

Safety properties of laminated glasses



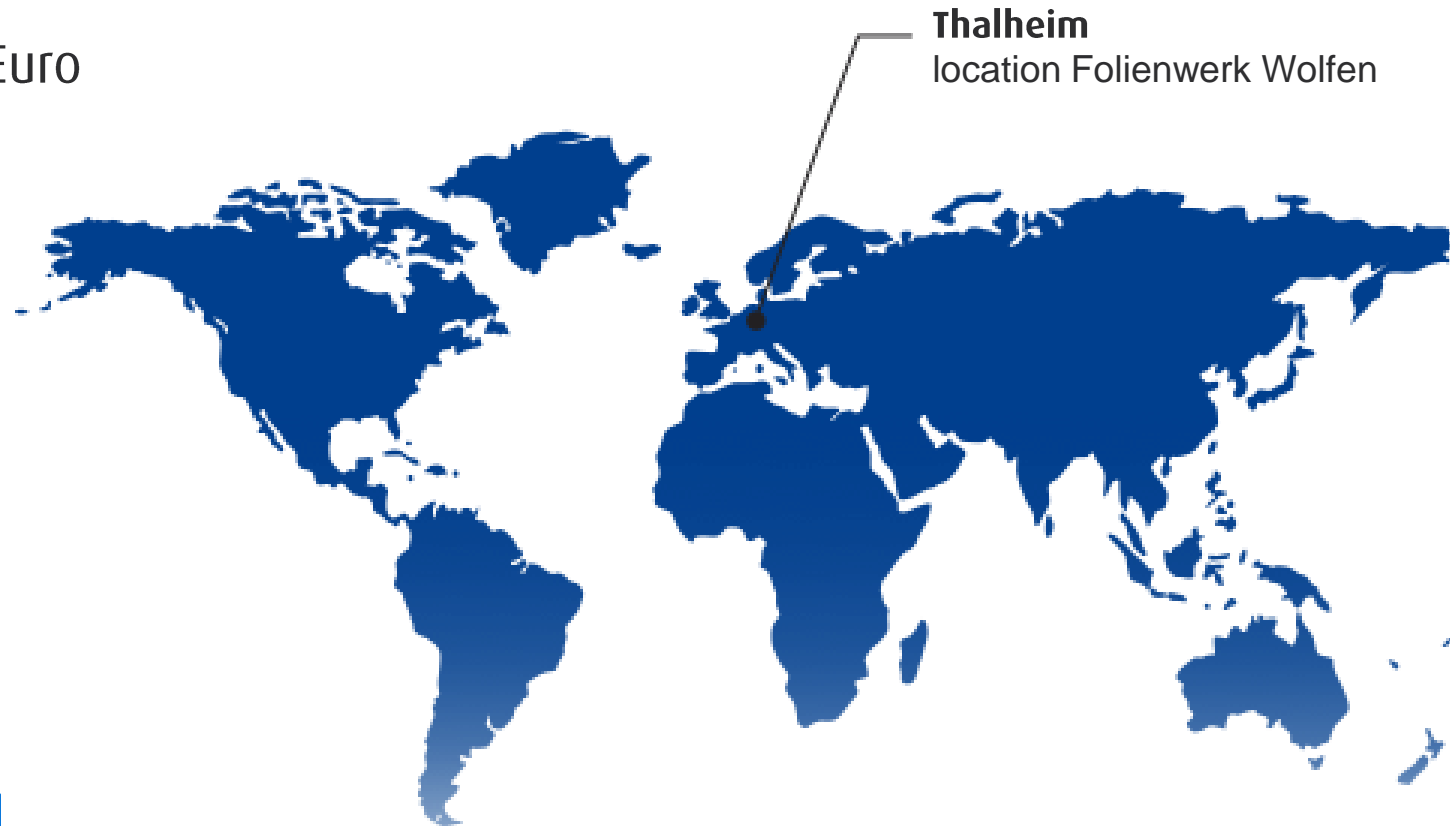
Overview

- Introduction
- Glass laminates
- Common safety tests
- Research project „PV extreme“



