

Edge Stability and Potential Cause of Blemishes in Laminated Safety Glass



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Open edge installation of laminated glass increasing!



Edge Stability and Potential Cause of Blemishes in Laminated Safety Glass

Increasing the risk for edge defects.



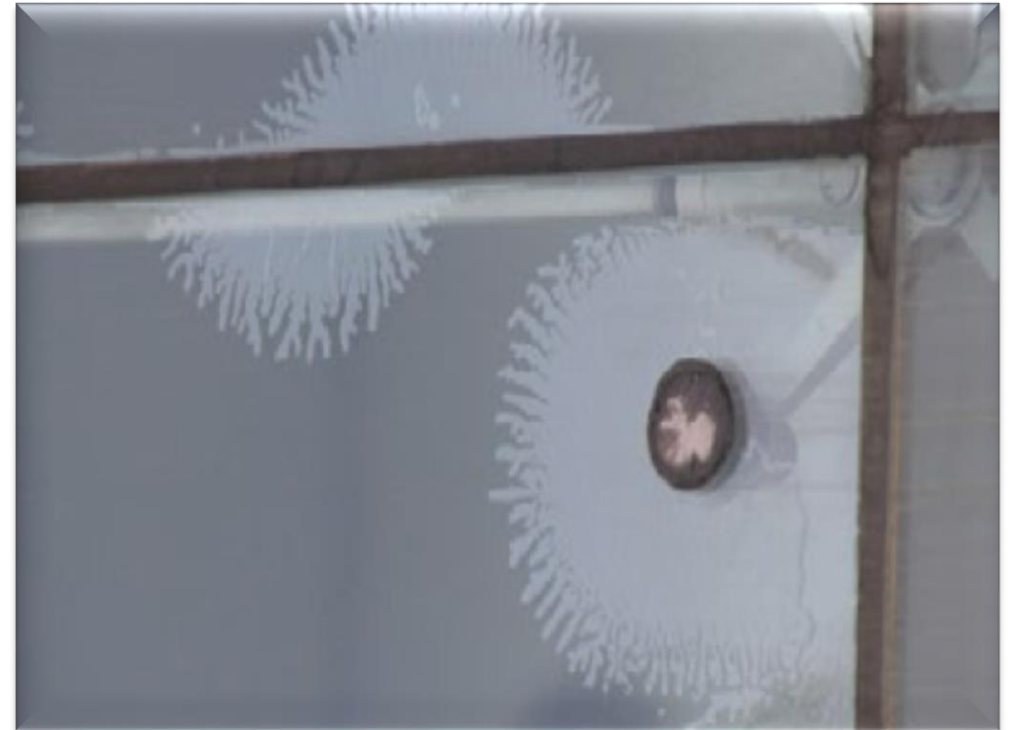
Edge Stability and Potential Cause of Blemishes in Laminated Safety Glass

What is Edge Stability?

- Edge stability is defined as a laminate's resistance over time to form defects along its edge.
- Defects can be small to large bubbles, discoloration, and even delamination

Testing

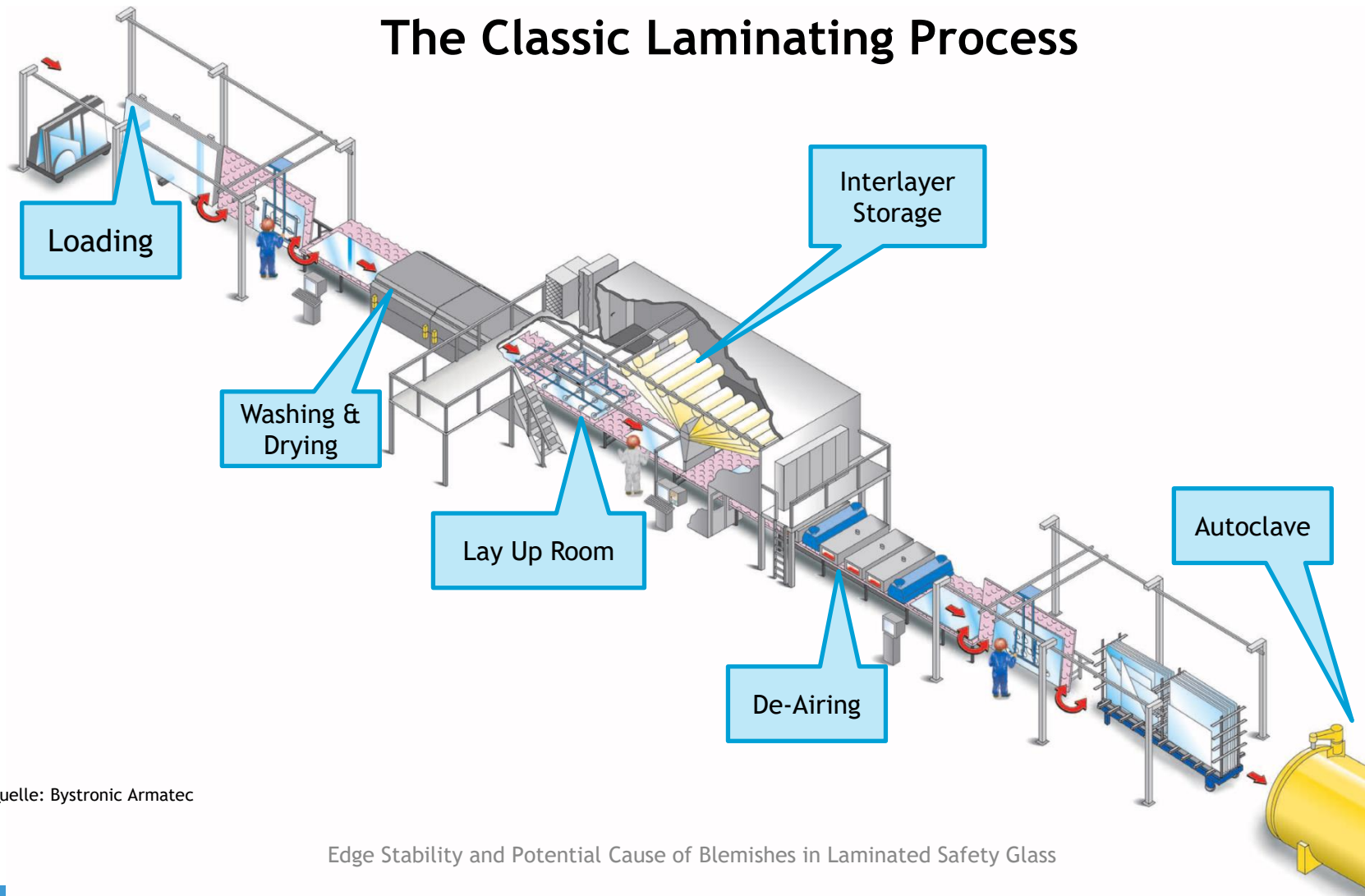
- Natural and accelerated weathering
 - Heat, humidity, and irradiance
 - ANSI Z97.1
 - ISO 12543-4
- Salt Spray (Fog) - ASTM B-117
- Compatibility Testing
 - Sealants and grouts
 - Low E/ Solar glass coatings
 - Frits and inks



