



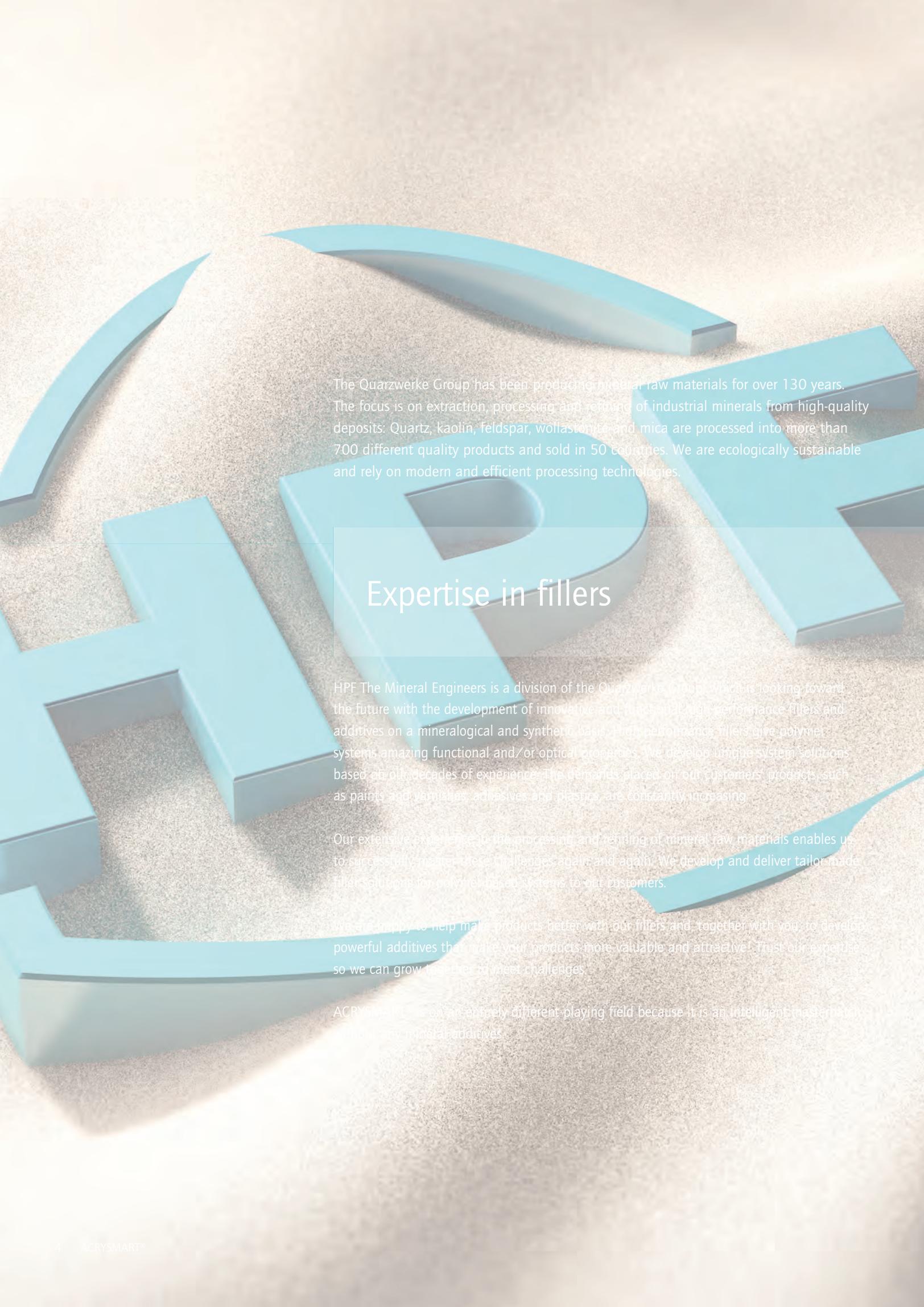
ACRYSMART®

Intelligent daylight and heat management
Smart temperature control



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The Quarzwerke Group has been producing mineral raw materials for over 130 years. The focus is on extraction, processing and refining of industrial minerals from high-quality deposits: Quartz, kaolin, feldspar, wollastonite and mica are processed into more than 700 different quality products and sold in 50 countries. We are ecologically sustainable and rely on modern and efficient processing technologies.

