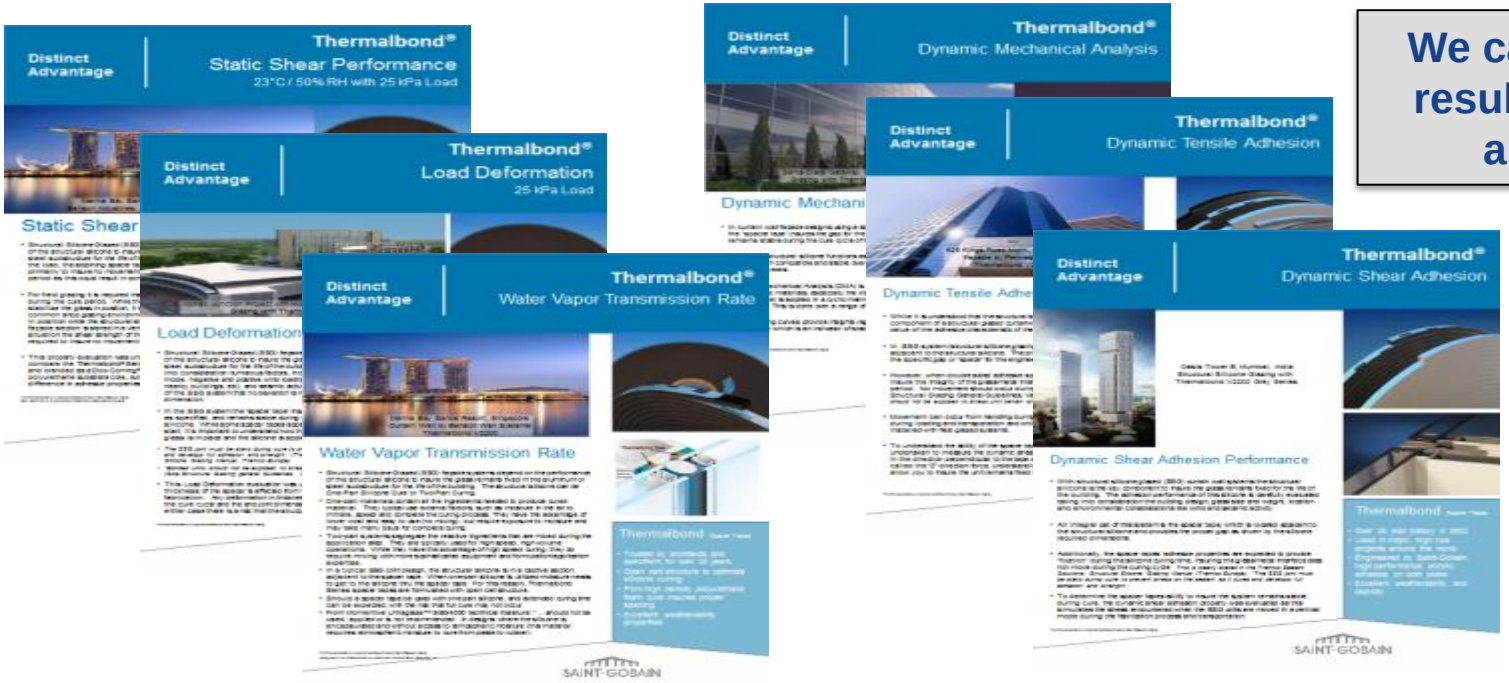


Fig.11: VOC permeability test results

THERMALBOND DISTINCT ADVANTAGE

We call these reports - **“Distinct Advantage”**



We can share these results with you as appropriate.

PROJECTS

THERMALBOND PROJECTS

From the tallest towers to the everyday office building

Planned tallest building in Bangkok

MahaNakhon
Bangkok, Thailand
Completed 2016
77 Floors, 314 M (1,030 ft)
Thermalbond V2200 Series

Hillsboro Civic Center
Oregon, USA
Thermalbond V2200

THERMALBOND PROJECTS

Suitable for Stone or Glass Clad Exteriors

Two Turtle Creek
Dallas, TX USA
Completed 1972
Thermalbond V2110

2 SIDED SYSTEM SHOWING A DISTINCT
“BANDED” APPEARANCE TO THE WALL.
THIS PROJECT INCORPORATED BOTH SSG
GLASS AND GRANITE FACADE THERMALBOND

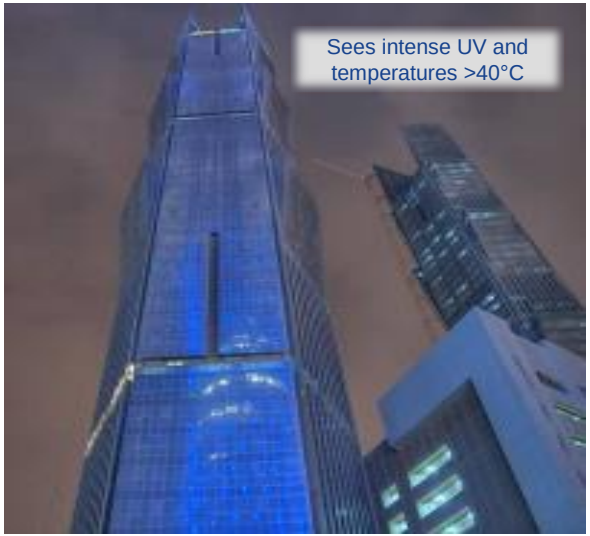
Later Day Saints Temple
Guatemala City

Later Day Saints Temple
Bogota, Columbia

Several architectural designs of LDS temples use Thermalbond to secure the stone tile while the structural silicone cures

