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Licht- und Lufttechnik GmbH

Lumira® aerogel

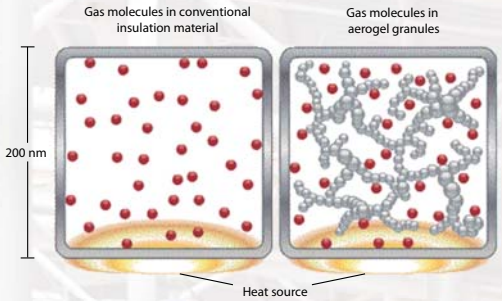
Characteristics of Lumira® aerogel

Lumira Aerogel is a silicate belonging to the product group of Silica aerogels. Aerogel is an amorphous form of silica, which pore structure ranges within nanometers. About 95% of the volume consists of air, making aerogel the lightest solid material of the world. Due to this low solid content and the extremely small pore size (app. 20 nanometers) Lumira prevents very effectively thermal conduction and convection. The amorphous silica is congenitally safe for all uses regarding construction. It is chemically stable and UV-resistant, non-toxic, classified as being non-combustible and not producing any smoke. It is permanently hydrophobic, i.e. water-repellent, humidity-resistant and it doesn't provide any breeding ground for mould or fungus development. Lumira is brightly translucent and doesn't bilge. With silica being an inert material (=sluggish in reaction), the aerogel can be even used and recycled beyond the lifespan of the system. Wherever natural daylighting is desired without wanting to compromise on the building's insulation, Lumira is the material to opt for.

Filled in polycarbonate multi-wall panel as an infill of roof lights, Lumira aerogel is used in ventilation systems, smoke and heat extractors and in façade systems. This unique combination of features offers the possibility to save significantly on weight, without having to dispense with an excellent thermal and noise insulation. Thus making Lumira equally interesting for new buildings and refurbishments alike. Lumira aerogel is certified for the use in polycarbonate panel via the French Avis Technique by CSTB (6706-1699).

Low Thermal Conductivity

The following chart illustrates how Lumira® aerogel works. In conventional matter free atoms are able to transmit heat nearly unhindered through the material in the form of kinetic energy (see chart on the left). By reducing the size of the interspaces (chart on the right) Lumira constrains the mobility of the atoms as much as they can hardly transmit anymore heat through the material. The result is a thermal conductivity value of no more than 0.018 W/(m·K). In comparison:
Concrete = 2.1 W/(m·K), POROTON = 0.08-0.45 W/(m·K), aerated concrete = 0.08-0.25 W/(m·K).



Polycarbonate multi-wall panels filled with Lumira reach a U-value of up to 0.54 W/(m²K) (with 40 mm click panels). Hence, roof and façade elements now allow for taking better advantage of natural daylight at minimal heat losses, which creates an enormous potential of architectural freedom. Building codes are easily met or even surpassed, without having to forego natural daylight (UK: part L; France: RT2005; Spain: CTE, Germany: Passive House Standards).

As the pictures of a thermographic camera illustrate, Lumira filled polycarbonate multi-wall panels have a significantly better thermal insulation in comparison with conventional materials. The reddish, much warmer items are single glazing elements set within a Lumira filled continuous skylight system.

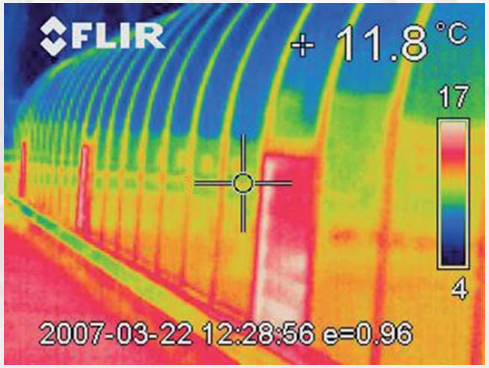


Illustration: Lumira filled roof lights provide a brilliant illumination in all areas of the extensive building of Monkseaton High School in Seatonville, England.

U-values of the various panels:

Plate thickness	Light transmission in % (for transparent multiwall panels)	U-value in W/m²K
10mm	65	2,39
+Lumira	65	1,93
16mm	59	1,82
+Lumira	57	1,31
25mm	40	1,50
+Lumira	32	0,89
40mm	59	1,20
+ Lumira	20	0,54

The respective U-values relate to vertical installation positions. When installed horizontally the U-value worsens in general. The U-value for Lumira® aerogel filled polycarbonate multi-wall panels has been taken from horizontally installed elements, i.e. in the most unfavourable installation position.

Illustration: Volkswagen Group also banks on the advantages of Lumira aerogel.

