Handling guide
evguard® laminating film

1. Introduction

evguard® laminating film is an elastic interlayer for laminating glass. Based on ethylene vinyl acetate copolymer, under temperature influence a highly cross-linked, three-dimensional composite layer forms between the panes that serves as a backbone in laminated or safety glass.

evguard® **laminating film is suitable for:**

→ the manufacture of ballistic and safety glass,
→ laminated glass with acoustic properties and insulation values,
→ decorative interlayer, e.g. coloured or sensitive switchable films,
→ encapsulation of photovoltaic modules.

evguard® laminating film has been developed in Germany. Laminated glass manufactured with it has been tested both in Europe and in climatically more demanding regions of the world.

We aim to provide you with the necessary information for the manufacture of laminated glass in order to meet the highest requirements for your special applications. Through constant research works, we keep on enhancing **ev**guard® according to your requirements.

Please follow our guidelines for the manufacture of laminated glass.

2. Advantages of **ev**guard® **laminating film**

→ "Made in Germany", produced from raw materials of European suppliers
→ certifiable for laminated safety glass (test certificates are available upon request)
→ lamination in a broad temperature range is possible, starting at 105 °C (220 F)
→ easy processing, both vacuum lamination and autoclave (pre-lam nip roll)
→ convincing clarity of laminated glass
→ good adhesion to glass and many other materials
→ non-hygroscopic, especially compared to PVB films
→ available as clear or milky-white film
→ logistic advantages, especially for Central Europe

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3. Key properties

evguard® laminating film is delivered in rolls.

Dimensions		
Film width	1,260 mm (49.61 ins)	
	2,250 mm (88.58 ins)	customized dimensions possible
Film thickness	0.380 mm (0.015 ins)	
	0.760 mm (0.030 ins)	
Film density	0.96 g/m³	

0,380 mm (0.015 ins)

This is the thinnest film thickness at the moment. The **ev**guard® laminating film is recommended for thinner glass laminates, and less for toughened glass. It is perfectly suitable to laminate decorative interlayers into the glass. Due to its excellent optical properties you can also use this thickness of **ev**guard® for the encapsulation of solar cells in photovoltaic modules.

0,760 mm (0.030 ins)

This **ev**guard® laminating film has a higher mechanical strength and is perfectly suitable for laminating thick glass panes or uneven surfaces. As with film of this thickness voids or unevennesses can be filled well. The use of this type of **ev**guard® helps to reduce the risk of subsequent delamination or shearing.

4. Storage guideline

→ maximum storage temperature 30 °C (85 F) at a humidity of approx. 50 %
→ no cold storage room required for storing the rolls
→ minimum shelf life of the unopened roll: 6 months from delivery
→ close packaging after cutting, to protect the **ev**guard® laminating film from dust, direct sunlight, heat and high humidity
→ do not touch the film with bare hands, use gloves as skin eliminations and natural greases can reduce the adhesion to glass

5. Lamination process

Always work in a clean environment to avoid dust and possible chemical contamination. Implement a quality control plan, if possible.
Due to its excellent melting behavior, **ev**guard® laminating film can be cross-linked over a broad temperature range from 105 °C (220 F) up to at least 150 °C (300 F). Cross-linking already at low temperatures enables you to work with temperature-sensitive inter-layers like switchable LC films. Lamination at high temperature allows short processing times and with it a high productivity.

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Preparation of laminates

Clean and dry surfaces are the basis for good adhesion. Clean the glass surfaces. It is advisable to use a glass washing machine, we recommend using water with a conductivity of < 7 μS in a washing cycle at approx. 65 °C (150 F). If you clean the glass surfaces by hand, use tenside-free cleaning agents. Make sure the glass is completely dry after the cleaning process.

Place the layers of **ev**guard® laminating film between the requested glass panes. Trim the overlapping film with a sharp knife before laminating.

Temperature profil

Due to the different lamination processes, we can only give recommendations regarding the safe implementation of the lamination process. Please be aware that there can be significant differences between the set temperatures and the real temperatures. The temperature distribution inside the laminator or the lamination oven depends on different parameters, for example heating capacity, airflow and air duct, mass and thickness of the glass to be heated or the type of vacuum bag used.

