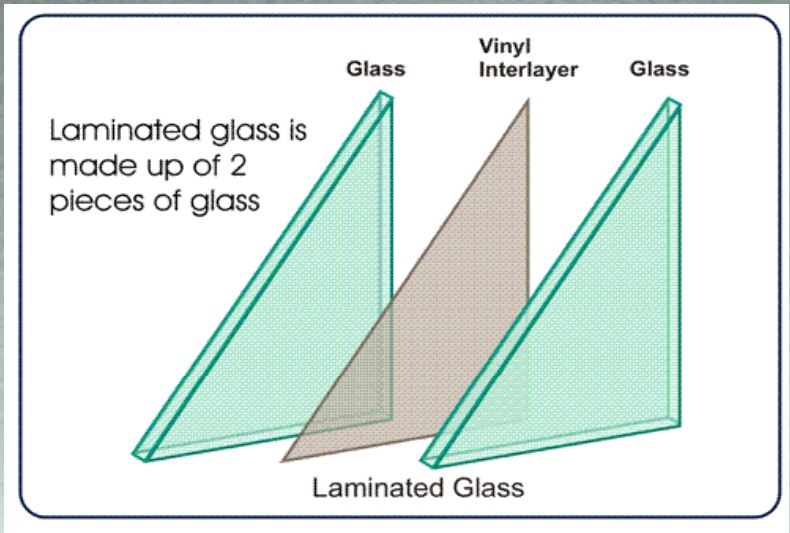
Gyrotron Technology, Inc.

Laminating Technology and Equipment

3412 Progress Drive Bensalem, PA 19020 USA 215-244-4740
gyrotrontech.com

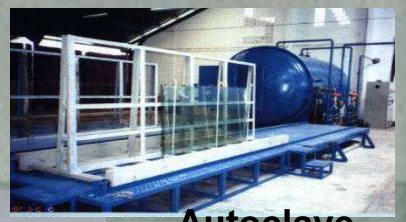
What is Laminated Glass?

Laminated glass consists of a tough protective interlayer, for example PVB, TPU, EVA, etc bonded together between two panes of glass under heat



The standard two-ply construction provides resistance to penetration when subjected to attempted forced entry. In multi-ply configurations, laminated glass can even resist bullets, heavy objects, or small explosions.

Existing Laminating Line



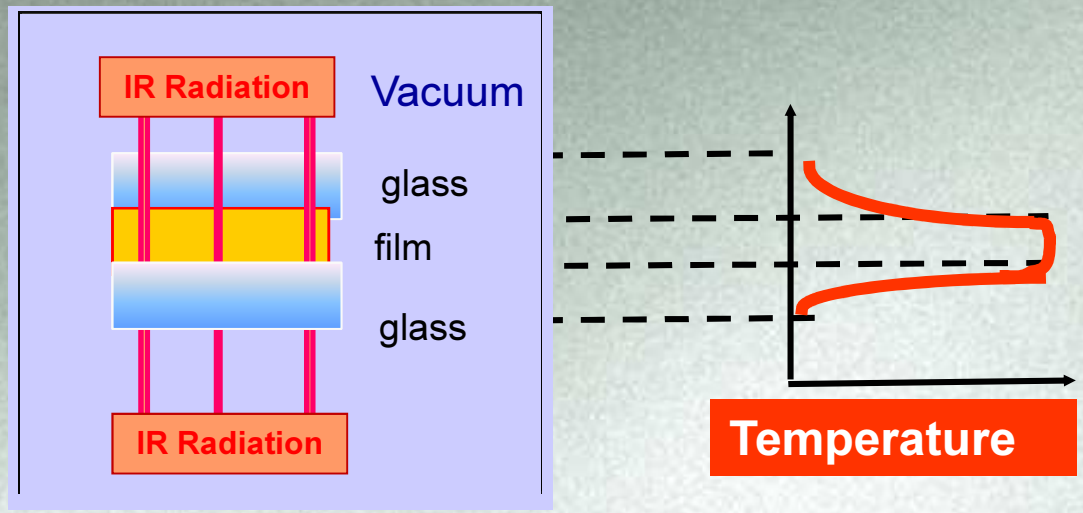
Autoclave

Specific current problems of conventional processing:

- High operating costs
- Losses
- Time consuming
- Floor space requirements
- Quality issues

GTI's Laminating Concept

The main concept of our process is heating an assembled product in a vacuum (around 0.05 Bar) by using penetrating electromagnetic radiation that heats the adhesive film much more than the glass.