Folienwerk Wolfen GmbH: Facts

- 25 years experience in coextrusion of films
- turnover 40 million Euro
- 160 employees
- 7 extrusion lines
- 20.000 t p.a.
- inhouse R&D



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Folienwerk Wolfen GmbH: Product portfolio

- packaging
- print
- medical devices
- card-lamination
- glass-lamination



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Future trends in urban life – smart buildings

- buildings become energy efficient
- façades will harvest energy
- windows can store heat

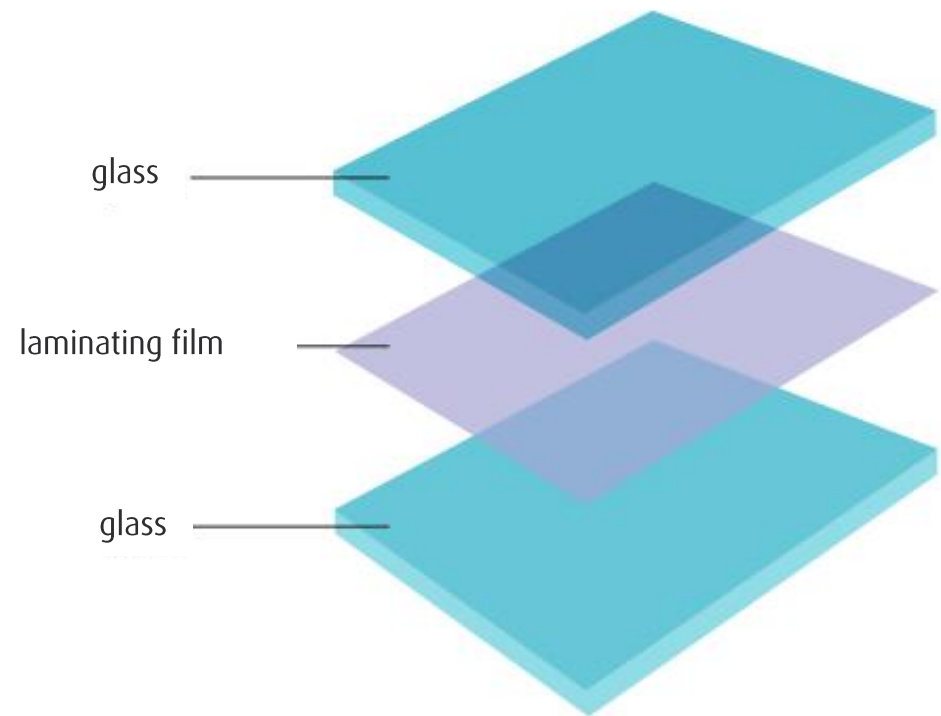


<https://www.honeywell.com/newsroom/news/2015/10/put-your-building-to-work-honeywell-smart-building-score-provides-smart-approach-to-better-facilities-and-business-results>

Glass laminates

What is laminated glass?

