

Edge Stability and Potential Cause of Blemishes in Laminated Safety Glass



#GPD2017

**ALL EYES
ON GLASS.**

**GLASS PERFORMANCE DAYS 2017
JUNE 28 - 30, 2017. TAMPERE, FINLAND**

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

**Vaughn Schauss
Kuraray**



Open edge installation of laminated glass increasing!





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

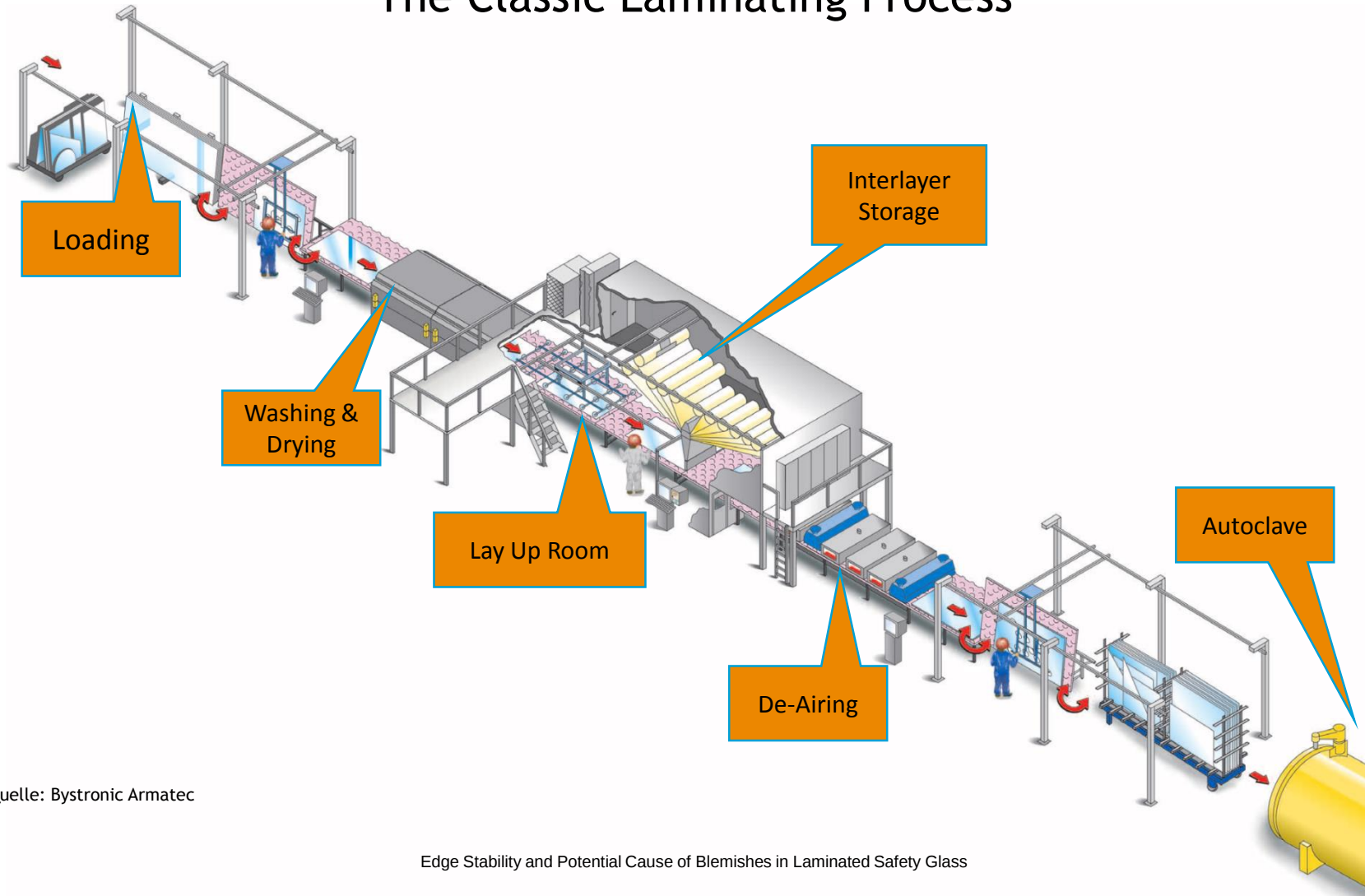


- Potential Causes
- Lamination Process
- Quality of glass
- Application



Edge Stability and Potential Cause of Blemishes in Laminated Safety Glass