- Potential Causes
- Lamination Process
- Quality of glass
- Application



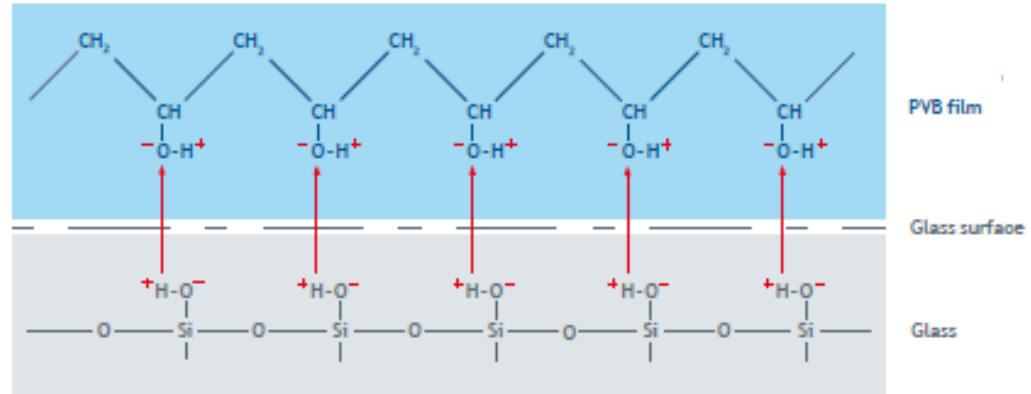
Edge Stability and Potential Cause of Blemishes in
Laminated Safety Glass



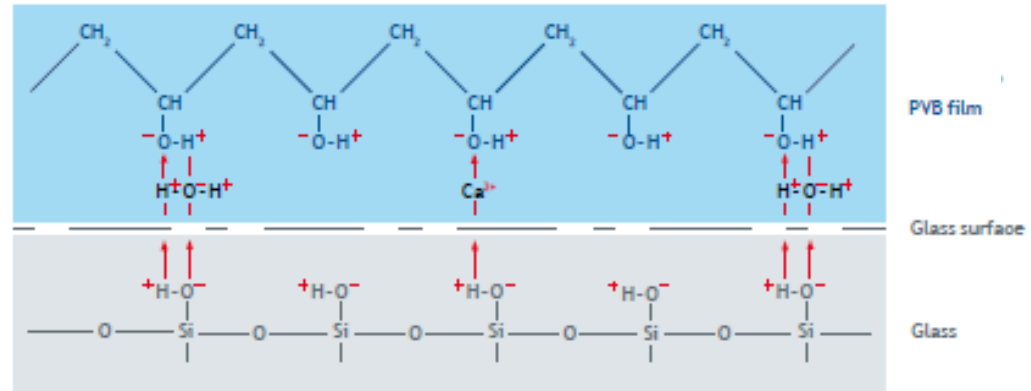
Quelle: Bystronic Armatec

Adhesion to Glass

- Adhesion plays a major role in edge stability
- The adhesion to glass is done primarily through the formation of hydrogen bonds
- Addition of water or ions can reduce the adhesion