Excellent Light Transmission and Light Scattering

Natural daylighting provides a pleasant ambiance, which has a positive effect on the mind, the well-being and subsequently also on motivation and commitment. Lumira® aerogel is characterised by an excellent light transmission of up to 90% at 1 cm of thickness. Filled in polycarbonate multi-wall panels, Lumira realises an increase of light incidence of up to 30% compared to the use of opal coloured polycarbonate multi-wall panels.

Most important for many users, however, is the tremendous light scattering. Daylight that penetrates through Lumira filled panels spreads in an even diffusion throughout the building. Glare and direct sunlight are avoided, thus enhancing the lighting conditions and adding to comfortableness within the room. This effect is clearly illustrated by the two following pictures showing a production hall before and after Lumira filled roof lights were mounted. Working in all areas of the hall has become much more pleasant and subsequently more efficient.

Illustration: The Freeman's Quay Swimming Pool and Leisure Centre in Durham: Lumira enables the use of daylight without the annoying glare on the water surface.

Further Benefits of Lumira® aerogel

- Enhanced noise protection: Due to its highly porous structure and the small percentage of solid material within the aerogel, there is only little solid oscillation. Inside the aerogel sound waives travel significantly slower than outside of it (100 m/s in comparison to 340 m/s in the air). This becomes clearly audible especially at low frequencies (40 – 500 Hz), like f.ex. occurring from aircraft or street noise. A 16 mm multi-wall panel filled with Lumira increases the sound reduction value by 3 dB in comparison to a non-filled panel. This value was assessed at Müller-BBM in Munich.
- Reduction of solar transmission: solar shading louvres become redundant thanks to a considerably reduced impact of heat during the summer. Investment and maintenance costs are spared and the design of the building or the look of the façade won't have to be altered.
- Chemically and UV-stable: even after many years of use Lumira aerogel doesn't show any changes in its chemical and physical characteristics.
- Permanently hydrophobic: Lumira is everlasting humidity-resistant. For this reason it doesn't provide any breeding ground for mound or fungus development. This is especially beneficial for the food industries.
- Non-combustible and no smoke development: classification Bs1,0 according to EN 13501-1
- Low weight: 70 – 100 kg/m3: when Lumira is used in multi-wall panels, the wind load of the panels doesn't need to be statically recalculated due to Lumira's low weight.
- Environmental friendly and ecological: less energy is required for heating, air conditioning and lighting. The building's costs for maintenance are saved and the carbon dioxide emission is reduced.

Illustration: Apart from a brilliant light transmission the most important benefit for this airplane hangar is the reduced solar transmission, as it is located in Qatar.

Saving options with Lumira® aerogel on the basis of a sample calculation

According to DIN 4701 a U-value reduction by 0.1 W/m²K saves 0.9 – 1.3 litres of fuel oil or 1.0 – 1.5 m³ of natural gas per m² glazed area. The following calculation illustrates the possible saving potentials per m² glazed area for the various U-value reductions of single glazing and Lumira filled polycarbonate multi-wall panels.

Option 1: 4 mm single glazing: U-value 5.9 W/m²K

Option 2: Lumira aerogel filled 16 mm polycarbonate panels: U-value 1.31 W/m²K

Heat loss wattage Q (kW) = area (m²) · U-value (W/m²K) · difference in temperature Δt (K)

Difference in temperature Δt:

Δt indicates the difference in temperature between the inside of the building and outside air. If a production hall is heated up to 20°C, the heat built-up under the roof of the hall is approximately 35°C, depending of the height of the hall. At an outside temperature of 0°C the difference in temperature value Δt equals 35°C = 35K.

Example for a glazed area of 1.000 m²

Calculation for single glazing:

Q = 1.000 m² · 5.9 W/m²K · 35 C° = 206,500 W = 206.5 kW

Calculation for Lumira filled 16 mm polycarbonate panels:

Q = 1.000 m² · 1.31 W/m²K · 35 C° = 45,850 W = 45.8 kW

Difference = 206.5 kW – 45.8 kW = 160.7 kW

Calculation of the heat difference summed up over a year:

160.7 kW · 24h · 220 Heiztage = 848,496 kWh

Bottom heating value for liquid gas ~ 12.87 kWh/kg
natural gas ~ 9.06 kWh/m³
fuel oil ~ 10.05 kWh/litre

Fuel oil savings:
848,496 kWh ÷ 10.05 kWh/litre = 84,427 litres of fuel oil = 67,542 €

Natural gas savings:
848,496 kWh ÷ 9.06 kWh/m³ = 93,653 m³ of natural gas = 56,192 €

Liquid gas savings:
848,496 kWh ÷ 12.87 kWh/kg = 65.928 kg of liquid gas = 59,335 €

Assumed prices: fuel oil: 0.80 €/litre, natural gas: 0.60 €/m³, liquid gas: 0.45 €/litres = 500g at 15°C

Illustration: The façade plus the roof lights of this production hall in Tulln, Germany have been filled with Lumira. The picture shows the result of the ambient lighting.