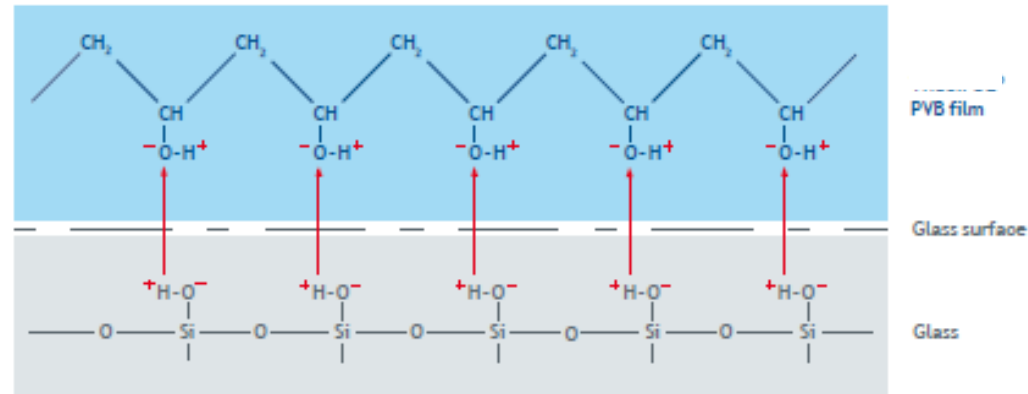
The Classic Laminating Process



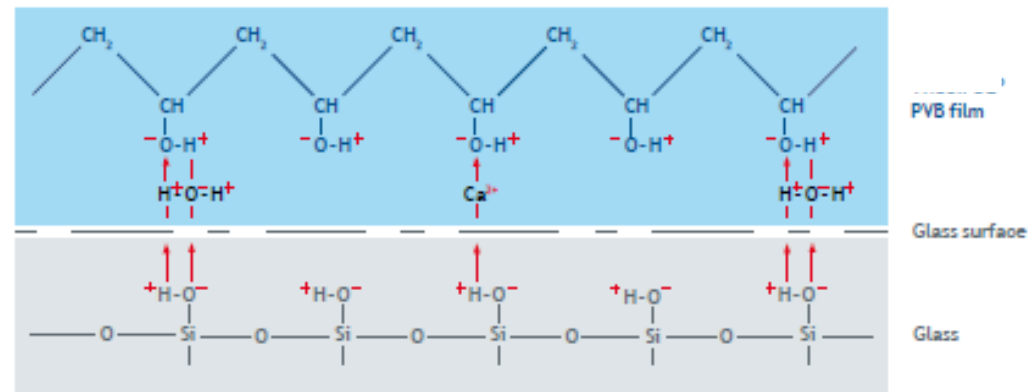
Quelle: Bystronic Armattec

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:
 $\leq 8^{\circ}\text{C}$ (46°F) without regulating the humidity
- Opened:
 $\leq 8^{\circ}\text{C}$ and 25 - 30% rel. humidity

Interleaved with PE film

- Sealed in original packaging :
 $\leq 30^{\circ}\text{C}$ (86°F) for long term storage without regulating the humidity
- Opened:
 $\leq 18^{\circ}\text{C}$ (64°F) and 25 - 30% rel. humidity