The following temperature values are related to the temperature of the glass inside the laminator or the lamination oven, not to any set-up temperature values or values measured away from the glass. As shown in Fig. 1, temperature differences up to 20 °C (70 F) are possible. Figure 1 contrasts the "set" temperature with the "real" temperature measured at the glass.
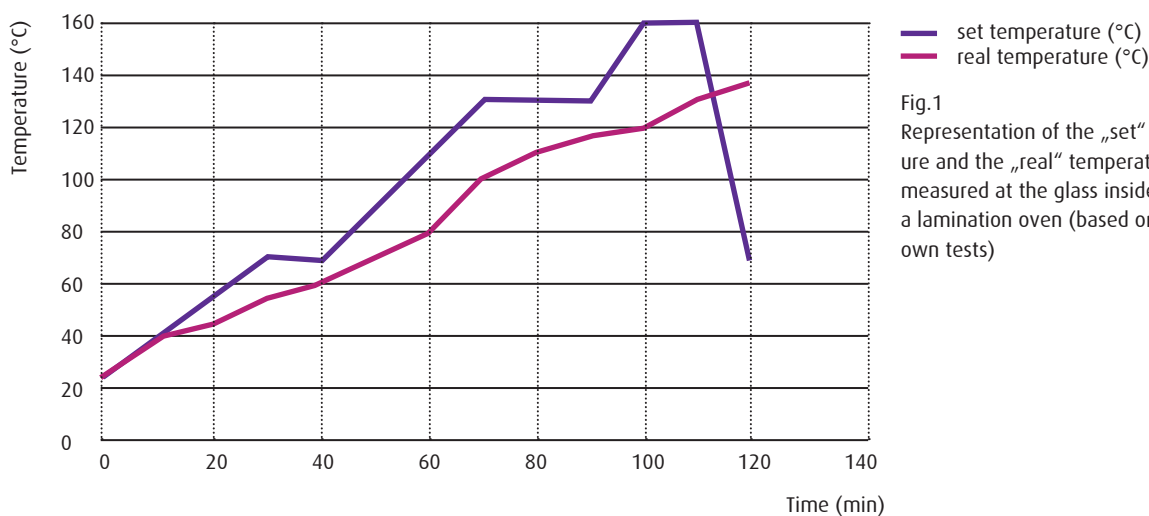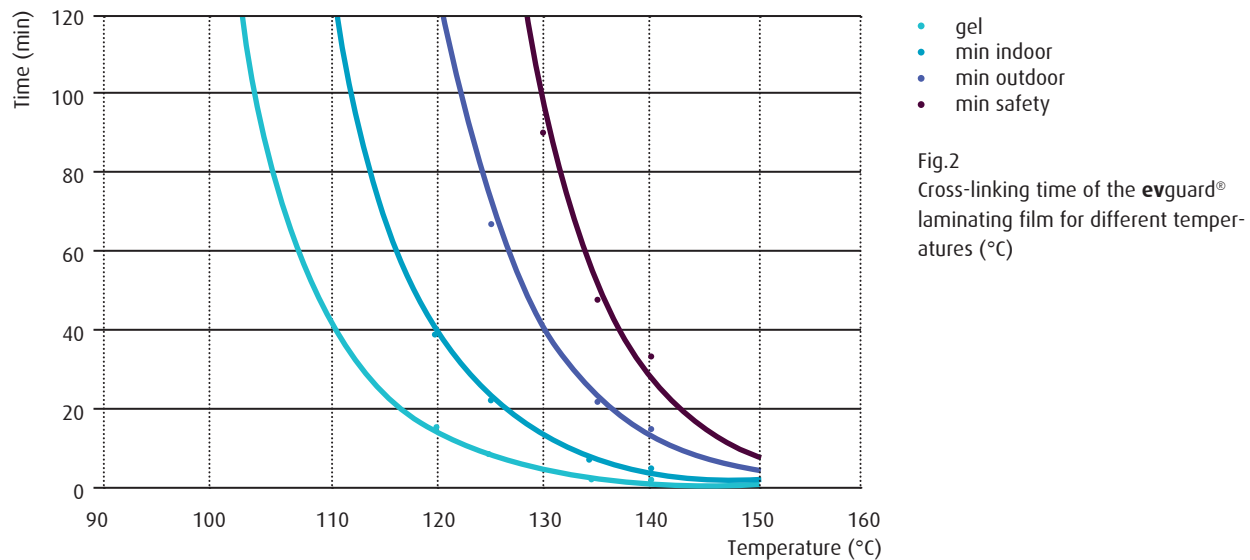

set temperature (°C)
real temperature (°C)