The company *Lafarge Cement* planned the construction of an extraordinary foyer. One the most significant requirements was to create a pleasant atmosphere with ideal lighting conditions without having to forego a good thermal insulation. Due to the low weight of the 16 mm glazing consisting of polycarbonate multi-wall panels filled with Lumira® aerogel, the architect was given the opportunity to create a delicately seeming frame construction. Through the entire ceiling light is penetrating without any glaring effects. The bright room creates a pleasant airy atmosphere. Thanks to the application of Lumira the required thermal insulation value is easily met.

The intention of the sports car producer *Ruf* in Zaisertshofen too was a significant improvement of the lighting conditions in order to create better working conditions. The ageing bilged roof lights allowed hardly any daylight incidence, so that workplaces were equipped with artificial lighting in order to assure sufficient illumination. The new barrel roof lights filled with Lumira® aerogel were installed over the whole length of the ridge and span about 3 m, now allowing natural daylight to illuminate the inside of the hall. Thanks to Lumira the light is diffusely spread throughout all areas of the hall, so that each individual workplace is provided with a sufficient amount of glare-free light. In many parts artificial lighting can now be spared, thus reducing the running costs. A further important benefit is the psychological effect that daylight has on employees. Daylight is felt much more pleasant than artificial lighting. Smoke and heat extractors were installed into the skylight system at equal distances. Their opening panels too were filled with Lumira. The devices are used for everyday ventilation adding to the improvement of the working climate.

In a gymnasium where we have to be capable of following quick movements, the importance is attached to a good illumination. The new multi-purpose hall of the *BBS Mainz* further called for modern materials able to meet the requirements of an energetically efficient design. Again, the responsible architectural office was very exited about the results that were generated thanks to Lumira® aerogel. The upper area of the hall was circumferentially equipped with a façade made from Lumira filled multi-wall panels. Smoke and heat extractors installed into the roof too were fitted with Lumira filled multi-wall panels. They grant a good aeration, which is important for a gymnasium and as they are installed into the roof the units provide the gymnasium with additional daylight.

In order to bring more natural daylight to the workplaces this food processing plant in Bavaria originally only wanted to replace their existing roof light glazing, as it was partly damaged and had bilged over the years. The positive effects of Lumira® aerogel convinced the responsible parties to have it installed, but at the end of the day another totally different benefit was the one that made the use of Lumira even more worthwhile: cleanliness. Especially in the food processing industry hygiene is a vital factor. Multi-wall panel do have the problem that dirt collects in their hollow chambers. This problem is even enhanced by the fact that especially in food processing plants condensation water may occur under the ceiling due to production processes. This water condenses in the hollow chambers of the panels providing a breeding ground for mould at that place. Due to the fact that Lumira is permanently hydrophobic, i.e. water-repellent and humidity-resistant, it doesn't provide any breeding ground for mould or fungus development within the panels. It simply takes up the room the dirt would have filled. Hence, the problem has been drastically reduced.

The Sirius School in Newcastle, England is characterised by a special design. Its building is that broad that not all of the rooms could be placed towards the outer walls of the building. Therefore a cube inside the building holds some of the classrooms, which would have never seen any daylight if they had been equipped with a conventional continuous rooflight system. This is why it was decided to use translucent polycarbonate multi-wall panels for the complete roof construction. However, the panels without a Lumira® aerogel filling would have turned the interior of the building into a greenhouse during the summer. Now temperatures stay moderate even in summer and the cube rooms are sufficiently illuminated by natural daylight thanks to the brilliant light scattering capability of Lumira.

The refurbishment of Canning Street School in Newcastle, England also affected a U-shaped skylight system spanning the entire building complex. The main demands made on the new infill were to prevent the intense solar transmission during the summer, to improve lighting conditions and to achieve a considerable reduction of the street noise arising from the road next to the building. The existing skylight system was therefore replaced with 16 mm polycarbonate sheets filled with Lumira® aerogel. The feedback received after the replacement was throughout positive. All required ambitions were fully met. The excellent thermal insulation now prevents an overheating of the building during the summer and reduces heating costs during the winter. The noise level arising from the road has been significantly reduced and the diffuse light scattering creates a pleasant ambiance.

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