Shelf life for unopened rolls - 4 years

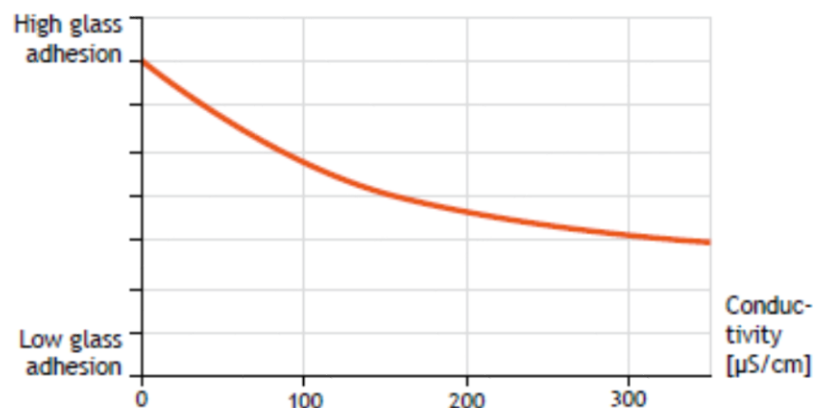
Ions

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

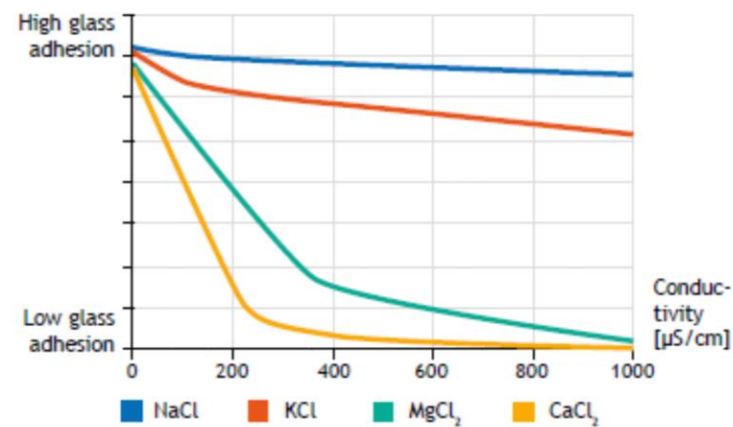
Influence of washing water to glass adhesion