Expertise in fillers

HPF The Mineral Engineers is a division of the Quarzwerke Group, which is looking toward the future with the development of innovative and functional high-performance fillers and additives on a mineralogical and synthetic basis. High performance fillers give polymer systems amazing functional and/or optical properties. We develop unique system solutions based on our decades of experience. The demands placed on our customers' products, such as paints and varnishes, adhesives and plastics, are constantly increasing.

Our extensive experience in the processing and refining of mineral raw materials enables us to successfully master these challenges again and again. We develop and deliver tailor-made filler solutions for polymer-based systems to our customers.

We are happy to help make products better with our fillers and, together with you, to develop powerful additives that make your products more valuable and attractive! Trust our expertise so we can grow together to meet challenges.

ACRYSMART® is on an entirely different playing field because it is an intelligent masterbatch without any mineral additives.



Smart synthesis of planning and development

Many things cannot be planned. But things are different with ACRYSMART®. The vision was clear. HPF The Mineral Engineers have identified promising marketing potential in "adaptive" materials, i.e. materials that change their properties when an environmental parameter changes. Such materials have exactly the properties that set ACRYSMART® apart: They are reliable, maintenance-free and work without technology.

We have relied on excellent scientific expertise in developing this innovative product. Project manager Dr. Olaf Mühling has already dealt with temperature-dependent changes in material properties at the Fraunhofer Institute for Applied Polymer Research IAP, Potsdam-Golm, and has brought ACRYSMART® to market maturity together with Dr. Dirk Kruber, head of HPF product development.

This kind of development work can only be mastered successfully in a team and in a company like Quarzwerke, which recognised the potential of ACRYSMART® far-sightedly and granted the developers the necessary time and important free space to develop the product. With the development of ACRYSMART®, HPF The Mineral Engineers has proven its efficiency and is significantly shaping the successful future of the company.



Can you attribute intelligence to inanimate substances? The addition of ACRYSMART® makes the reactions of acrylic glass to changes in temperature appear very "conscious". Ultimately, of course, it is a matter of definition. But no matter how the material-modifying properties of ACRYSMART® are described: They are convincing!

That is not surprising, because ACRYSMART® was specially developed for use in acrylic glass. ACRYSMART® glass changes its transmittance to light and solar heat as a function of the ambient temperature: At higher temperatures, it automatically protects against the sun; at lower temperatures, it enables optimal use of sunlight.

On hot days, ACRYSMART® glass changes from a transparent (OFF) to a milky white state (ON). At lower temperatures, the plastic glass returns to the OFF state.

ACRYSMART® is easy to incorporate, dilute and mix evenly with impact-modified PMMA moulding compounds.

Life is unthinkable without light. However, artificial light can never fully compensate for the benefits of natural light. As an energy source, light is indispensable and basically unlimited in the form of sunlight. But too much light can be too much of a good thing. Solar heat control is becoming more and more important, especially since the consequences of climate change are becoming more and more noticeable in Europe as well.

Generous, perfectly-oriented glass surfaces allow for the optimal use of natural solar energy in winter and can noticeably reduce energy consumption and associated heating and lighting costs. In addition, natural light and a visual connection with the environment are proven to contribute to well-being and higher productivity.

This also applies in principle to the summer. But an efficient heat management to ensure pleasant room temperatures during the summer season is becoming an ever greater challenge. Looking at things across the entire year, it is important to ensure the best possible use of solar energy without overheating rooms.

Quality of life and well-being

ACRYSMART® glass regulates the use of daylight and solar energy automatically; energy resources are conserved and the costs for cooling, heating and lighting are noticeably reduced.