Clean glass surface + right film moisture content = good adhesion



Unclean glass surface (e.g. mineral residue) or excessive film moisture content = poor adhesion

Moisture

- Recommended storage conditions for opened rolls of PVB film



Quelle: Bystronic Armatec

Refrigerated Rolls

- Sealed in original packaging:
≤ 8°C (46°F) without regulating the humidity
- Opened:
≤ 8°C and 25 - 30% rel. humidity

Interleaved with PE film

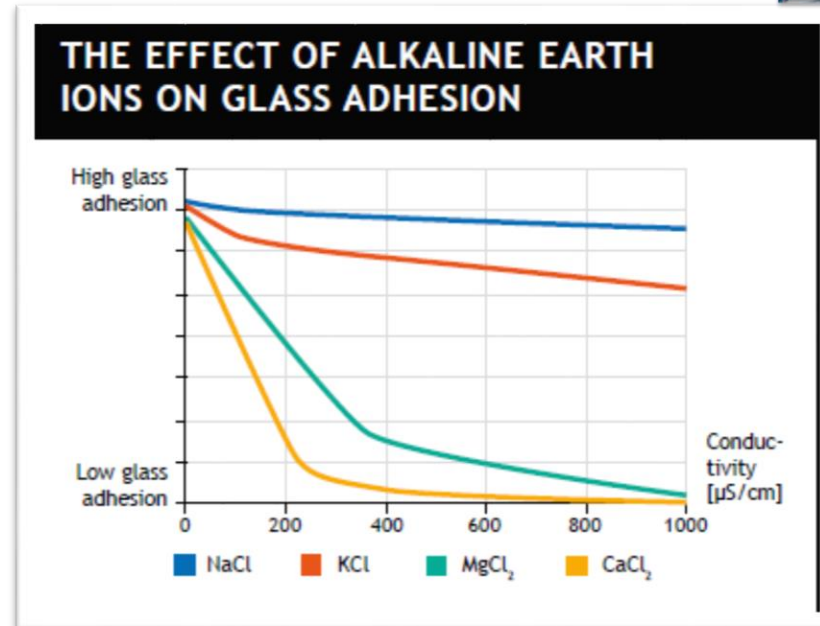
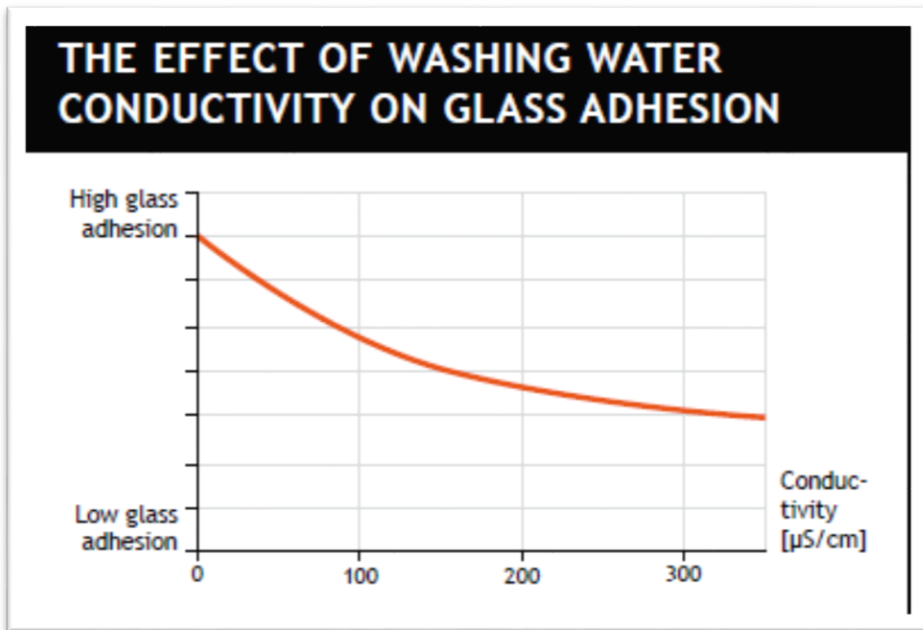
- Sealed in original packaging :
≤ 30°C (86°F) for long term storage without regulating the humidity
- Opened:
≤ 18°C (64°F) and 25 - 30% rel. humidity

Shelf life for unopened rolls - 4 years

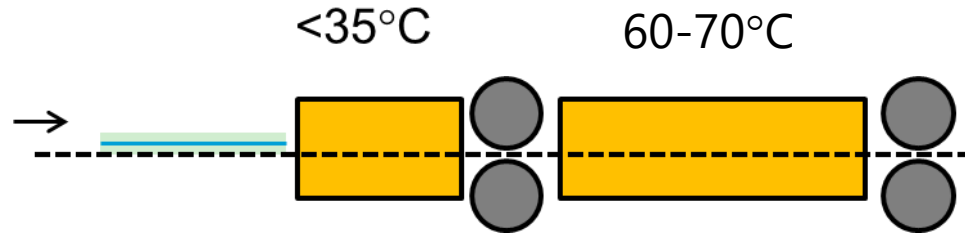
Ions

Last rinse water= demineralized water (conductivity $\leq 20\mu\text{S}$)