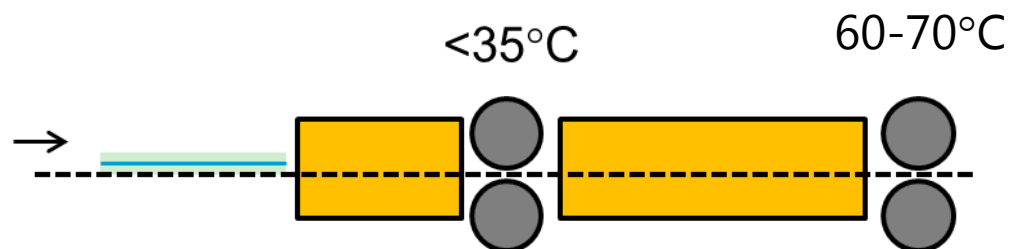
THE EFFECT OF WASHING WATER CONDUCTIVITY ON GLASS ADHESION



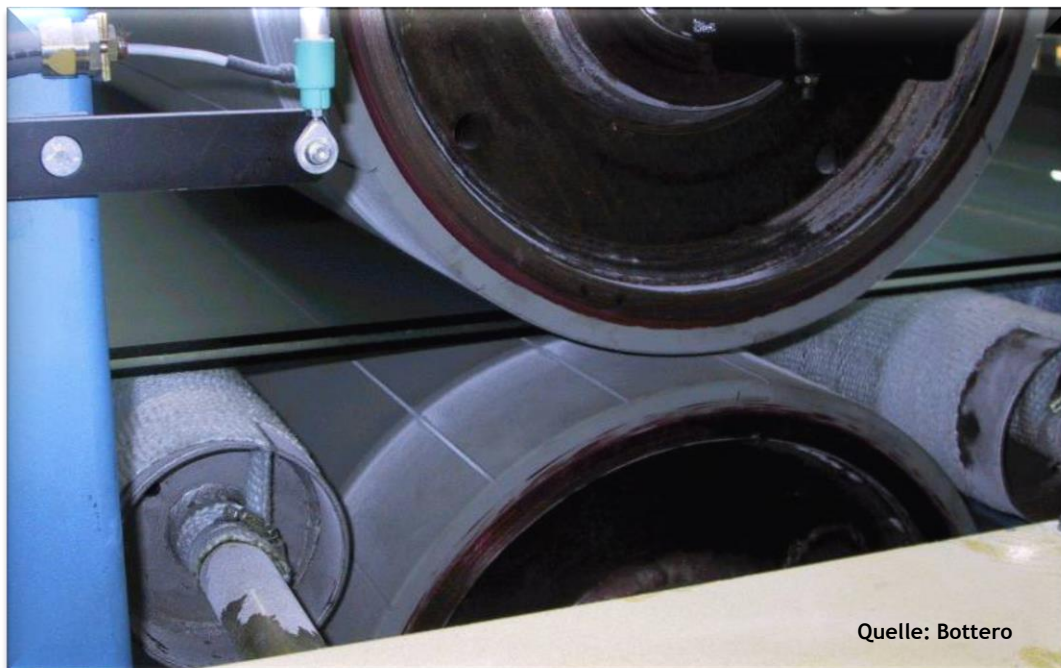
THE EFFECT OF ALKALINE EARTH IONS ON GLASS ADHESION



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



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

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



Quality of Glass - A Tempered Glass Study



Wavy Heat Treated Glass

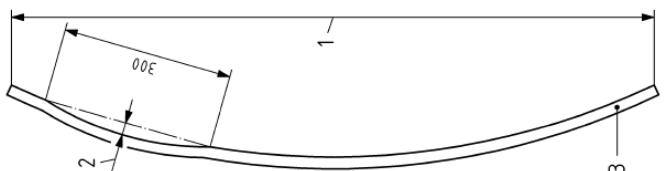