Material with a vision

Many planners and builders - whether for private, commercial or public buildings - rely on transparency and spaces with light today. Acrylic glass is highly transparent, half as light as glass, but much more resistant to breakage. It has good mechanical properties and an excellent weathering and ageing resistance. It is also easy to shape and therefore often used in construction to add architectural accents.

Common designs are so-called "semi-finished products" – extruded solid, corrugated and multiwall sheets. The masterbatch is added as plastic pellets. In powder form, it is used for cast PMMA sheets.

Semi-finished products of ACRYSMART® glass can be used for a variety of applications such as daylight systems, roofing, facades and glazing. The use of ACRYSMART® glass is particularly interesting where glazing is not primarily employed for viewing, but rather for lighting:

- Skylight domes / continuous rooflights
- Conservatories and greenhouses
- Balcony and patio roofs
- Carports and canopies
- Riding and industrial halls
- Functional hall glazing
- Petrol station and parking roofs
- Bus shelters
- Skylights of motorhomes and caravans



Robust and versatile

Holidays in and with a caravan are becoming more and more popular. Many people are attracted to the water because it takes them far away from everyday life, and the refreshing water also allows them to cool off.

Boats, yachts, motorhomes and caravans have in common that the greatest possible comfort and functionality has to be achieved in a compact space. So openings are often designed to optimally use the daylight and are placed in an area where they are inconspicuous and allow as much light as possible – on the roof. But that also leads to rising temperatures at least in warm weather!

They take up valuable useful space, and the mechanics and moving parts require a lot of maintenance and are also very sensitive. Skylights or rooflights made of ACRYSMART® glass solve this problem elegantly: no moving parts, no maintenance, but an optimum temperature control effect.

ACRYSMART® glass adds value for all applications through its obvious benefits. This stimulates the value chain positively as customers are willing to pay a higher price.



More ideas – more options

Whether public buildings, riding halls or industrial halls, bus stops or carports: The aesthetic demands on functional buildings in the commercial and private sectors are increasing. Glazing in particular plays an important role as a consciously applied design element in the form of facade panels, skylight domes or continuous rooflights.

Anyone who has waited in a glazed bus shelter in summer knows that the temperatures quickly exceed the "comfort zone". So it is important that there are materials that meet the highest visual demands and also have functional advantages. Materials like ACRYSMART® glass.

Due to its temperature-specific material properties, it provides effective, temperature-

lowering shading at high temperatures, while providing pleasant, uniform daylight.

This is particularly beneficial in environments where people are working or doing sports, such as in riding halls or indoor tennis halls. Comfortable temperatures increase the performance of humans and animals. This ensures that distractions from "high operating temperatures" are minimised and accidents are avoided.

The use of ACRYSMART® glass in construction is a smart option for regulating temperatures intelligently without the use of energy or technology.



Innovative and modern

The qualities of adaptive ACRYSMART® glass are really put to their full use in greenhouses: At cooler temperatures, ACRYSMART® glass allows plenty of light and solar energy to pass through. If temperatures rise above a certain temperature range, ACRYSMART® glass becomes milky-white: Part of the solar radiation is reflected while another part is absorbed. The consequence: Temperatures drop significantly, creating an optimal growth climate where plants thrive particularly well and evenly. Less water is also needed for irrigation.

Independent of the seasons



Live and grow

Today's consumers are demanding: Fruit and vegetables should be served fresh at any time of the year. This poses great challenges for professional gardeners and horticultural companies. The use of greenhouses with the highest level of natural light requires careful and complex energy management in order to achieve the desired growth and breeding success. But also hobby gardeners often put a lot of ambition in the cultivation of vegetables or other plants.

Higher temperatures may be desirable to stimulate growth in greenhouses, but there are limits here as well. If they are exceeded it is not beneficial to the plants.

Greenhouses that use ACRYSMART® glass show higher yields. For example with tomatoes that love cooler temperatures: The quality of the tomatoes is better, water consumption is lower and growth is considerably accelerated.