Fig.1
Representation of the „set" temperature and the „real" temperature in °C measured at the glass inside a lamination oven (based on own tests)

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Cross-linking time

Under temperature influence, a reaction is started in the **ev**guard® laminating film leading to the formation of a three-dimensional structure that provides the laminated glass with the requested properties. In the following figure, instructions for temperature control of the lamination process are given.

- gel
- min indoor
- min outdoor
- min safety

Fig.2
Cross-linking time of the **ev**guard® laminating film for different temperatures (°C)

Example – How to use Fig. 2
Manufacture of a laminated glass including a temperature-sensitive interlayer

If the maximum process temperature for the interlayer is 125 °C (255 F), the following holding times are advised.

	description	lamination time (at 125 °C (255 F))
• **gel point**	The laminated glass becomes transparent.	> 10 min
• **indoor**	The laminated glass can be used for interior use with low exposure to UV radiation and humidity.	> 23 min
• **outdoor**	The use of the transparent laminated glass in outdoors with middle exposure to UV radiation and humidity is possible.	> 68 min
• **safety**	The transparent laminated glass has properties of a laminated safety glass.	> 180 min

For the production of transparent safety class, lamination at a temperature of 130 to 145 °C (265 – 295 F) is recommended.

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Vacuum lamination

For the manufacture of laminated glass with the vacuum method you need the following materials:
→ two or more glass panes of the same size
→ a vacuum bag, i.e.a silicon rubber sheet, larger than the glass panes
→ peel ply and breather to protect the silicon rubber sheet
→ temperature-resistant lamination tape

Please also follow the information of your lamination equipment supplier.

Place the **ev**guard® laminating film between two or more glass panes. Please only use clean antistatic gloves while working to keep the panes free from dust and fingerprints. Seal the edges with the laminating tape. The better you do this, the less cleaning you have after the successful lamination.

An efficient vacuum is required to get rid of the air from the laminate. The specially developed surface of our **ev**guard® film helps in doing so. Please make sure that a vacuum below 30 mbar (0,435 psi) is reached. Once the vacuum pump is switched off, the vacuum should not increase above 70 mbar (1 psi) within 2 min. Set the laminating program according to the times and temperatures from the diagram curves for the glass surfaces.
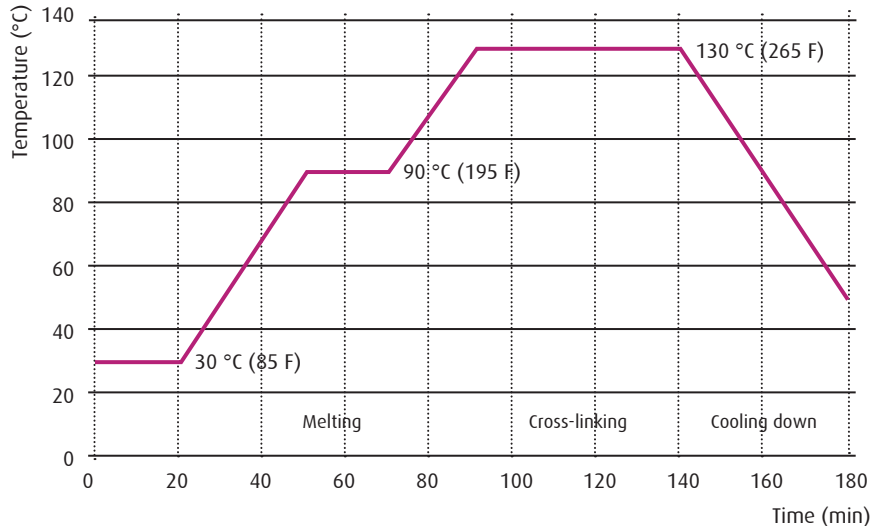
The **ev**guard® laminating film melts at a temperature of at least 70 °C (160 F). Cross-linking starts above 100 °C (210 F). To avoid bubbles in the glass and to reach an even melting and distribution of the **ev**guard® laminating film in the laminate, we recommend holding the temperature for a short time between the melting and the cross-linking temperatures. It has proven effective to hold the temperature at 90 °C (195 F). The thicker the glass pane, the longer holding time is advised (this also helps to distribute the heat on the entire glass surface). After this, you may set the required lamination temperature. Once the glass temperature reaches the required temperature, you should hold this temperature for the time recommended in Fig. 1 to finish the cross-linking process according to your requirements.