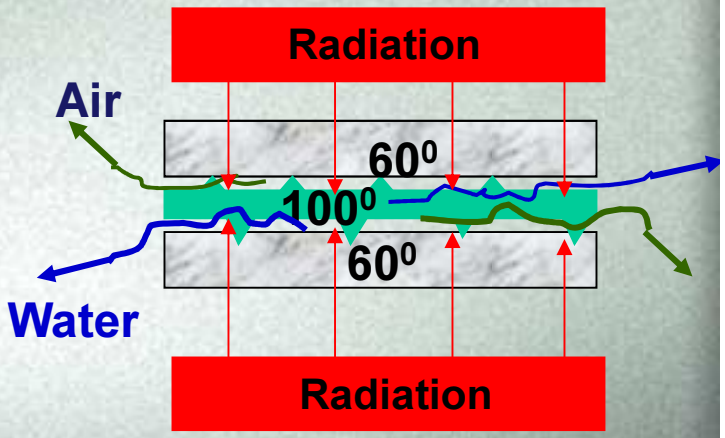


GTI's Laminating Diagram

There are three main stages in GTI's laminating process. At the initial stage the film preheats to a higher temperature than both of the glass sheets. This approach allows evacuating/pumping air and water from the film and its surrounding area because the film does not stick to the inside surfaces of the sheets (due to low glass temperature).
Note: The preheating stage can be started at normal pressure, as well.

Water Boiling Point (F) vs. Pressure (Bar)

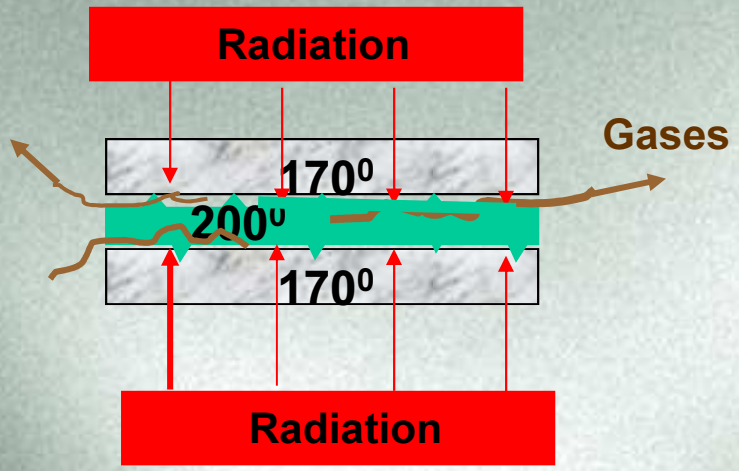
Pressure, Bar	1	0.2	0.1	**0.05**
Boiling point, T (F)	212	150	115	**90**

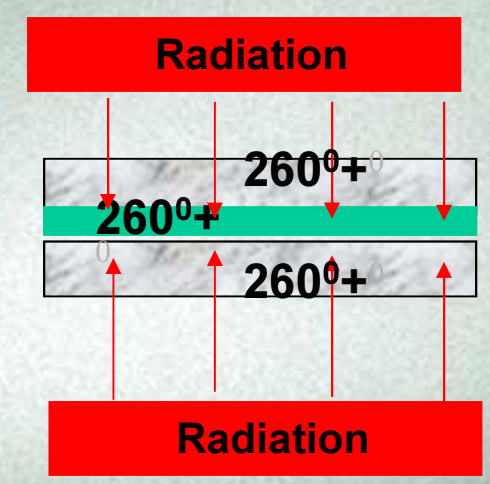


GTI's Laminating Diagram

Further heating leads to spreading of adhesion of the film over the glass surfaces because there is no water or air left. This stage is accomplished in a vacuum chamber

At around 212F (100C) the entire surface of both glass sheets are bonded, however the heating process continues to achieve the necessary adhesion level. This stage is accomplished in vacuum or at normal pressure.





Line Options

Vacuum Laminator

Entire laminating process can be accomplished in laminator.

Preheating Oven + Vacuum Laminator

Or pre-heating in conventional oven and laminating in vacuum laminator.

Vacuum Laminator + Final Oven

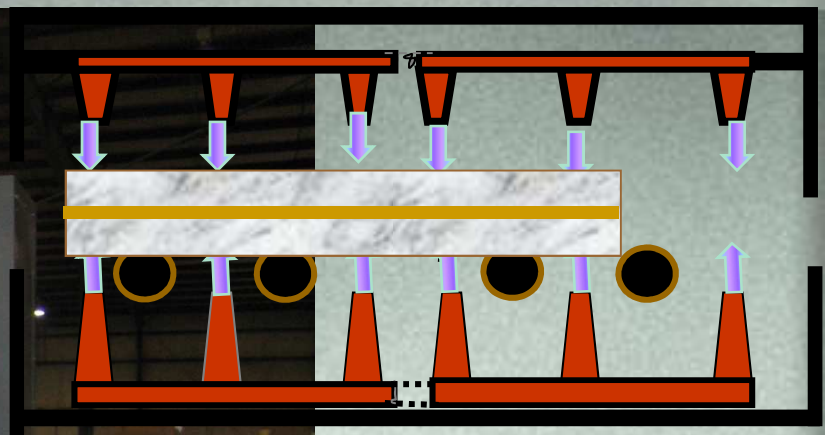
Pre-laminating in vacuum laminator and final curing in conventional oven.