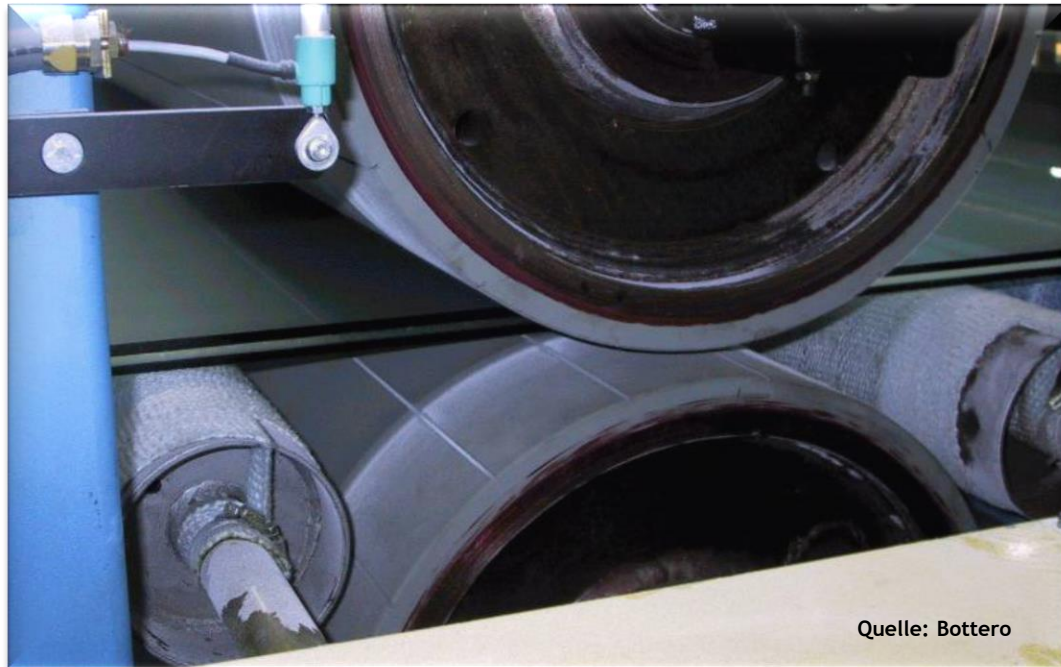
Influence of washing water to glass adhesion



Edge Seal



- Edges should be clear after final nip roll



Quelle: Bottero

- Too hot during de-airing can lead to trapped air resulting in edge bubbles



- Releasing the pressure above 50°C can result in edge bubbles

Autoclave



- Absorption of the remaining air into the PVB under pressure (~12 bar) and temperature (~140°C). The remaining air is not pushed out!
- Achieving desired adhesion levels through intensive contact of PVB and glass surface



