

glasstec 2016: Professional Article No. 2

The future of quality insulation glass is multifunctional

Is there any way to enhance the technical properties of contemporary quality insulation glass, i.e. its Ug value, light transmission and sound absorption? Several major forums are currently discussing the limits of feasibility and realism. The good news is that there is no shortage of ideas. But what will prove to be feasible in the future?

Several years ago the question was asked whether triple glazing might also be an unrivalled option on large surfaces. Since then it has become the most common standard in quality insulation glass. But is there really no alternative?

Requirements on quality insulation glass are continually rising, particularly in legislation. Moreover, the manufacturing industry is increasingly faced with the issue of multifunctionality, i.e. the need to create smart window and façade glass which can preserve heat, use solar radiation, insulate sound and warrant security. Says Albert Schweitzer, sales manager at arcon Flachglas-Veredlung GmbH in Feuchtwangen: "In insulation glass with standard triple glazing and low-emission layers, a Ug value of 0.5 W/(m²K) must be seen as the end of the story – for the time being, at any rate."¹⁾

Current state of the art

The current standard is a 4/4/4 design, filled with argon gas and with Ug values of 0.5 to 0.6 W/(m²K). Some manufacturers use krypton for the space between the glazing layers, an inert gas which, according to their data sheets, has a Ug value of 0.4 W/(m²K). These are certainly the best values that can be achieved at the moment.



Messe Düsseldorf GmbH
Postfach 10 10 06
40001 Düsseldorf
Messeplatz
40474 Düsseldorf
Germany

Telefon +49 (0) 2 11/45 60-01
Telefax +49 (0) 2 11/45 60-6 68
Internet www.messe-duesseldorf.de
E-Mail info@messe-duesseldorf.de

Geschäftsführung:
Werner M. Dornscheidt (Vorsitzender)
Hans Werner Reinhard
Joachim Schäfer
Bernhard Stempfle
Vorsitzender des Aufsichtsrates:
Thomas Geisel

Amtsgericht Düsseldorf HRB 63
USt-IdNr. DE 119 360 948
St.Nr. 105/5830/0663

Mitgliedschaften der
Messe Düsseldorf:

 The global
Association of the
Exhibition Industry

 AUMA Messe-Ausschuss der
Deutschen Wirtschaft

 FKM – Gesellschaft zur
Freiwilligen Kontrolle von
Messe- und Ausstellungszahlen

Öffentliche Verkehrsmittel:
U78, U79: Messe Ost/Stockumer Kirchstr.
Bus 722: Messe-Center Verwaltung

Yet another crucial point in triple glazing has always been its substantial weight of 30 kg/m² and the resulting problems in transportation and installation. It's a problem which has been highlighted by window manufacturers for quite a while. So what might be possible solutions?

“Vacuum windows”

Vacuum insulation glass (VIG) with its low E-coating and Ug values of 0.3 W/(m²K) has been under discussion for many years now as a smart, lightweight alternative, although it is still not available as a marketable product. Weighing about 50% less than triple glazing, such insulation glass was clearly in the lead. Various research teams – also in Germany and Switzerland – were given the task of eliminating the blatant weakness of the glass, e.g. in the edge seal of VIG, and of paving the way for mass production. The VIG project ran from 2004 to 2006. Another project, entitled Production Engineering for Vacuum-Insulated Glass (ProVIG) ran from 2007 to 2011, sponsored by the German Ministry for Economic Affairs and Energy. The final report has now been available since January 2012. Next, a research project called Winsmart was launched in August 2012, sponsored by the EU with EUR 3.8 million. It is designed to look at all the various multifunctionality aspects of VIG. The results have been impressive, and the project is due to be completed in September 2016.



We do of course need to remind ourselves that vacuum insulation glass has been made and used in Japan (Pilkington) and China (Synergy) for quite a while. Unfortunately, however, such glass has been relatively short-lived until now. 25 years should really be the minimum. One reason has been the inflexible edge seal which was unable to compensate for thermal strain. Since then the Chinese and Japanese have achieved improvements and created an edge seal in parallel with the glass surface and consisting of thin, outwardly protruding sheet metal. This seal is tightly bonded to the glass. The valve is situated in a hole in the VG unit. The filler gas is either argon or krypton, and the outer window pane is a low-E glass. The Chinese company Synergy is currently advertising for its products with a total thickness of 6.2 mm

and a U_g value of $0.3 \text{ W}/(\text{m}^2\text{K})$. East Asian manufacturers even speak of dimensions up to 2.8×1.8 metres.