Line Option

The laminating process divided in three parts: pre-heating in conventional oven, laminating in vacuum laminator and final film curing in conventional oven.

Vacuum Laminator/Chamber (general view)

Hot-air Oven (general view)



GLS Applications

The GTI process is applicable to safety, hurricane, ballistic, fire-rated and other laminated flat glass products, as well as an array of PV products.

- Suitable for clear, coated, mirrored, textured or colored glass in an annealed or tempered state
- Best choice for encapsulating solar modules or for other processes sensitive to pressure and temperature
- Process uses standard films: PVB, EVA and others in standard thicknesses
- Easily processes multilayer and thick laminates

GLS Advantages

- Lower operating costs due to reduced labor, energy, and maintenance requirements
- Increased throughput (2-3x) utilizing the same floor space
- Film is less sensitive to moisture control
- Faster response time
- New product opportunities
- Any type of adhesive film can be used

GLS Customers

Glass laminating companies who:

- **Are interested in the reduction of production costs**
- **expand production capabilities**
- **want to bring laminating business “in house”**
- **need to avoid pressure and moisture**
- **want to replace low performance/expensive thermoset films and liquids with thermoplastic films**

Certified Test Results: Boil

Boil Test - Passed

Architectural Testing

Test Results:

3/16" - 0.010 - 3/16" Interlayer Thickness:

Sample Type	Overall Thickness	Lite Thickness		Interlayer Thickness
		Side 1	Side 2	
Boil	0.387"	0.187"	0.188"	0.012"

BOIL TEST / ANSI Z97.1-2004

Spec. No.	Overall Thickness	Test Results [1]		Notes:
		Observations	Pass/Fail	
1	0.387"	No bubbles	Pass	1. Acceptance Criteria: No bubbles or defects more than 1/2" from edge or crack.
2	0.396"	No bubbles	Pass	
3	0.397"	No bubbles	Pass	

***Conclusion**: Meets the boil requirements of the referenced standard.*

For ARCHITECTURAL TESTING, INC.:

Andrew O'Neill
Technician

Scott T. Swaltek, P.E.
Senior Project Engineer

APO:apo/nlb

Certified Test Results: Impact

Impact test- Passed

Architectural Testing

Test Results:

3/16" - 0.030 - 3/16" Interlayer Thickness:

Sample Type	Overall Thickness	Lite Thickness		Interlayer Thickness
		Side 1	Side 2	
Impact	0.412"	0.192"	0.191"	0.029"

IMPACT TEST:

Spec. No.	Test Standard	Thickness	Impact Drop Height	Test Results[1]	
				Observations	Pass or Fail
1	ANSI Z97.1-1984	0.412"	12"	No opening	Pass
2	ANSI Z97.1-1984	0.404"	12"	No opening	Pass
3	ANSI Z97.1-1984	0.396"	12"	No opening	Pass
4	ANSI Z97.1-1984	0.412"	12"	No opening	Pass
5	16 CFR 1201	0.405"	48"	No opening	Pass

1. Acceptance Criteria: No shear or opening through which a 3" sphere can freely pass.

Conclusion: *Meets the impact requirements of the referenced standard.*

For ARCHITECTURAL TESTING, INC.:

Digitally Signed by: Andrew O'Neill
Andrew O'Neill
Technician

Digitally Signed by: Scott Swaltek
Scott T. Swaltek, P.E.
Senior Project Engineer

APO:apo/nlb

Certified Test Results: Impact

Passed

Certified Test Results: Pummel

Pummel Test - Passed

Architectural Testing

August 31, 2005

Ms. Lian Sawires
Gyrotron Technology, Inc.
2814 Ford Road, Unit K
Bristol, Pennsylvania 19007

RE: PUMMEL TEST RESULTS

Dear Ms. Sawires:

Architectural Testing, Inc. (ATI) has completed the pummel test of three samples provided to us by your firm. The table below details the results of the evaluation and the attached photos are for reference to the values.