Quality of Glass - A Tempered Glass Study



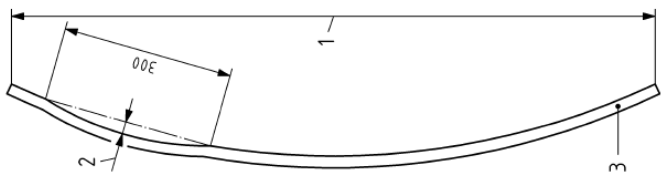
Wavy Heat Treated Glass

Lamination of heat treated glass

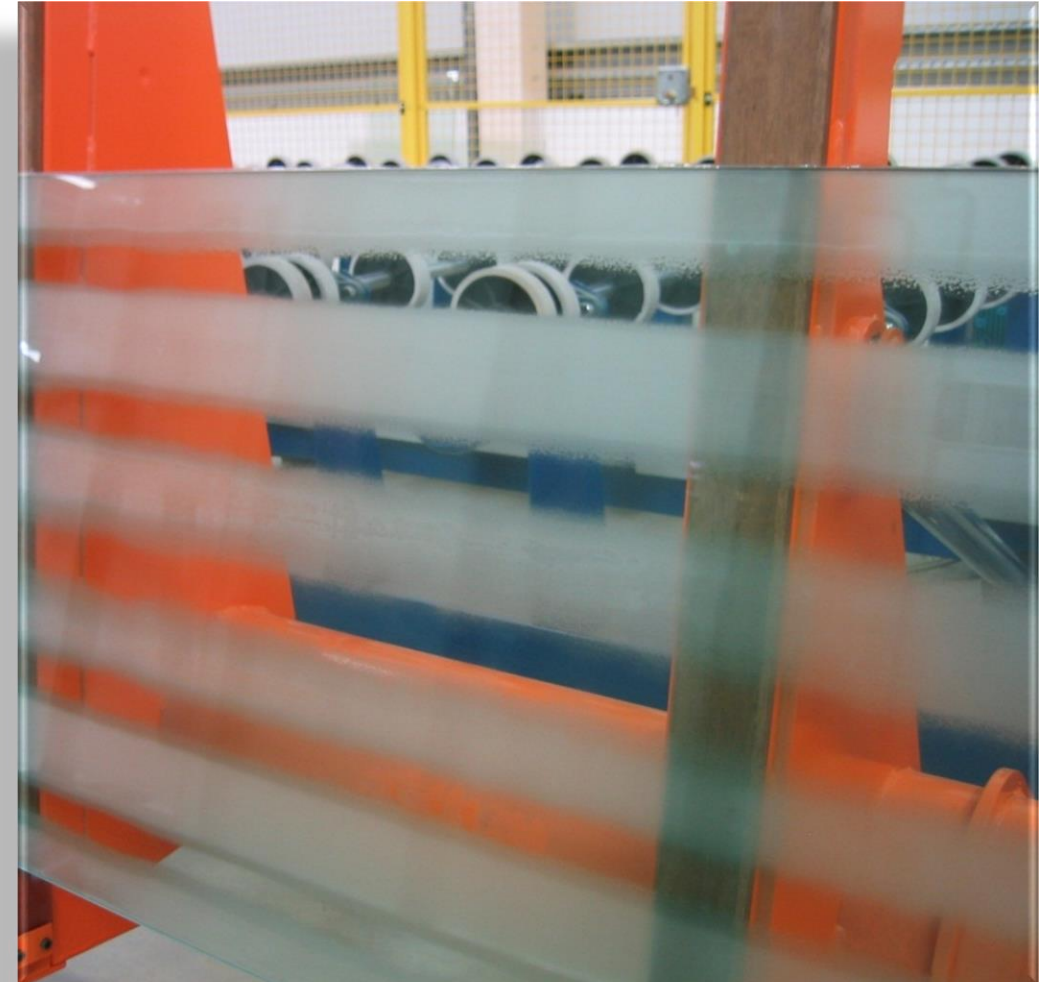
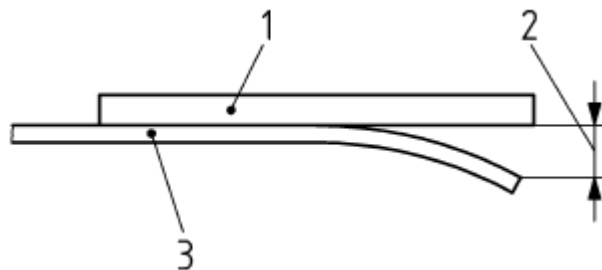
- The flatness of the individual lites is critical
 - Waviness