Generally the lamination process can be divided into different phases:

Removing entrapped air at room temperature	15 min	no heating
Heating up the glass for melting the laminating film	25 min	heating up to 90 °C (195 F)
"Melting" – step for removing entrapped air and for melting	20 min	hold at 90 °C (195 F)
Heating up to the requested cross-linking temperature		
"Cross-linking" – cross-linking (time according to Fig. 2)	50 min*	hold at 130 °C (265 F)
"Cooling down" – cooling down the laminated glass (vacuum no longer required)		

*3 to 6 mm (0.117 – 0.234 ins) thick glass

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— Temperature (°C)

Fig. 3
Typical lamination process
using **ev**guard® laminating film and
3 to 6 mm (0.117 – 0.234 ins) thick
flat glass

You can use the presented temperature program as a starting point for your lamination with **ev**guard®. In the vacuum lamination process, the heat-up phases are related to the heating capacity of your lamination oven. Please check the instruction manual of the equipment for corresponding information. To avoid the entry of air, we recommend maintaining the vacuum from the start to the end of the phase "cross-linking".

evguard® laminating film can be used for sensitive inter-layers such as printed decorative films or electrically switchable LC films. The cross-linking has to be done at lower temperatures to reduce the risk of damaging these materials. Please be aware of the necessary longer time for the cross-linking.

Thicker glass also needs a longer cross-linking time.

We recommend the following times:

flat glass thickness	time and temperature
8 mm (0.312 ins)	60 min at 130 °C (265 F)
10 mm (0.390 ins)	70 min at 130 °C (265 F)
12 mm (0.468 ins)	80 min at 130 °C (265 F)
15 mm (0.585 ins)	95 min at 130 °C (265 F)

Autoclave (pre-lam nip roll)

This process is commonly used for the manufacture of laminated glass by using PVB (polyvinyl butyral) film. The **ev**guard® laminating film is also very suitable for processing in the autoclave process.

The autoclave process typically contains the following steps:
→ cleaning of the glas**s** using a washing machine
→ placing the films between the glass
→ manufacture of a pre-lam by nip rolling
→ lamination of the glass in the autoclave

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The cleaning of the glass and the placing of the films are as usual. When using **ev**guard® laminating film, you should reduce the temperatures of the pre-press process by approx. 5 °C (40 F) compared to the usual PVB program for the manufacture of the pre-press.The temperature of the glass at the end of the pre-press process should be between 50 and 65 °C (120 – 149 F) depending on glass thickness.

Laminated glass to be manufactured with **ev**guard® can be laminated together with laminated glass containing PVB in the autoclave. You may use your standard autoclave program. Please bear in mind that the holding time should be long enough for a sufficient cross-linking of the **ev**guard® laminating film (see Fig. 2).

Trouble shooting

Glass is hazy	Check the temperature and holding time of the glass in the lamination oven. Probably the temperature was too low or the holding time was to short. Increase temperature or holding time.
Glass is cloudy	The temperature distribution in the lamination oven may be uneven. Measure the temperature on various points of the oven (on the glass) or contact the supplier of the equipment.
Glass is having brown or black spots	Check the temperature program of the lamination oven. Maybe there are temperature peaks or regions with overheating. The temperature might also have been too high or the holding time too long.
Bubbles in the glass	Check the vacuum system for leaks. If there is sufficient vacuum, we recommend to extend phase "Removing entrapped air at room temperature" or phase "Melting".
Insufficient adhesion	Check your glass cleaning process and refer to our recommendations on water quality. Also check the storage conditions and shelf life.
Particles between the panes of the glass	Check the glass cleaning process and the exposure to dust in the whole production process.

We are available to assist you in the processing of our films.

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