Lamination of heat treated glass

- The flatness of the individual lites is critical

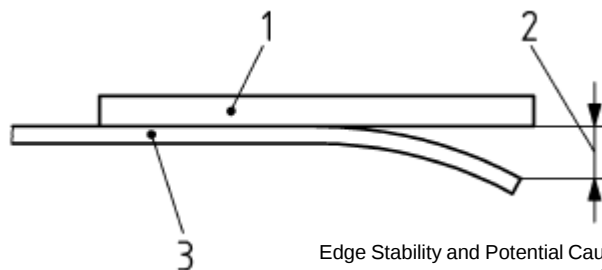
- Waviness



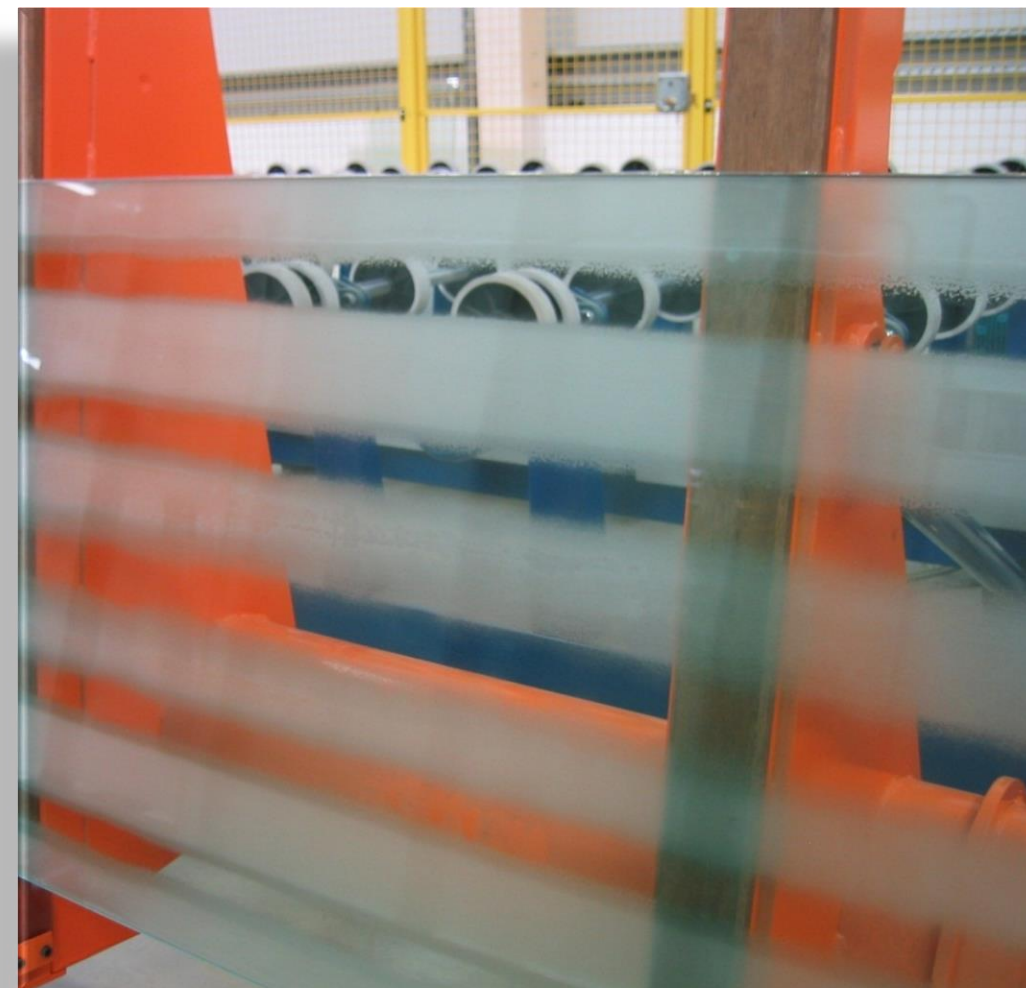
- Local and general bow



- Edge Curl

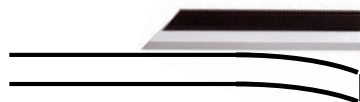


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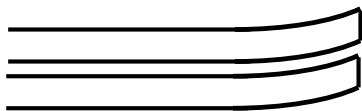
Wavy Heated Treated Glass

- Measuring edge curl

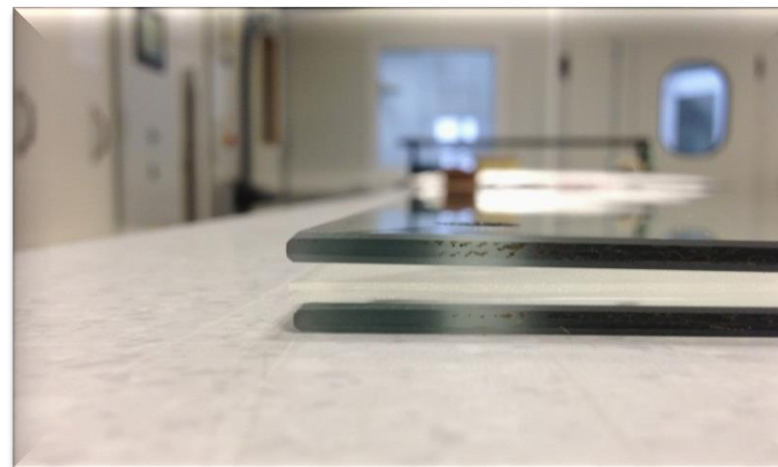
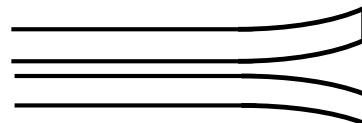