ACRYSMART® glass can also be used in conservatories. Conventional mechanical shading systems have limited suitability since they can only react to daily or seasonal changes to a limited extent or not at all. They require more or less complex assembly work, are often expensive and are maintenance intensive due to the mechanics. Air conditioners are questionable for environmental reasons.



Smart material

ACRYSMART® glass is nearly in a league of its own when it comes to maintenance-free and visually appealing temperature regulation and efficient energy management.

ACRYSMART® glass has three phases, which are determined by the temperature. An example of a switching temperature of 26°

→ OFF state

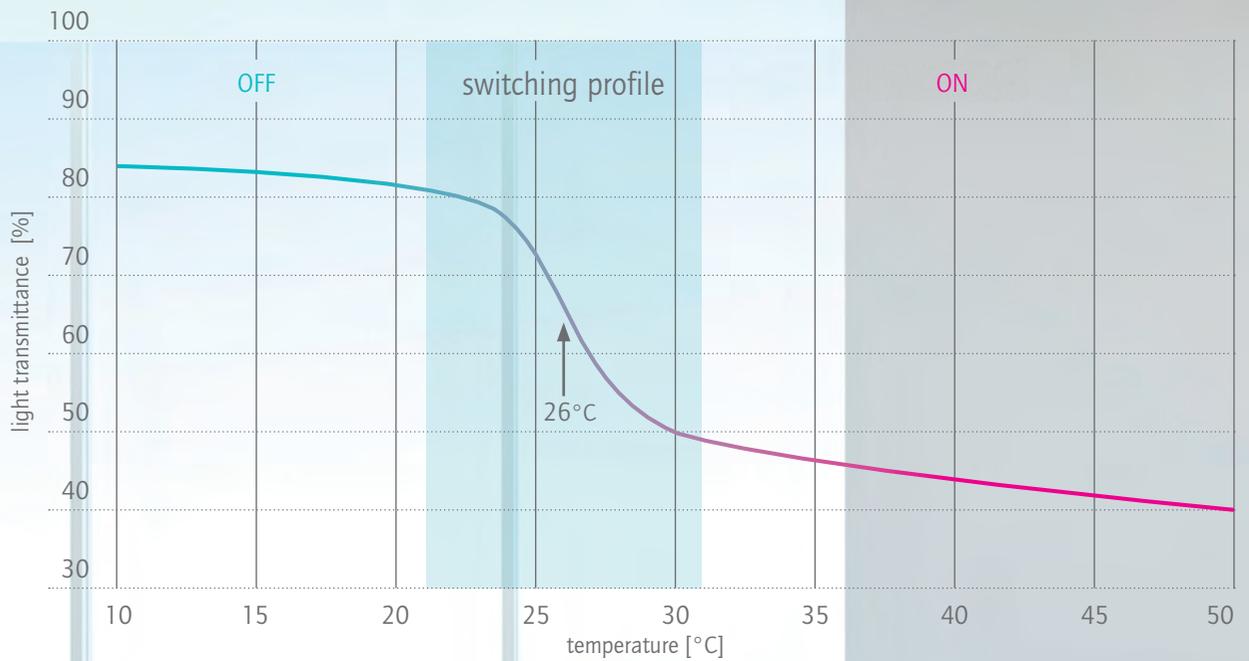
If the temperature is less than 21°C, ACRYSMART® glass has a maximum transmittance for light and solar energy.

→ Switching range

The transition from OFF to ON state takes place between 21°C and 31°C. In this temperature range, ACRYSMART® glass reacts highly sensitive to temperature changes.

→ ON state

This state is reached at a temperature of 31°C; the glass is milky-white and no longer transparent.



Clever switching

The switching profile shows how the light transmission changes with the material temperature. The switching behaviour is thus decisively determined by the material temperature. But other factors also play a role and make it possible to adapt ACRYSMART® glass to the specific performance requirements of an application. This includes the sheet thickness and the proportion of ACRYSMART® masterbatch.