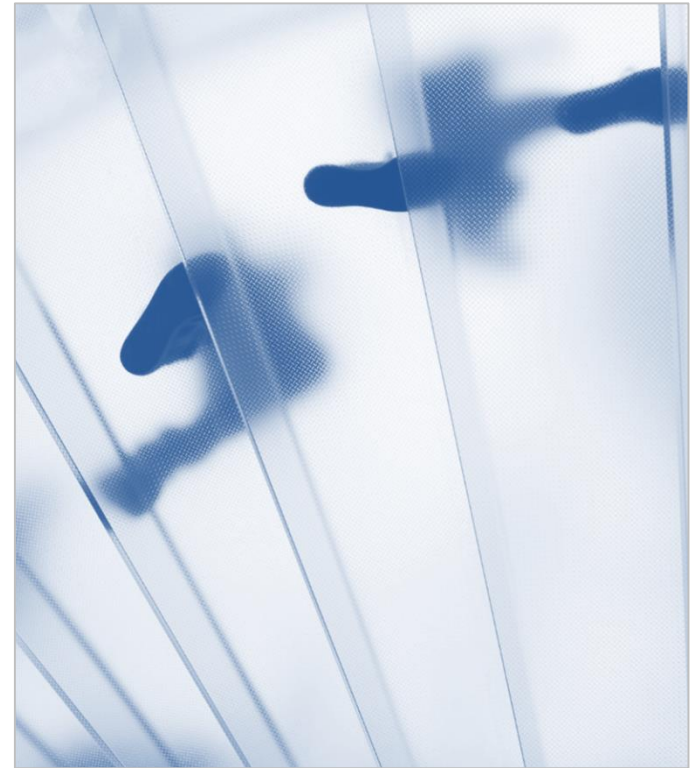
- assembly of sheets of glass joined together with one or more interlayers
- interlayer = laminating film
 - adherence of the glass panels
 - retention of glass fragments



Glass laminates

What opportunities can we get?

- **safety:** shatter protection due to the interlayer
- smart glass: possibility to add functionality
- environmental bonus: weight reduction



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Some common safety tests on laminated glass

Pendulum test

Sand blast

Hurricane resistance

Pummel test

Bullet proof

Peel strength

Bake test

Weight load

Edge stability

Shear modulus

Boil test

Ball drop

Yellowing index

Weathering test

Tornado proof

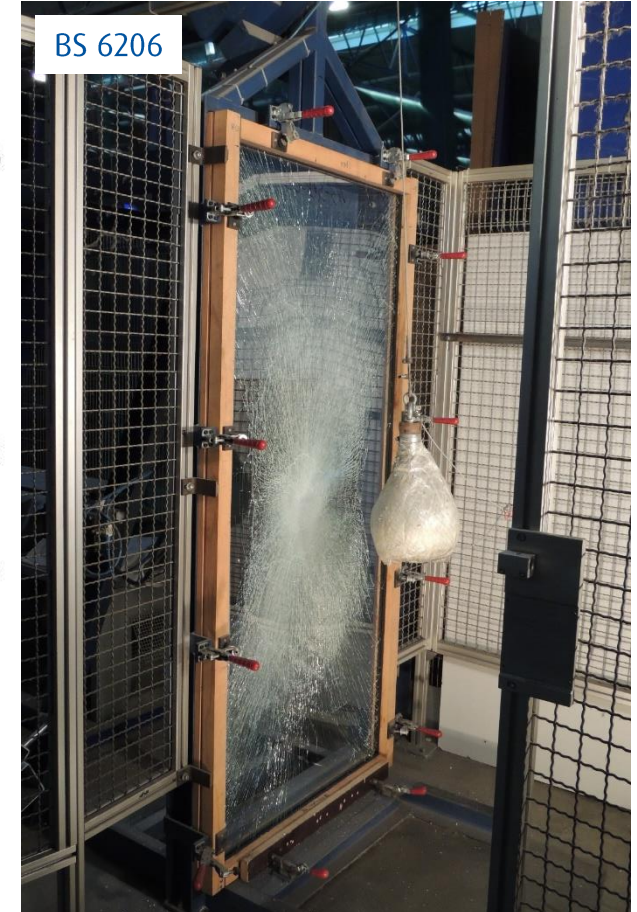
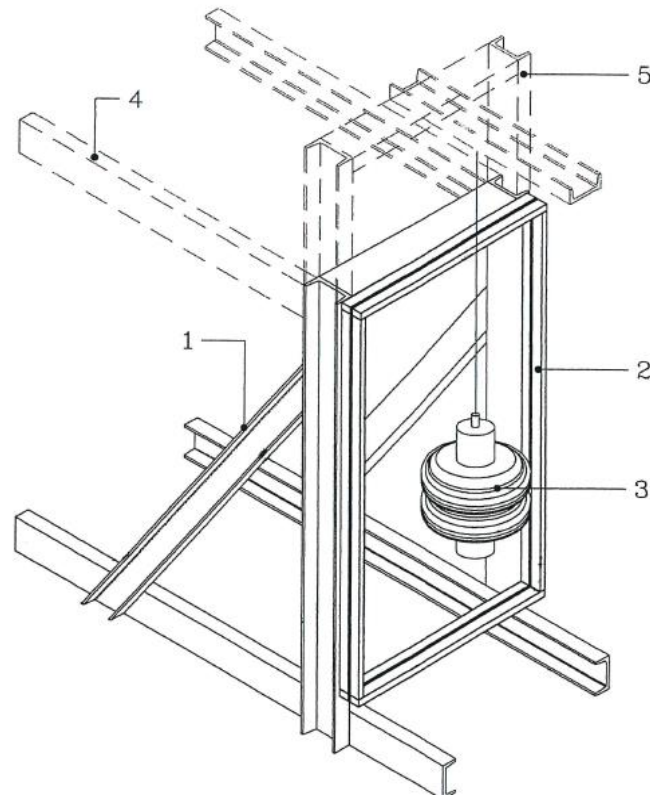