- Two types of edge curl oriented laminates were tested - A & B

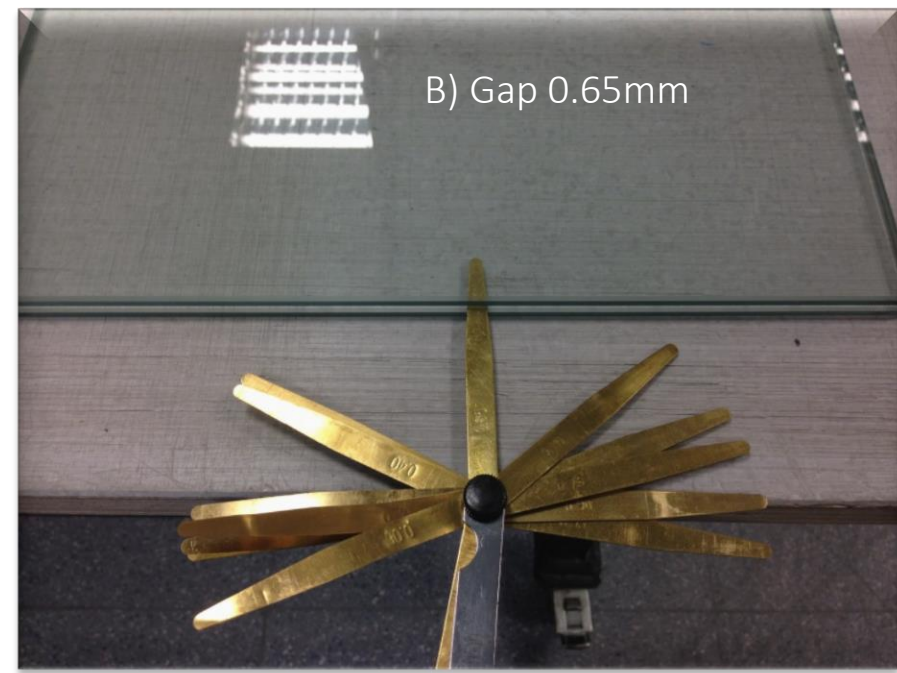
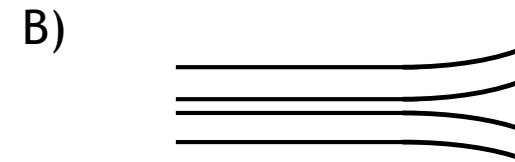
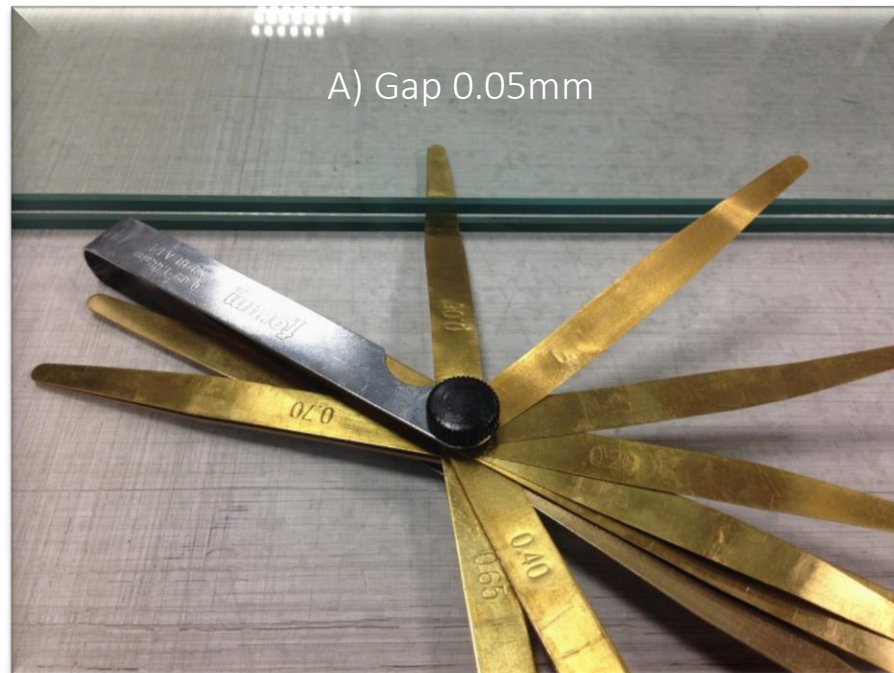
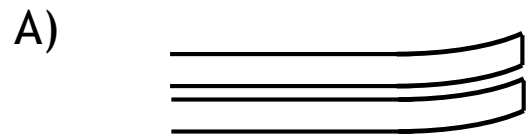
A)



