The pros and cons of toughened thin glass for solar panels

A glass-glass-module based on thin toughened glass on the front and back of a solar photovoltaic module can have a dramatic impact on its environmental capabilities. Johann Weixlberger* and Markus Jandl** explain.

Since the world faces increased challenges in renewable energy recourses, all kind of aspects come into play of not only cost-effective but also energy effective manufacturing methods for photovoltaic (PV) modules, reducing carbon emissions and optimised energy harvesting properties.

Conventional approach

Today's conventional crystalline PV module manufacturing process involves three major 'energy spending materials' – silicon as cell material (mono - as well as poly crystalline), glass and backsheet as encapsulation materials and finally framing and substructure material (typically aluminium).

Several institutions are working on new approaches for poly-silicon production. This paper focuses on encapsulation material and - as 'added value' - on framing and substructure.

As glass is the proven 'face' of a PV module, absorbing the first portion of sun radiation, efforts towards minimising this absorption are of interest. Low iron content of glass and anti reflection coatings are proven concepts; thinner glass was limited by manufacturing processes such as thermal toughening to around 3mm.

Any additional reduction could bring a portion of transmission efficiency, thus a reasonable amount of payback over the lifetime of a PV module.

Thin glass approach

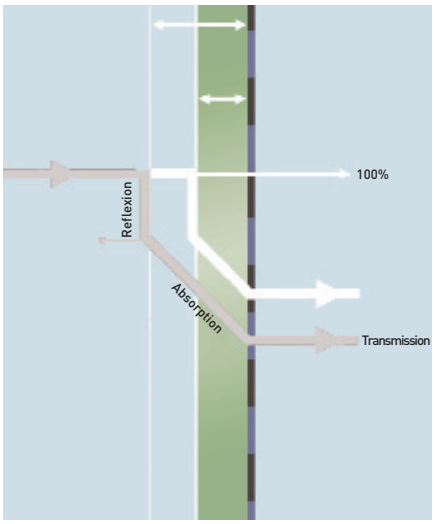
The commercial availability of 2mm thermally toughened ultra clear glass is an enabling tool for this route.

Float glass as well as patterned glass with these properties is largely available today and has experienced strong capacity growth.

In terms of cost reduction, glass with side 2mm offers the highest potential in respect of reduced material versus increased effort and costs for handling and breakage.

Going any thinner might not be feasible from today's point of view.

Toughened glass is competitive when comparing 2mm glass in terms of cost with conventional backsheet materials.



▲ It makes sense to consider glass as a backsheet replacement.

As glass is a proven, long-lasting, stable and hermetic resistant material it makes sense to consider it as a replacement of backsheet material – along with a hermetic edge sealing, it is the choice for new PV modules.

Advantages

- Transmission – thinner glass provides higher transmission efficiency.
- Module thickness – 5.5mm overall thickness.
- Module weight – less than 10kg/m².
- Hermeticity – glass is excellent in this respect to humidity, gases.
- Frameless – suits backrail mounting solution, thus BIPV applications.
- Less energy input into materials used for encapsulation.
- Unique mechanical properties due to symmetrical laminate, which enables even bending of modules without cell breakage.

Energy balance

To specify the energy savings in this configuration only the encapsulation material was compared (no cells and embedding foils were considered).

The energy consumption for producing float glass is well known (2.5kWh/kg) and can easily be scaled for 2 x 2mm (front and back = 12.5kWh) in comparison to 1 x 3.2mm (front only = 20kWh).

The same applies for the thermal toughening process (0.3kWh/kg glass).

The amount of energy for a typical backsheet was evaluated with approximately 14kWh/m² and aluminium frame elimination – just acc. aluminium melting process – gives another 32kWh for a typical 2.5kg of aluminium/m² of PV module.

This calculation gives 56% lower energy consumption for raw material production for a glass-glass-module compared to a conventional glass-backsheet module.

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Any disadvantages?

When looking into the list of features and advantages one might think there is nothing left to be considered as a disadvantage. Costs come to mind straight away – but even there it is proven that this kind of module can be produced in a similar cost range, unfortunately not any cheaper.

Additional features allow higher market prices, thus can be more profitable at the end. Weak aspects can be the frameless design – the unprotected glass edge is a critical topic, handling and mounting is not as used to be with framed modules.

This problem is already known with thin film modules, so there is a solution and corresponding awareness needs to be created.

Hermeticity can also be a disadvantage to materials with outgassing properties – anything left within the encapsulation (glass and edge sealant) stays trapped there forever, there is no escape. With materials such as EVA this could lead to bubbles and cell corrosion (acid content cannot diffuse through backsheet).

Energy balance of encapsulation materials		
module size 1,65 x 0.98m		
	3.2 Glass-Backsheet	2+2 Glass-Glass
	[kWh]	[kWh]
Frontglass 3,2 mm	20.0	
Frontglass 2 mm		14.0
glass tempering	2.5	1.5
Backsheet	14.0	
Backglass		14.0
Frame (Edge sealant)	32.0	0.5
Total (kWh)	**68.5**	**30.0**
	56% energy savings	

▲ Table 1. Energy balance - not considering cells and embedding foil materials.

Outlook

Considering the cost pressure from Chinese module manufacturers, it is essential to work on further cost reductions and to also consider the environmental impact of overall module production. Energy consumption is a major topic in respect to CO_2-footprint, influencing the total environmental balance. If an advantage can be gained along with other multiple features such as enhanced lifetime through hermetic encapsulation and lower weight with reduced substructure, there is no reason not to switch towards this technology.

The trend is showing increasing demand so efforts should be made to introduce glass-glass modules for crystalline technology. ■

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