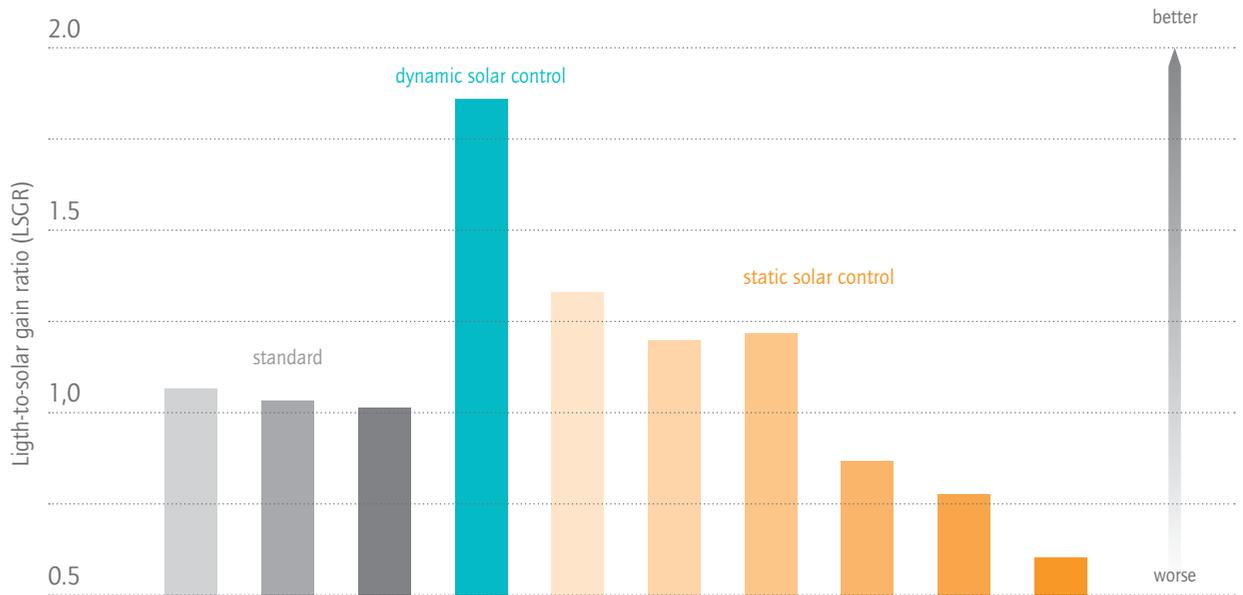
A rule of thumb: The thicker the ACRYSMART® glass and the higher the proportion of masterbatch, the more intense the switching.

Transparent colouring also opens up further options and additional design possibilities.

Last but not least, the switching range can be shifted individually according to the customer's requirements (for details see the glossary).

A long, bright hallway with a large skylight on the ceiling. The skylight is made of a grid of white frames holding translucent panels. Sunlight streams through the skylight, casting a grid of shadows on the floor. The walls are white and the floor is a light color. A teal banner is overlaid on the upper part of the image.

Light and protection



ACRYSMART® glass shows the best overall performance throughout the year compared to other material.

- | | | | | |
|---|--|---|--|--|
|  PMMA clear - 3 mm |  PMMA opal - 3 mm |  PMMA white (red) opal - 3 mm |  PC blueish transparent - 3 mm |  PC grey hazy, low LT - 3 mm |
|  PC clear - 3 mm |  Acrysmart® glass - 4 mm, 30% |  PC green transparent - 3 mm |  PC grey hazy, medium LT - 3 mm |  PC grey hazy, very low LT - 3 mm |

Powerful at full wavelength - 365 days a year!

Conventional plastic sheets for solar control are „static“, meaning that regardless of the season, their solar control properties are always the same. Especially in winter, static solar control sheets have crucial disadvantages. Due to the low light transmission, the incident of daylight is low. Savings in artificial lighting and heating energy are hardly possible. Furthermore, the tinting of these sheets leads to an undesired change in the colour rendering indoors.