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Safety tests: Pendulum test



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Safety tests: Weight load test

Weight load test of damaged laminated glasses

- load of $0,5 \text{ kN/m}^2$
- set up at beginning

Test was carried out at
Labor für Stahl- und
Leichtmetallbau GmbH,
Munich



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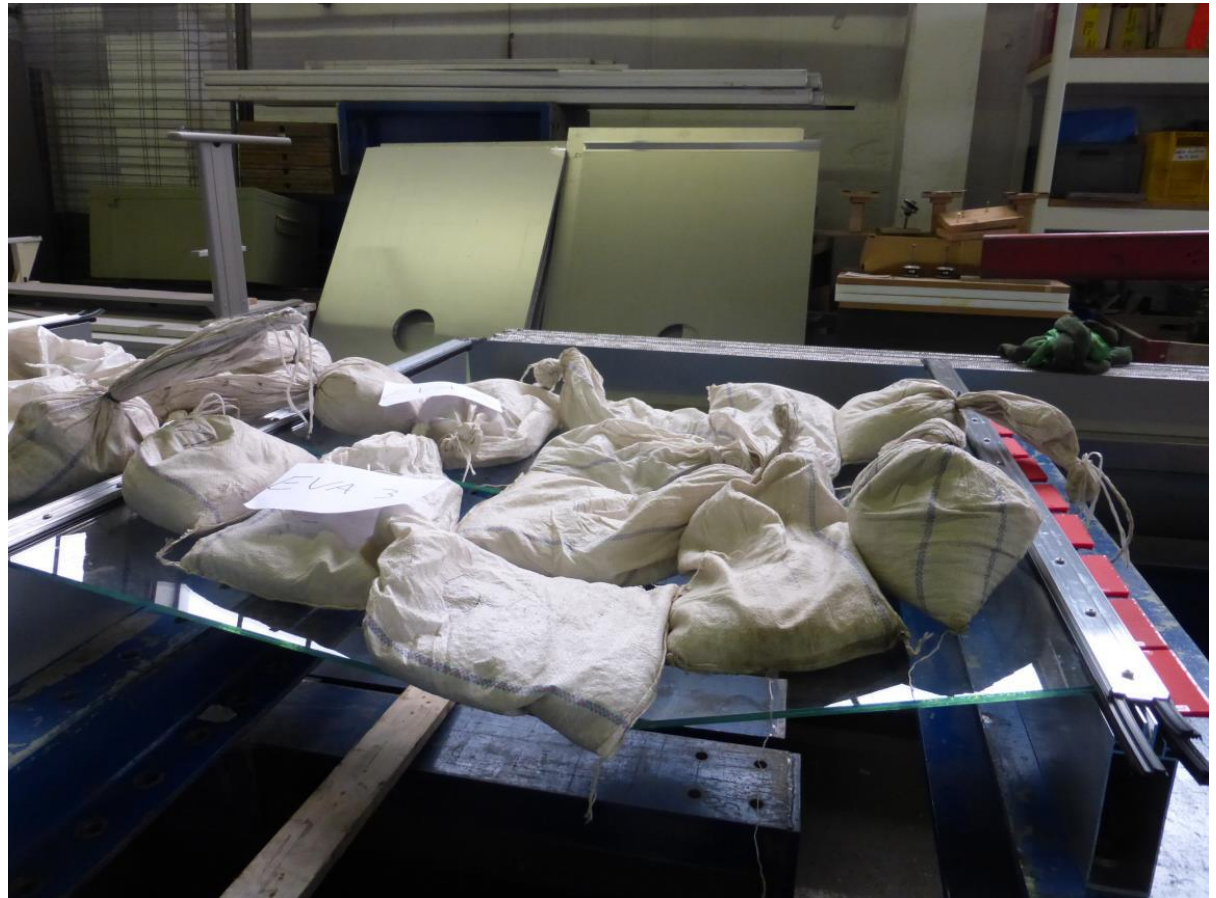
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Safety tests: Weight load test