Open Area Percentages

Sample	Side 1 - End 1	Side 2 - End 1	Side 1 - End 2	Side 2 - End 2	Average	Rank
A	24	86	82	72	66.0	Middle
B	60	70	80	20	**57.5**	**Best**
C	82	70	90	40	70.5	Worst

If you have any questions regarding this letter or the information contained herein, please contact me at your convenience.

For ARCHITECTURAL TESTING, INC.

Todd D. Burroughs
Director - Component/Materials Testing

TDB:tdb/nlb
cc: 59771.01-106-31

Attachments
Photographs

130 Derry Court
York, PA 17402-9405
phone: 717-764-7700
fax: 717-764-4129
www.archtest.com

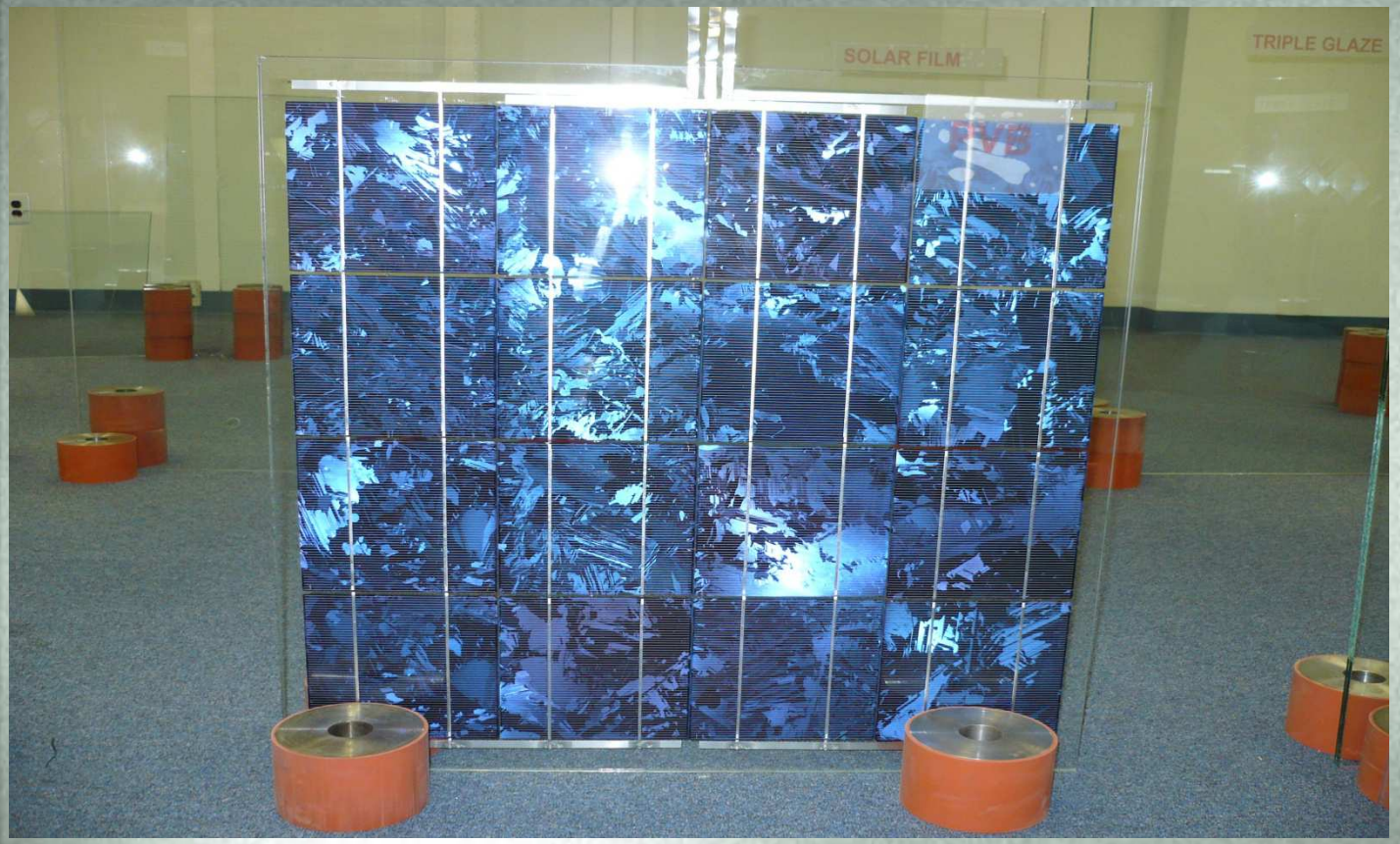
Adhesion is controlled by temperature alone

Flat Glass

Decorative Glass

Curved Glass

Solar Modules Laminated By PVB



Solar Modules Laminated By EVA