- Local and general bow



- Edge Curl



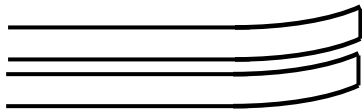
Wavy Heated Treated Glass

- Measuring edge curl

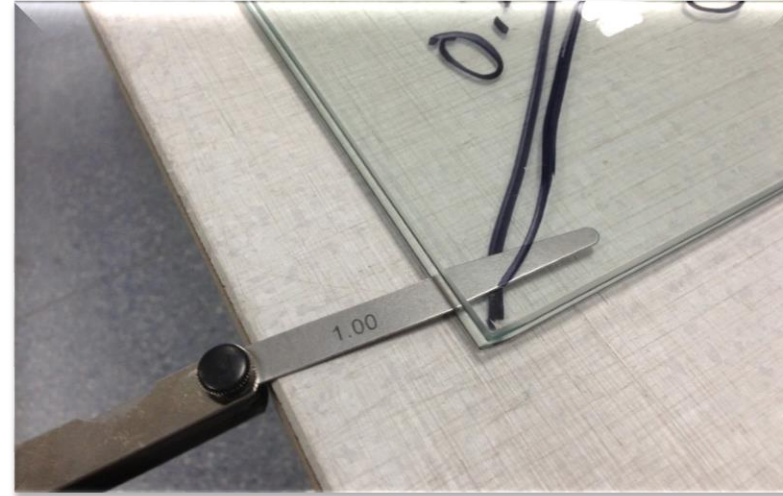


- Two types of edge curl oriented laminates were tested - A & B

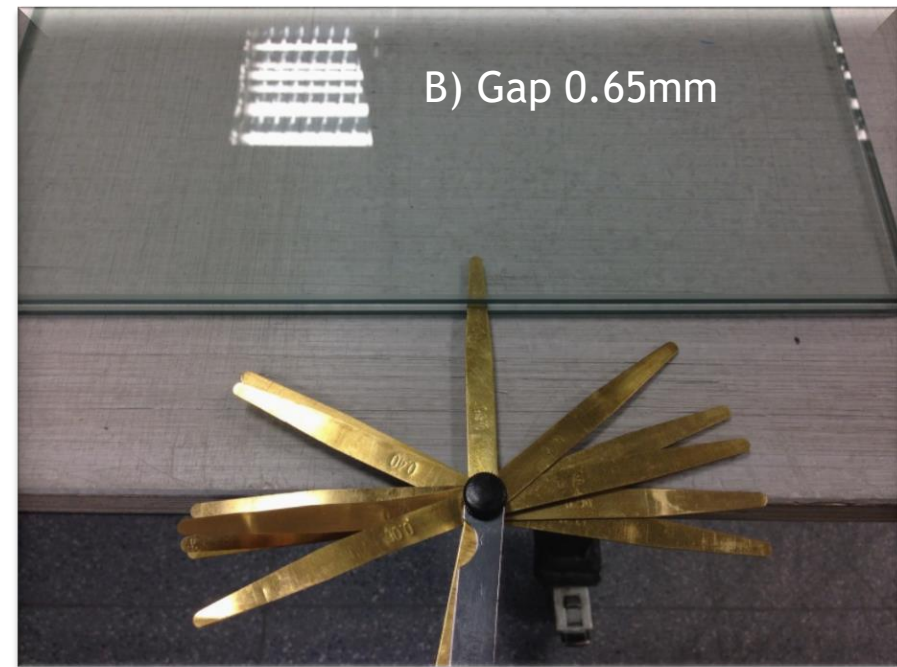
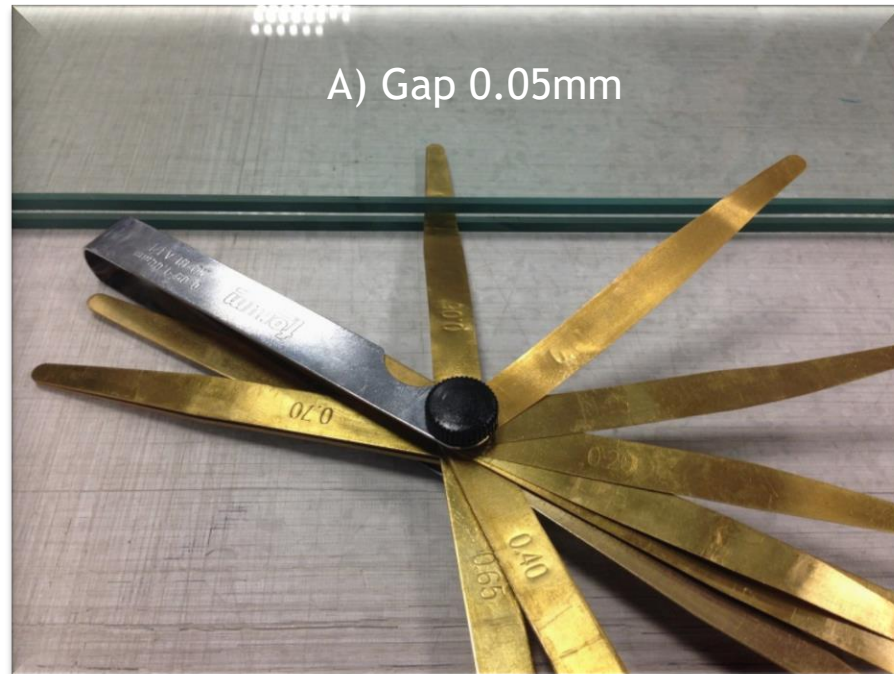
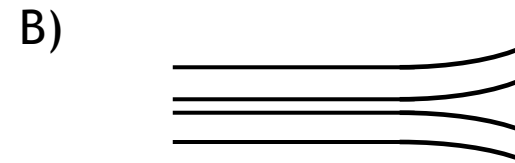
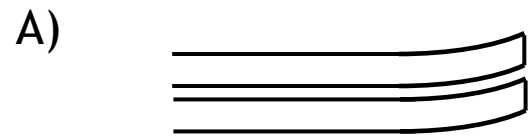
A)



B)