THERMALBOND PROJECTS

Used in the hotest to coldest climates



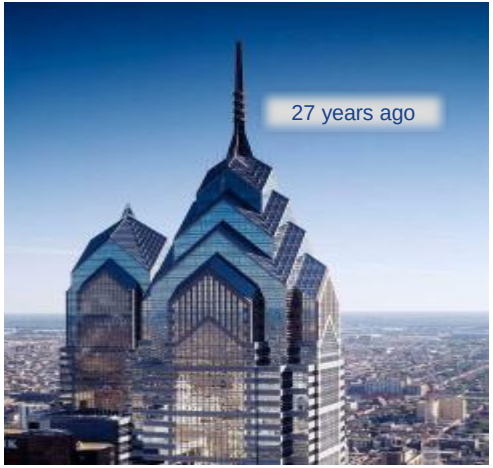
Twin Palm Towers, Doha, Qatar
Average temperature range: 12°C to 41°C

Moscow World Trade Center
Average temperature range: -10°C to 30°C

THERMALBOND PROJECTS

Multiple tower projects

Emirates Tower Hotel
Dubai, UAE
Completed 1999
309 m, 22 Floors
Thermalbond V2200 Series



Liberty Place, One and Two
Philadelphia, Pennsylvania, USA
Completed 1990
Thermalbond V2200 Series

Deira Twin Towers (aka Dubai Creek)
Dubai, UAE
102m, 22 floors
Completed 1998
Thermalbond V2200 Series

Z Towers
Riga, Latvia, Europe
Expected completed 2017
33 Floors, 121 and 133 M
Thermalbond V2100 Series

THERMALBOND PROJECTS

In projects with curved walls and sloped glazing

National Bank of Dubai
Dubai, UAE
Thermalbond V2200 Series
4 side SSG, factory glazed

One Museum Park East
Chicago, IL USA
Completed 2008
219 m, 65 floors

Fountain Place (Allied Bank)
Dallas, Texas USA
Completed 1986
Thermalbond V2100 Series

Tatilya Field House
Istanbul, Turkey
(now closed)

THERMALBOND PROJECTS

And in world class momumental buildings around the world

One World Trade Center
New York, USA
Curtain Wall: Benson Global Ind.
Thermalbond V2100 Series

Marina Bay Sands Resort
Singapore,
Completed 2010
Curtain Wall: Benson Wall Systems
Thermalbond V2200 Series

Burj Al Arab, Jumeriah Beach Complex
Dubai, UAE
Completed 1999
Thermalbond V2200 Series

SUMMARY

THERMALBOND – THE INDUSTRY STANDARD

- Full complement of supporting documentation
  - Technical Data Sheets and MSDS

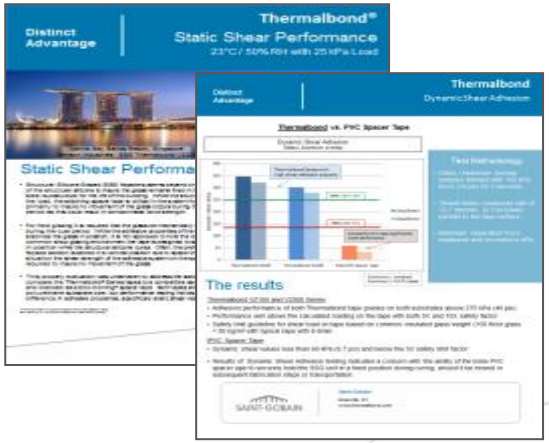
- Recognized compatibility with all major silicone manufacturers

- Principles of Sustainability
  - Saint-Gobain's Vision – "Invent Sustainable Buildings"
  - Thermalbond LCA documentation – the only SSG spacer with this
  - Thermalbond can support LEED credits

THERMALBOND – THE INDUSTRY STANDARD

- Global Technical Service Team
  - Available to support you - anywhere
  - Review drawings, product recommendations
  - Training, field visits, troubleshooting

- ’Distinct Advantage’ reports
  - Methodical analysis of all available spacer options
  - Testing conducted in our state of the art labs
  - Quantifiable results to provide clear understanding
  - Available to support or dispute marketing claims



THERMALBOND – THE INDUSTRY STANDARD

- Global manufacturing
  - We formulate, mix, coat, laminate and finish - we control the whole process
  - Thermalbond is manufactured in 2 locations today, 3 in near future
  - Provides for optimized raw material purchasing and product shipping
  - Ensures contingency plan for uninterrupted supply

- Regional Saint-Gobain offices and plant facilities
  - Maintain master log stocks for local area
  - Convert (slit to roll) locally – provides for fast service of specified dimensions
  - Supports local distributors

- Available in wide range of dimensions, black and grey color
  - Gauges from 3.2mm to 12.7mm / widths from 6 mm to 1400mm
  - Custom slit to order – no large minimum order concerns

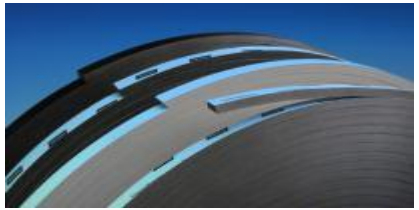
THERMALBOND – THE INDUSTRY STANDARD

While we all need to be diligent in watching our purchasing costs.

Consider the cost of the SSG spacer to the Façade or complete building cost.

And ask yourself if this is where I want to take a risk?

Those responsible for creating and building the greatest buildings in the world - choose Thermalbond



Planned tallest building in South Korea

Lotte World Premium Tower
Seoul, South Korea
Expected completed 2015
123 Floors, Roof 555 M (1,820 ft)
Thermalbond V2110

December 2013

This is why Thermalbond is THE standard for over 30 years.

THANK YOU