By now there are also quite a few manufacturers with vacuum façade panels in their product ranges – clearly a sign that lightweight construction is greatly valued in the building industry. Private customers and DIY home-builders, on the other hand, have far less choice in terms of suppliers. In Europe lean VIG panels – made, for instance, by Pilkington – are largely used for the restoration of listed buildings. It means that the general historic impression can be preserved while using the original profiles.

So why has this product still not gained widespread acceptance? The issue has been under discussion in the industry since 2001, and research is still taking place. This shows the complexity of the underlying technologies and the obstacles that need to be overcome. The Winsmart research project, which is still in progress, is seeking to solve the problem of the edge seal through the use of tin. A liquid tin alloy is injected into the edge area between the panes. To create a tight glass-tin seal, the frame is briefly exposed to a suitable electric current. Moreover, the Winsmart project also seeks to ensure multifunctionality.



Nevertheless, there are still doubts about the marketability of VIG. The valve may start leaking, and both the valve and the metallic spacers between the panes are seen by many as vulnerable and visually distracting. Should efforts finally succeed in eliminating all the drawbacks, then it is still in the balance whether a mass product might actually be financially viable. Even Winsmart is assuming that the development will take 5 to 10 years (from 2012) before the project is of a sufficiently high quality in all aspects, so that it can then become standard.

Quadruple glazing – a step in the right direction?

Prof. Franz Feldmeier from the University of Rosenheim says: “This is actually the question we asked ourselves with triple glazing, which is now standard. Quadruple glazing, too, has its advantages and disadvantages, such as thicker edge seals, more weight and, in particular, less daylight and less solar energy. A decision is therefore

required from case to case, weighing the pros and cons. On the one hand quadruple glazing has somewhat better thermal insulation, while on the other hand it has values around $0.4 \text{ W}/(\text{m}^2\text{K})$, which is clearly below those in triple glazing. So there is no clear answer.”²⁾

To obtain genuine benefits, the new quadruple glazing apparently requires new techniques and products, e.g. pre-stressed thin glass, anti-reflexive coatings or indeed pressure compensation. “The solution is obviously neither quadruple glazing nor indeed triple glazing with an extra pane,” Feldmeier continues.

The fact is that quadruple glazing is already available on the market, as SGT GmbH in Tauberbischofsheim has developed a quadruple glazing product based on thin glass, And the technical specifications are impressive: with a structure of 2/2/2/2, 12 mm spaces and a Ug value of $0.3 \text{ W}/(\text{m}^2\text{K})$, its total weight is no more than $20 \text{ kg}/\text{m}^3$.

Critics, however, fear that more glass, more frames and more fittings will primarily mean higher production costs and thus a poorer energy balance for the entire product, so that its excellent Ug values are then rendered irrelevant.

The industry is set to accept this further responsibility. Helped by EU sponsorship funds, it launched a research project in early October 2015. The ambitious character of this project is reflected in a description given by the University of Kassel whose engineering scientists have been asked to handle the question of the eco-balance.

Working under a research project entitled Membranes for Windows (MEM4WIN), set up under the 7th EU framework programme, an eco-balance (LCA) is being set up, accompanying an innovative window system for zero energy buildings. Its purpose is to unite the developments of several project partners from both industry and research. It involves a quadruple glazing unit based on thin glass in conjunction with a shading and light control system made from micromirrors (so-called active windows, INA, University of Kassel) as well as segments using organic photovoltaics, a solar thermal setup and organic light diodes (OLED).”



Ultra-thin glass here means thermally pre-treated thin glass with a thickness of 1.6 mm – the same type of glass that is used on a smart phone. Unlike 4 mm float glass, it is very light – weighing only 15 kg/m² – while also being strong, highly elastic and requiring very few resources. Also, manufacturing costs are apparently 15% lower, and CO₂ emissions 45% less than with similar insulation glass. Here, too, the aim is to reach a Ug value of 0.3 W/(m²K). The opening casement will no longer have a frame. The fittings of the casement are embedded within the insulated edge seal.