ACRYSMART® glass is a dynamic glass. The solar control effect is only activated when it is really needed.

ACRYSMART® also convinces users with its accurate colour reproduction and stability: ACRYSMART® glass is virtually colour-neutral – which is an important design parameter!

Another plus: In a climatic chamber, ACRYSMART® glass has already completed 4,000 switching cycles from 10°C to 70°C and back to 10°C. That means a lifetime of minimum 20 years in Germany.



Acrylic glass (→ PMMA): Acrylic glass is highly transparent, half as light as glass, but much more resistant to breakage. It offers good mechanical properties and excellent weathering and ageing resistance.

ACRYSMART® glass: An → acrylic glass whose product properties are modified by an → HPF developed masterbatch. ACRYSMART® glass changes its transmittance to light and solar radiation as a function of temperature.

ACRYSMART® grade A2501 XT: → Masterbatch in the form of pellets; particularly suitable for the production of extruded → semi-finished products. → HPF The Mineral Engineers manufactures the masterbatch, but does not process it into semi-finished products.

ACRYSMART® grade P2503 GS: → Additive in powder form particularly suitable for the production of cast → semi-finished products. → HPF The Mineral Engineers manufactures the additive, but does not process it into semi-finished products.

Additives: Are used in the production of → semi-finished products (→ extruded or → cast) such as solid, multiwall or corrugated sheets, profiles and tubes or solid rods.

Extrusion: Manufacturing process for → semi-finished products (solid, multiwall or corrugated sheets, profiles and tubes or solid rods)

Casting: Manufacturing process for → semi-finished products (solid sheets)

Semi-finished products: Solid, multiwall or corrugated sheets, profiles and tubes or solid rods made of plastic. Their material properties can be changed by adding → additives or → masterbatches.

HPF: High Performance Filler; short name for the Quarzwerke Division HPF The Mineral Engineers

Masterbatches: → Plastic additives with special product properties in the form of pellets. Their content of colourants and/or → additives is higher than in the final application. They are mixed with natural plastics (raw polymer) for colouring or for changing properties. Masterbatches increase the process reliability compared to powders, pastes or liquid additives and are very easy to process.

PMMA: Plastic; short for: polymethyl methacrylate; known on the market as → acrylic glass.

Switching range: The temperature interval at which → ACRYSMART® glass changes from the transparent to the translucent state; the switching temperature marks the transition within the switching range. The switching range is usually 10°C and should be based on the intended location and purpose.

Switching profile: The switching profile describes the course of light and solar transmission as a function of temperature. The switching range and switching temperature can be individually selected within certain limits. For example, the switching range can begin at 21°C (OFF state) and then end at 31°C (ON state); the switching temperature lies at 26°C in this interval.

Temperature regulation: → ACRYSMART® glass changes its transmittance to light and solar radiation as a function of temperature. The temperature-regulating effect is currently only effective on the basis of PMMA. Work is being done on other grades with changed → switching ranges and modified effectiveness.



For further information:



[www.quarzwerke.com/produkte/
high-performance-fillers/
acrysmart/](http://www.quarzwerke.com/produkte/high-performance-fillers/acrysmart/)

Some of our products are classified into the STOT RE cat. 1 or 2 according to the European CLP Regulation (EC/1272/2008). More detailed information is available from the respective material safety data-sheet.

The figures documented in this application technique report were collected and shown to the best of our knowledge. However, we ask for understanding that we cannot take over liability for the results in individual cases and for the suitability and completeness of our recommendations, and cannot guarantee that no third-party patent rights are restricted.

*The use of the symbol ® herein signifies the registration of the associated trademark in one or more, but not all, countries.
We are available for further questions and consultation.*

 The Mineral Engineers

Quarzwerke GmbH
Augustinusstr. 9D
D-50226 Frechen

fon: +49 (0) 22 34 / 101-439
fax: +49 (0) 22 34 / 101-480

sales@hpfminerals.com
www.hpfminerals.com

 **The Mineral Engineers**
A DIVISION OF QUARZWERKE GROUP