
PRODUCT TECHNICAL DATA

Saflex® Storm (VSO2) Composite PVB Interlayer

Saflex® Storm, also known as Saflex VSO2 is the name given to a composite interlayer by Eastman Chemical Company that is manufactured to meet the high-performance glazing requirements for applications needing significant impact, along with rigidity, tear resistance and the ability to retain glass shards in a post breakage mode. Applications where this product is commonly used are safety glazing, hurricane and security (such as forced entry, air-blast and ballistic).

Further information about Eastman's offering of tough, resilient, protective interlayers can be obtained at www.saflex.com and www.vanceva.com. Saflex Storm is designed to enable the production of laminates with high PVB to glass high adhesion.

Product Overview:

Saflex® Storm products have been specifically formulated and developed to meet the exacting requirements for glass to glass laminates used in architectural glazing for hurricane regions and other high risk associated regions. These products have demonstrated that when using the minimum interlayer thickness of 1.91 mm (0.075 in), and being properly selected, laminated, and installed, they can meet or exceed many of the regulations and standards for laminated glazings including those set forth by the CPSC, ASTM, UL, and DIN standards. Saflex® Storm products were specifically formulated to provide exceptional durability and a long-life cycle. Typical applications for Saflex® Storm are:

- Large Missile Cyclone/Hurricane/Typhoon (4.5 kg (9 lb.) 2 x 4 timber at 15 m/sec (50 ft. /sec))
- Large Size Glazing (>4.65 sqm (50 sqft))
- High Wind Loads (>4.3 kPa (90 psf))
- Blast Loads (>69kPa (10 psi) @ 621 kPa*msec (90 psi*msec))

Saflex® Storm can also be utilized for small missile protection with no known size limitations or special glazing techniques required. Dade County Product Approval (Dade County Florida) has granted Saflex® Storm a component Notice of Acceptance (NOA) under its product approval protocol that mandates the identification of interlayer in a laminate. Solutia provides this number for the authorized use of qualified laminators and their fenestration manufacturing customers.

Saflex® Storm products have been shown to be compatible with most reflective and low emissivity metal coated glasses although the compatibility of each coating with the interlayer should be verified with the laminator.

Available Forms:

Saflex® Storm products are supplied in two thicknesses and roll lengths depending on the product form, and variety of roll widths. All Saflex® Storm product is supplied in roll form on 15.2 cm (6 inch) diameter cores.

The thicknesses of the interlayers are documented as nominal 1.91 mm (0.075 in) and 2.29 mm (0.090 in) within our product tracking systems to accommodate our nomenclature system. The actual target thickness for Saflex® Storm products are 1.96 mm (0.077 in) and 2.34 mm (0.092 in) respectively. The only difference in the nominal and target gauges are for product control and tracking purposes. It is very common to see the product referenced as an “075” product or an “090” product for this reason.

| Saflex® Storm interlayer | | |
|---------------------------------|----------------------|--------------------------|
| Product Designation | VSO2 | VSR8 #216500 or # 218000 |
| Thickness | 1.96 mm (0.077 inch) | 2.34 mm (0.092 inch) |
| Color | Clear | Diffuse White |

Saflex® Storm is available in clear or diffuse white. The diffuse white products are produced using high durability colorants that have been shown to undergo minimal change in hue after years of exposure to natural sunlight.

Hurricane applications require the use of only one layer of Saflex Storm to be laminated between two pieces of glass. Multiple layers of Saflex Storm, Saflex or Vanceva® interlayers can be constructed to achieve some of the highest targeted performance for blast resistant and other security applications as well.

Storage Conditions:

Saflex Storm interlayer should be stored inside the moisture barrier bag that the roll is shipped in. Saflex interlayers are supplied as refrigerated rolls that must be stored between 5°C and 10°C (41°F to 50°F) to prevent the material from sticking to itself (blocking) or as rolls interleaved with polyethylene (additional charge applies) that do not require refrigeration. Interleaving is not available for all products.

It is recommended that the interlayer be used within a two-year period from purchase to minimize this blocking tendency.

Laminating Conditions:

A Laminating Guide which details recommended practices for storage, handling, and lamination is available to Eastman’s laminating partners. This technical guide is available only from your Saflex Technical Service (TS) Representative or Saflex Sales Manager.

Please contact your Saflex Sales Manager, Customer Service Representative or visit www.saflex.com for further information.

Select Saflex® Storm Properties:

| Physical | Gauge Tolerance | Nominal | Property Details | | |
|----------|--------------------|-------------|--|-----------------|--------|
| | VSO2 | 1.96 mm | Nominal gauge +3 mm / – 2.5 mm (+0.002 in/ - 0.001 in) | | |
| | VSR8 | 2.34 mm | Nominal gauge +3 mm / – 2.5 mm (+0.002 in/ - 0.001 in) | | |
| | Description | Test Method | Units | Test Conditions | Result |
| | Specific Gravity | ASTM D 792 | | 23°C | 1.11 |
| | Specific Heat (Cp) | ASTM D 1461 | Joules/g-K | 25°C | 1.27 |