Weight load test of damaged laminated glasses

- load of $0,5 \text{ kN/m}^2$
- set up after 24 hours

Test was carried out at
Labor für Stahl- und
Leichtmetallbau GmbH,
Munich



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Safety tests: Ball drop test

Ball drop test following several international standards

- following the requests of burglary-proof, safety, construction or ballistic scenarios
- different heights and ball dimensions
- example: EN 356 classification



evguard® laminating film

- EVA film for glass lamination
- Developed and produced by Folienwerk Wolfen GmbH
- Made in Germany
- European raw material sources
- certified company and product
- unique product due to crosslinking



DIBT certified Z-703-238



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Research project: PV extreme

Ageing performance

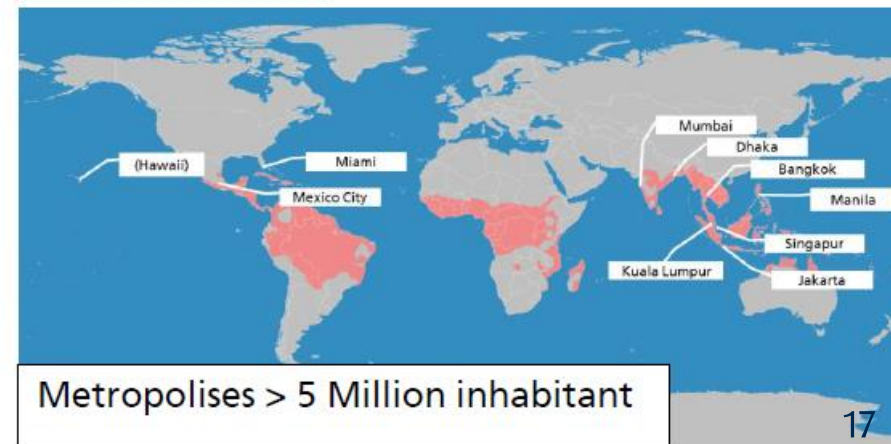
- development of test program for harsh environment
- long term behavior of laminated glass under desert and tropical climate conditions

In cooperation with
Fraunhofer CSP, IMWS (Halle/Saale),
financial support by
Federal Government of Saxony-Anhalt
and European Union

Desert / Dry Climates



Tropical Climate



Summary

- several safety tests needed for laminates, depending on governmental or industrial requirements
- **evguard®**, the EVA laminating film made by Folienwerk Wolfen GmbH, the certified product for laminated safety glasses
- Folienwerk Wolfen GmbH participates on research projects for new technologies



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Many thanks for your attention!

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