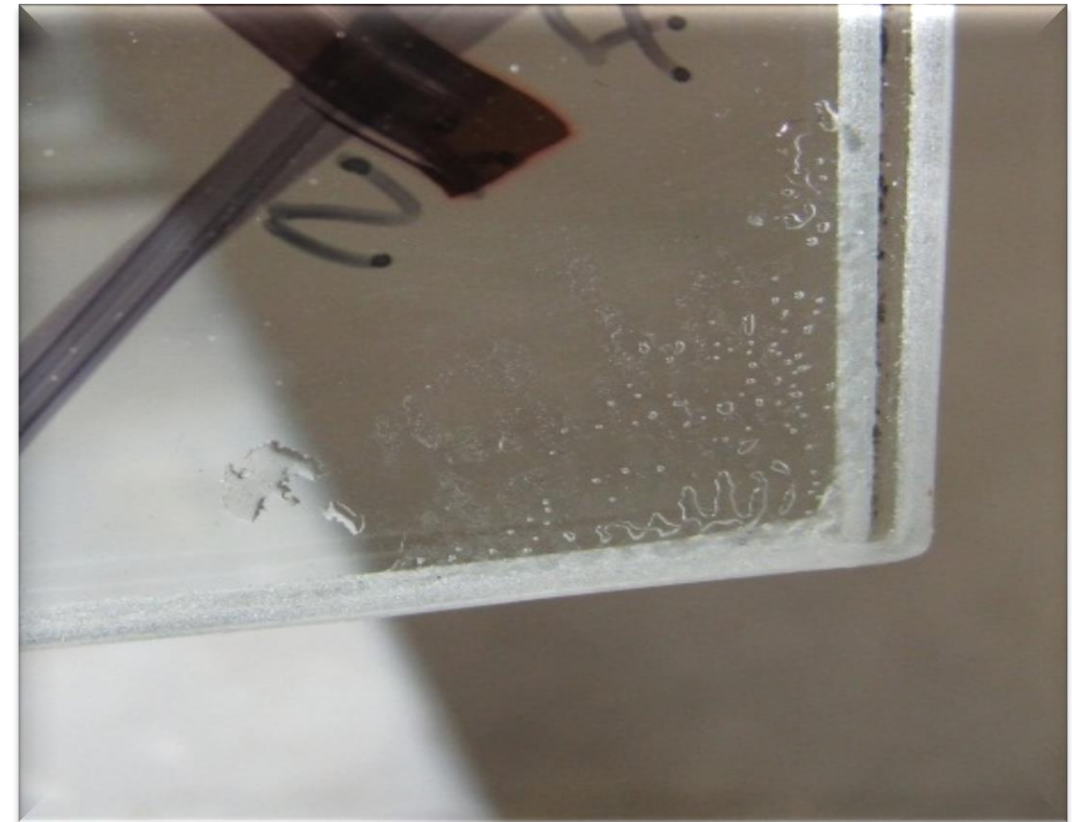


Wavy Heated Treated Glass



Wavy Heated Treated Glass

- Orientation B



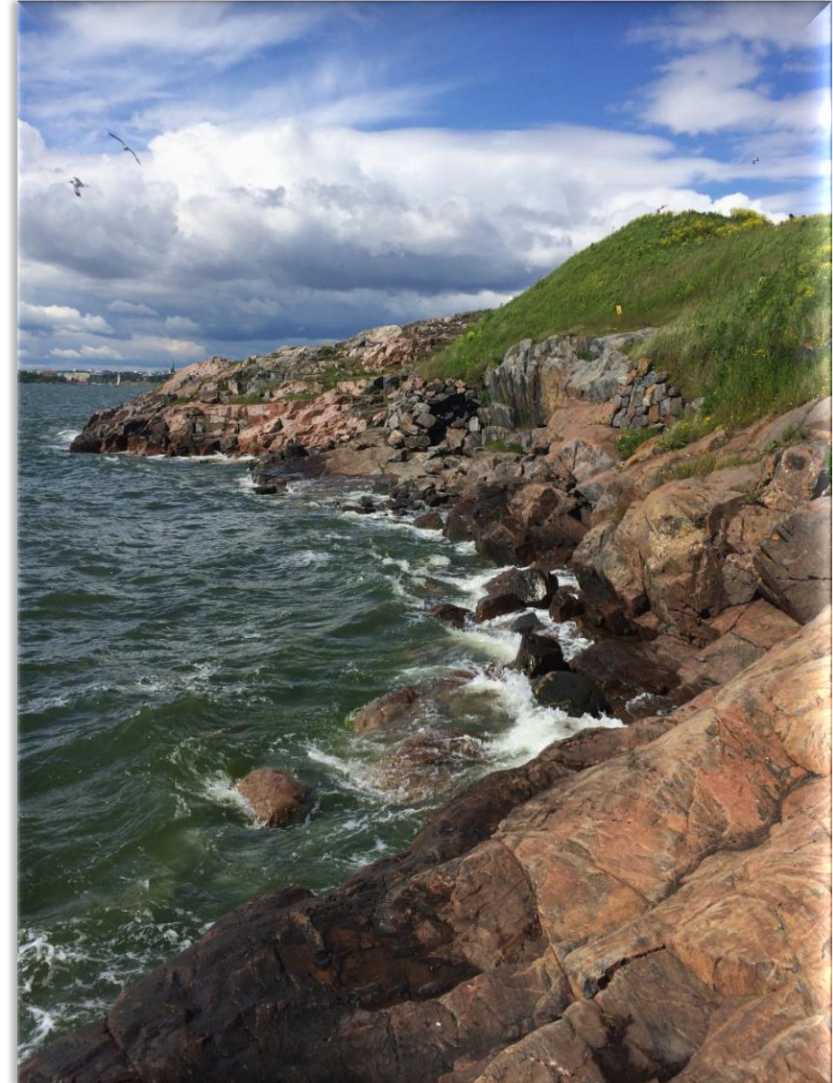
After Autoclave

Wavy Heated Treated Glass

- Orientation B after storage under temperature and humidity (several months at 85° C/85% rh)



