

Super insulating silica aerogel glazing

- Results from EU Project HILIT+ (No. ENK6-CT-2002-00648)

General information:

- Technology developer:
 - Technical University of Denmark, Department of Civil Engineering, Section for Building Physics and Services (DK)
 - Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V. (De)
 - Association Pour La Recherche Et Le Developpement Des Methodes Et Processus Industriels (Fr)
 - Centre Scientifique Et Technique Du Batiment (Fr)
 - Produits Chimiques Auxiliaires Et De Synthèse Sa (Fr)
 - Airglass Ab (Sweden)
 - Norwegian University Of Science And Technology (Norway)
 - Lund University(Sweden)
- Date of issue (year): 2005

Aims and Objectives

The first main objective of the project was the “aerogel process optimisation”. The general goal was to demonstrate that the elaboration process, developed through the project HILIT (Highly Insulating and Light Transmitting aerogel glazing for windows), permitted to obtain a significant amount of light transmitting, insulating and transparent 15-20 mm monolithic and crack-free nano-structured aerogel materials, through a reasonably fast and reproducible process. The applicative part of this project aimed at elaborating, studying and optimising “state-of-the-art” (0.5 W/m²K) aerogel glazings for windows. It was expected to develop final aerogel glazing prototypes with a total U-value lower than 0.6W/m²K and a total solar energy transmittance above 75%.

A Short Description of the Technology

Monolithic silica aerogel (aerogel) is a highly porous material with pore diameters in the range of 10–100 nm, composed of 99.8% air and chemically similar to ordinary glass. The porosity is above 90%, which combined with the nanometre pore size makes the aerogel a highly insulating material with a thermal conductivity lower than of still air. Further decrease in thermal conductivity can be achieved if evacuated to a rough vacuum, i.e. below approximately 50 hPa, in this case the thermal conductivity in the pore gas is almost eliminated.

Moreover, beside the low thermal conductivity a high solar energy and daylight transmittance can be achieved by using of this material. All these characteristics make monolithic silica aerogel a very interesting material for use in highly energy efficient windows. The compression strength of aerogel is sufficient to take up the atmospheric pressure if evacuated but the tensile strength is very low, which makes the material fragile, i.e. if in contact with liquid water the surface tension in the pores would demolish the aerogel structure.

Therefore, the application of aerogel for window glazing requires the aerogel to be protected against water and tensile stress. This can be achieved by placing the aerogel between two layers of glass and apply a gas and vapour tight rim seal. When evacuated to a rough vacuum only compression stresses will be present in the aerogel due to the external atmospheric pressure.



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Results and Achievements

The advantage of aerogel windows relative to commercial available low energy glazing is shown in the figure below, for which the reduction in U-value is achieved by multiple layers of glass and low emissive coatings — measures that all reduces the solar energy and daylight transmittance.

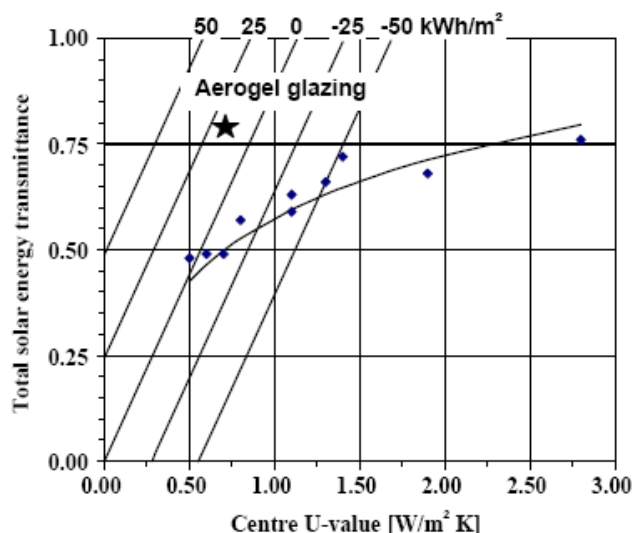


Figure Thermal and solar properties of HILIT/HILIT+ aerogel glazing (15mm aerogel) compared with typical commercially available low energy glazings.

(The dots mark the values for specific glazing units. The solid curved line shows the tendency in the traditional glazing development. The straight lines show the net energy balance during the heating season for a north facing glazing in a Danish climate)

The measured overall U-value of the glazing is deduced from the measurements by subtracting the heat loss through the framing system.

The result of an average total U-value of $0.72\text{W/m}^2\text{K} \pm 0.04\text{W/m}^2\text{K}$ compared to the average centre value of $0.66\text{W/m}^2\text{K}$ confirms the very small thermal bridge effect of the developed rim seal solution. The measurements have been performed outdoors at a clear day by means of a pyranometer measuring the normal radiation with and without the glazing in front of the pyranometer respectively.

The average solar transmittance for two glazings was measured to $73\% \pm 2\%$. The diffuse part of the radiation was less than 10% measured by shading the sensing area of the pyranometer. Normal/hemispherical transmittance in the solar range has been measured in the range of 75–76% under laboratory conditions on other aerogel glazing samples. The total solar energy transmittance, the g-value, has not been measured but would be approximately 4–6%-points higher based on the assumption that the solar energy absorbed in the inner glass as well as the half of the solar energy absorbed in the aerogel becomes useful to the indoor environment.

Several prototypes have been made during the HILIT project based on aerogel sheets made by project Swedish partner Airglass AB. The optimised aerogel elaboration process has been developed during the project on the basis of the previously patented route, aerogel can be obtained through super-critical CO_2 drying of the gel. The aerogel thickness was $15\text{mm} \pm 1\text{mm}$. The centre U-values of the optimised glazing prototypes have been measured by means of a hot plate apparatus. The average centre U-value is found to be $0.66\text{W/m}^2\text{K}$ $70.03\text{W/m}^2\text{K}$, with which the average aerogel thickness of 14.8mm correspond to an estimated thermal conductivity of 0.010W/mK . This indirect determined thermal conductivity is in accordance with the measured material properties at a pressure level of 1–10 hPa.

Four of the optimised prototypes have been used for a test window measuring 1.2 by 1.2m² designed for hotbox measurements of the overall U-value. The well-insulated framing system is made only for fixation of the four glazings and will not withstand exposure to real climate for longer periods.



Final aerogel glazing

- energy efficient building materials, components and systems not yet introduced into the building market or in their first market phase;
- innovative applications of heating/cooling and power supply technologies, combined with the use of renewable energy sources, in building sector;
- best EU demonstration eco-building projects.

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- High insulating glazing

Possible application area

Beside the application in glazing production the HILIT+ aerogel material it self has a large variety of applications:

- Thermal insulation in various fields from cryogenic applications (spatial tankers, ...) to high-temperature applications (ovens, ...) passing by moderate temperatures (pipelines, risers, geothermal resources, ...)

Reference:

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Eco-Building Club: an innovative RTD&D results' promotion approach

Different from common market promotion approaches, where market operators are only simple message receivers, the project proposes an innovative approach: Eco-Building Club is a virtual round table, around which building market operators will be main actors for market penetration of research and demonstration results, through the following actions:

- determining what are more appropriated innovative RTD&D results for local market transferring;
- demonstrating the feasibilities of the research and demonstration results on real cases.