In this research project all four panes have single-sided AR coating, and the two inner panes and insides of the outer panes, on the other hand, have low E-coating. The spaces between the panes will be filled with argon. What makes this window a smart window – i.e. a window with its own electric power supply – is the photovoltaic cells printed on it by means of an inkjet printer. This is required to light up the integrated OLEDs, so that the entire surface – which functions as a window during daylight hours – turns into large-scale lighting after dark. The University of Kassel contributes mobile micromirror actuators which provide shading and ensure optimum lighting conditions. The lighting within a room (i.e. the strength and the direction of the light) then depends on the positioning of the mirrors. All this is made possible by nano-imprint lithography. Forming part of the system, solar thermal collectors are used, heating up the process water of the building, both in a residential and commercial property.



Implemented in its current form, a MEM4WIN window will have a total thickness of 70 mm. The edge seal has been designed so that fittings can be attached directly.

The project is due to be completed at the end of March 2016, when it will enter the race for mass manufacturing capability and marketability. By 2021 legislators want to see all construction sites producing zero energy buildings only.

glasstec 2016 will feature a range of solutions and innovations whereby the glass industry is seeking to master future challenges in this segment of highly insulating thermal multiple glazing. The leading global trade fair for the glass industry will be held in Düsseldorf from 20 to 23 September. As well as presenting the entire range of construction glass, the international trade fair will provide a comprehensive overview of the latest production and finishing technologies for display glass. The trade fair – particularly with its special show Glass Technology Live – is an ideal venue for architects, planners and façade builders wanting to gain new ideas and a place that showcases energy-efficient systems and forward-looking multifunctional façades.

Captions:

- *bcgaaghg.png and cibgghjh.png (these images belong together): Depending on the position of the coating, multiple glazing panes are exposed to considerable temperature differences. This usually requires prestressed glass.*

Copyright: Prof. Franz Feldmeier, University of Applied Sciences, Rosenheim

- *SGIC_SCHALLSCHUTZ_GS_Illu_04_RZ.jpg: Soundproof double glazing, SGG CLIMAPLUS SAFE (each with 4 mm basic glass)*
Copyright: SAINT-GOBAIN GLASS DEUTSCHLAND GMBH

- *SGIC_SCHALLSCHUTZ_GS_Illu_05_RZ.jpg: Soundproof triple glazing, SGG CLIMAPLUS SAFE (each with 4 mm basic glass)*
Copyright: SAINT-GOBAIN GLASS DEUTSCHLAND GMBH

- *SGIC_SCHALLSCHUTZ_Illu_05_RZ.jpg: Soundproof triple glazing, SGG CLIMAPLUS SAFE with thin glass)*
Copyright: SAINT-GOBAIN GLASS DEUTSCHLAND GMBH

- *SGIC_SCHALLSCHUTZ_Illu_04_RZ.jpg: Soundproof double glazing, SGG CLIMAPLUS SAFE with thin glass)*
Copyright: SAINT-GOBAIN GLASS DEUTSCHLAND GMBH

- *Fassadenexponat(C)PROFACTOR.JPG: MEM4WIN exhibit at the glasstec 2014 Innovation Stand*
Copyright: MEM4WIN

- *MEM4WIN_Glasstec_Schnittmuster_final.jpg: Structure of a setup involving thermally pretreated thin glass and a variety of coats*
Copyright: MEM4WIN

- *MEM4WIN_logo_1.jpg*

- *THERMOPLUS_Temperaturverlauf.jpg: Text in illustration*
Copyright: Flachglas Markenkreis

- *Audi Akademie RN_0386_gm_003.jpg: Audi Academy, Ingolstadt. The façade of the building was given two types of sun-protection glass. The ground floor has INFRASTOP® Brillant 70/35, a glass with excellent 70% translucence for optimum lighting in the ground floor rooms. On the upper floors the architects decided on sun-protection glass – INFRASTOP® Brillant 50/25. As well as featuring a low level of total energy transmittance (25%), this glass type also persuaded the architects with its good visual impact.*
Copyright: Flachglas Markenkreis, © 2015 RADON photography, Norman Radon