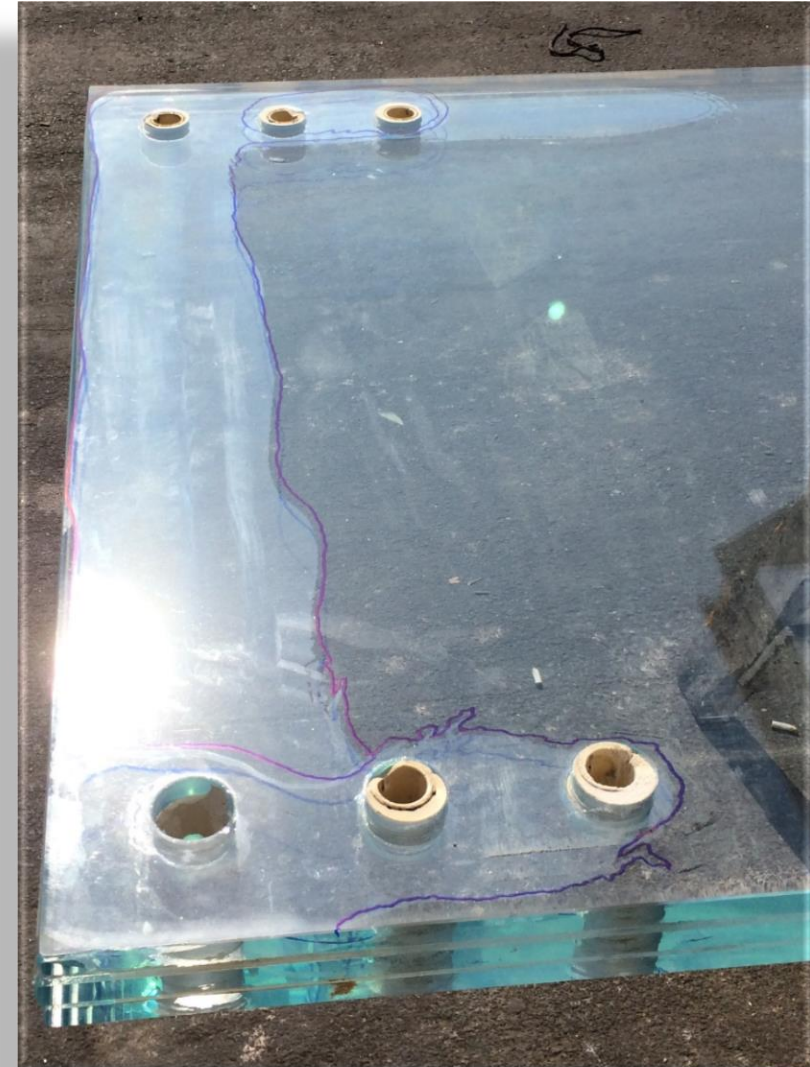
Orientation A showed no abnormalities after identical exposure



**Application
Installation & Environment**

Installation

- Compatibility with
 - Sealants
 - Grouts
 - Gaskets
- Constant exposure to water
- Over-tightening of mechanical fasteners



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Environmental Conditions

Salt Spray Testing

Test Method

ASTM B117-11

“Standard Practice for Operating Salt Spray (Fog) Apparatus”



Concentration of salt solution	:	5 ± 1% w/w NaCl
S.G. of condensate	:	1.029 – 1.033
pH of condensate	:	6.5 – 6.9
Volume of condensate	:	1.0 – 2.0 ml/hr/80 cm ²
Test chamber temperature	:	35 ± 2°C
Position of specimens	:	Inclined 15° from vertical
Exposure period	:	3,000 hours
Method of Cleaning	:	
Before test		Nil
After test		Water-rinse and air-dry

**Visual Assessment
@ every 500 hours**

- **Cloudiness of Interlayer**
- **Delaminations**
- **Bubble Formation**

Salt Spray Test Results

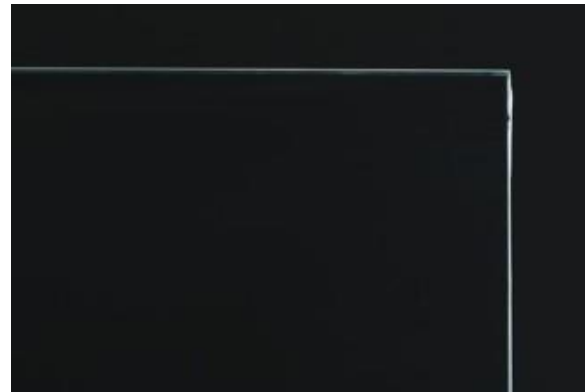
Standard PVB

- After 1,500 hours
- No bubbles
- No delamination
- Cloudiness observed at corners and edges



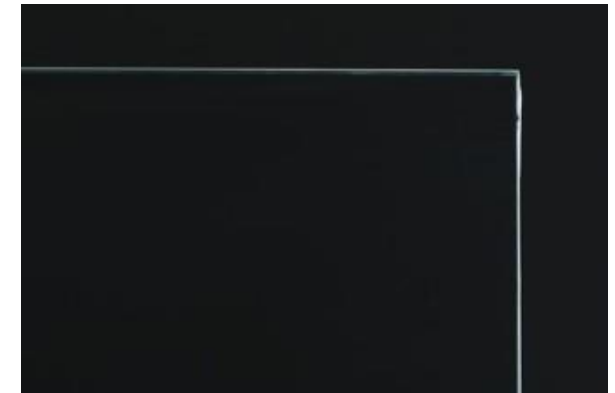
High Adhesion PVB

- After 3,000 hours
- No bubbles
- No delamination
- No cloudiness



Ionoplast

- After 3,000 hours
- No bubbles
- No delamination
- No cloudiness



➤ Select the best interlayer for the application

Conclusion



Open edge applications for laminated glass is growing.

Key areas to reduce the potential edge defects

- Proper lamination
- Good moisture and ion control
- Quality tempered glass
- Check for compatibility with sealants and other components
- Proper installation
- Know the environmental conditions
- Select the best interlayer for the application



Thank you for your attention!