B)

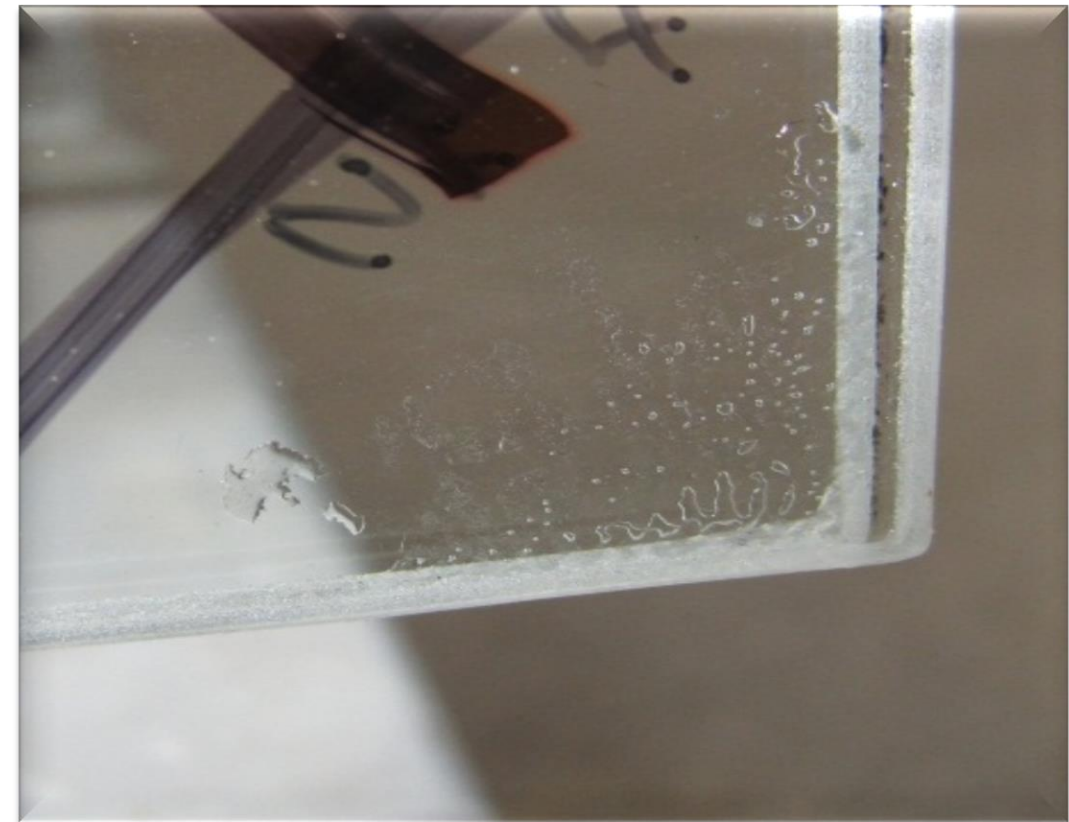


Wavy Heated Treated Glass



Wavy Heated Treated Glass

- Orientation B



After Autoclave

Wavy Heated Treated Glass

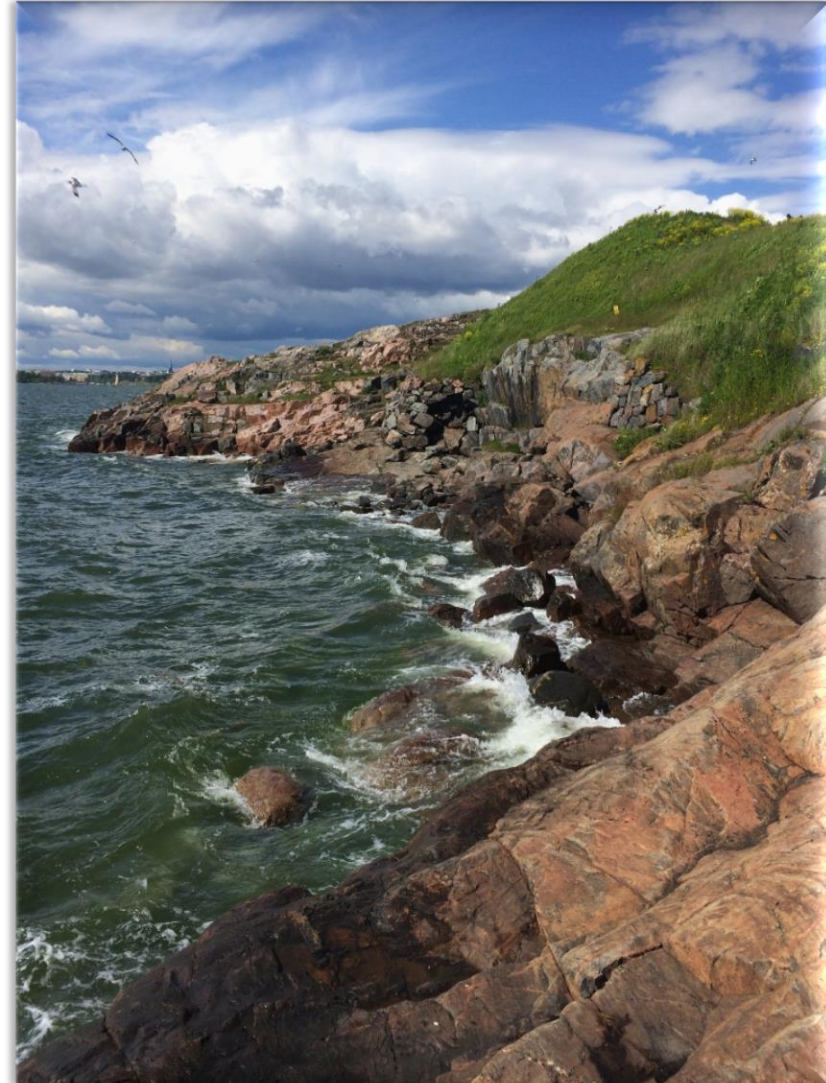
- Orientation B after storage under temperature and humidity (several months at 85°C/85% rh)



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