- *BOC 140410-7911.jpg: Bonneshof Office Center, Düsseldorf-Golzheim: The pleated effect that characterises the shapes of the office buildings T.O.C. and B.O.C. creates a differentiated outside structure. On the original building the graphite-black façades were given special emphasis by some blue glass circles and, to provide a contrast, another building was panelled with reflective silvery balustrades. This theme was then varied in the new B.O.C. building.*
- *BOC 140212-0543.jpg: Bonneshof Office Center, Düsseldorf-Golzheim - The transparent structure was given an additional glass shell. Depending on the direction and the interior, the architects used black "photovoltaic panes" and "climate panes" with white print for the secondary façades of the B.O.C. Not only does this produce less heat, but it also creates a pleasant, variable lighting ambience within the building.
Copyright: Flachglas Markenkreis, © Ansgar M. van Treeck, Düsseldorf*
- *GIZ 5 04.jpg: New building created by the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Society for National Cooperation, GIZ) in Eschborn.: The room-high glazing of the flat façades involves the use of impact-proof glass from FLACHGLAS Wernberg. It is a soundproof type of glass, called PHONSTOP® 35/44L. As well as fulfilling its function of being impact-proof (outer pane, VSG), the structure of the glass has good sound insulation values (44 dB) and has impressed both the owner and the architects with its Ug value of 1.1W/m² K, as it meets the required thermal insulation values.
Copyright: Flachglas Markenkreis, © Ansgar M. van Treeck, Düsseldorf*
- *INFRASTOP_45_24_Funktion.jpg: The general principle can be illustrated by the INFRASTOP® III Brillant 45/24 with its sun-protection coating whose outer pane strongly reflects the infrared radiation of the sun. Any loss in heating energy is substantially reduced by the thermal insulation coating of the inner pane. Both effects are enhanced by the spaces between the panes, which are filled with inert gas.
Copyright: Flachglas Markenkreis*
- *THERMOPLUS_III_S3_Funktion.jpg: This principle can be illustrated with THERMOPLUS® III S3 where the heat transfer is effectively reduced by two heat-insulating coats of precious metal and two spaces between panes, filled with inert gas. Further heat is obtained from the sunlight.
Copyright: Flachglas Markenkreis*
- *1.jpg: Casement with double glazing and Super Spacer® hot edge spacer from edgetech Europe GmbH
Copyright © QUANEX-Edgetech Europe GmbH*
- *2.jpg: Double glazing with Super Spacer® hot spacer from edgetech Europe GmbH
Copyright © QUANEX-Edgetech Europe GmbH*
- *2009 10 SS Unit Coopglas end view.jpg: Triple heat-insulation glazing with Super Spacer® hot spacer from edgetech Europe GmbH
Copyright © QUANEX-Edgetech Europe GmbH*
- *E-Quad-Sill-Jamb-Corner-White-SuperSpacer-Triple-MUNTIN2.jpg: EnergyCore® casement, triple heat-insulation glazing with step (from edgetech Europe GmbH)
Copyright © QUANEX-Edgetech Europe GmbH*
- *sash-super-spacer.jpg: Sash door with heat-insulation glazing and Super Spacer® hot spacer from edgetech Europe GmbH
Copyright © QUANEX-Edgetech Europe GmbH*
- *Super Spacer Triples Clean Corners.jpg: Triple glazing with Super Spacer® hot spacer from edgetech Europe GmbH
Copyright © QUANEX-Edgetech Europe GmbH*

¹⁾ Interview in Glaswelt magazine, October 2015



2) Presentation: "Drei sind nicht genug – kommt die Vierscheibenverglasung?"
("Three isn't enough – will we have quadruple glazing"), Glasbau (Glass
Engineering) convention in Dresden, 2015

Sources:

Saint-Gobain glassolutions Deutschland GmbH

Mem4win.eu

Empa.ch

Research Portal of the University of Kassel,

<http://forschung.uni-kassel.de/converis/project/12313>

Daniel Krauß

Brigitte Küppers

Tel.: +49(0)211/4560-598 oder -929

Fax: +49(0)211/4560-87 598

E-mail: KraussD@messe-duesseldorf.de oder

KueppersB@messe-duesseldorf.de



Press Contact

glasstec 2016