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

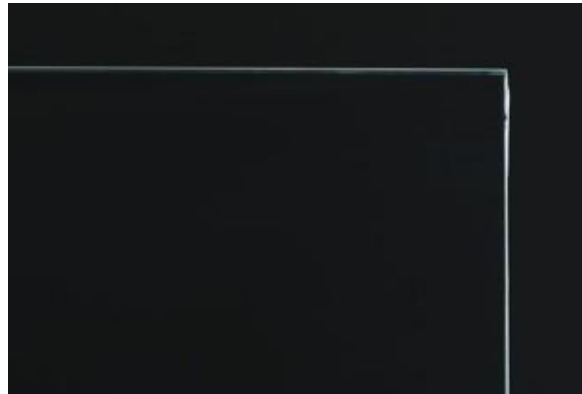
Standard PVB

- After 3,000 hours
- No bubbles
- No delamination
- Cloudiness observed at corners and edges



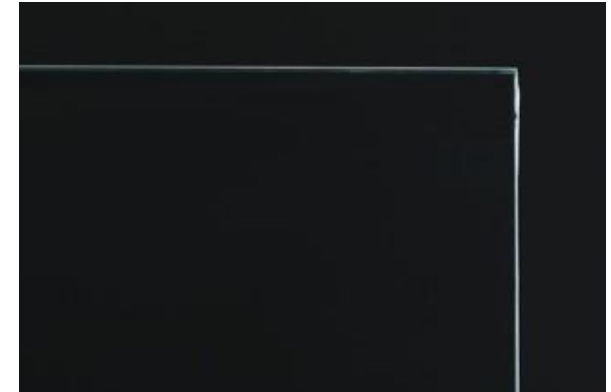
High Adhesion PVB

- 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!