| Mechanical | Description | Test Method | Units | Test Conditions | Result |
|------------|------------------------|------------------|-------|-----------------|--------|
| | Compressive Strength | ASTM D 695 | MPa | @ 10% strain | 8.55 |
| | Compressive Strength | ASTM D 695 | MPa | @ 25% strain | 17.5 |
| | Poisson's Ratio | ASTM D 638 | | | 0.50 |
| | Shear Storage Modulus* | See tables below | | | |
| | Tensile Strength | ASTM D 638 | MPa | @ 10% strain | 25.4 |
| | Young's Modulus* | See tables below | | | |

| | | | | | |
|----------------|------------------|------------|--|------|------|
| Optical | Refractive Index | ASTM D 542 | | 21°C | 1.65 |
|----------------|------------------|------------|--|------|------|

| | | | | | |
|----------------|----------------------|-------------|---------|--|---------|
| Thermal | Thermal Conductivity | ASTM D 1461 | W/(m*K) | | 0.161 |
| | Thermal Diffusivity | ASTM D 1461 | cm/m | | 0.00104 |
| | Emissivity | ASTM C 1371 | | | 0.085 |

| | Description | Test Method | Units | Test Conditions | Result | Description |
|----------------|--------------|------------------------------|-------|--------------------------------|---------------------------|-------------|
| Solar** | UV Screening | Spectral Analysis | | 280 – 380 nm | | >99% |
| | | Transmitted Solar (%) | | Transmitted Visible (%) | Absorbed Solar (%) | SHGC |
| | VSO2 | 71 | | 87 | 21 | 0.77 |
| | VSR8 # 2165 | 49 | | 57 | 46 | 0.63 |
| | VSR8 # 2180 | 62 | | 78 | 32 | 0.71 |

* Modulus supplied for PVB layer of composite only. Default 0.500 Poisson's ratio is used in the calculation of Young's modulus.

**Solar Properties based upon laminated samples with 3 mm (1/8 in) clear glass

Shear storage modulus and Young's modulus data versus load duration are provided in the tables below. It should be noted that only the Saflex PVB component of the composite is reported in the below data. The composite material is expected to exceed the below values, however accurate composite data cannot be obtained using the standard methods of plate to plate evaluation in torsion mode.

Saflex® Storm/VSO2 Shear Storage Modulus (PVB component only)

| Load Duration | Temperature | | | | | | | | |
|---------------|-------------|------|------|------|------|------|------|------|------|
| | 20°C | 25°C | 30°C | 35°C | 40°C | 45°C | 50°C | 55°C | 60°C |
| | MPa | | | | | | | | |
| 1 sec | 132 | 50 | 13 | 3.0 | 1.2 | 0.8 | 0.7 | 0.6 | 0.6 |
| 3 secs | 101 | 28 | 5.7 | 1.6 | 0.9 | 0.7 | 0.6 | 0.6 | 0.5 |
| 30 sec | 43 | 6.8 | 1.5 | 0.8 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 |
| 1 min | 30 | 4.1 | 1.1 | 0.7 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 |
| 5 min | 11 | 1.7 | 0.8 | 0.6 | 0.5 | 0.5 | 0.4 | 0.3 | 0.2 |
| 10 min | 7.5 | 1.3 | 0.8 | 0.6 | 0.5 | 0.4 | 0.4 | 0.3 | 0.2 |
| 30 min | 3.4 | 0.9 | 0.6 | 0.5 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 1 hour | 2.3 | 0.8 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.2 | 0.1 |
| 6 hours | 1.1 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 |
| 12 hours | 0.9 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 |
| 1 day | 0.8 | 0.6 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | -- |
| 5 days | 0.6 | 0.5 | 0.4 | 0.2 | 0.1 | 0.1 | 0.1 | -- | -- |
| 1 week | 0.6 | 0.5 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | -- | -- |
| 3 weeks | 0.5 | 0.4 | 0.2 | 0.1 | 0.1 | 0.1 | -- | -- | -- |
| 1 month | 0.5 | 0.4 | 0.2 | 0.1 | 0.1 | -- | -- | -- | -- |
| 1 year | 0.4 | 0.2 | 0.1 | 0.1 | -- | -- | -- | -- | -- |
| 10 years | 0.3 | 0.1 | 0.1 | -- | -- | -- | -- | -- | -- |
| 15 years | 0.3 | 0.1 | 0.1 | -- | -- | -- | -- | -- | -- |
| 50 years | 0.2 | 0.1 | -- | -- | -- | -- | -- | -- | -- |

Saflex® Storm/VSO2 Young's Modulus (PVB component only) *

| Load Duration | Temperature | | | | | | | | |
|---------------|-------------|------|------|------|------|------|------|------|------|
| | 20°C | 25°C | 30°C | 35°C | 40°C | 45°C | 50°C | 55°C | 60°C |
| | MPa | | | | | | | | |
| 1 sec | 396 | 150 | 39 | 9.0 | 3.6 | 2.4 | 2.1 | 1.8 | 1.8 |
| 3 secs | 303 | 84 | 17 | 4.8 | 2.7 | 2.1 | 1.8 | 1.8 | 1.5 |
| 30 sec | 129 | 20 | 4.5 | 2.4 | 1.8 | 1.8 | 1.5 | 1.5 | 1.2 |
| 1 min | 90 | 12 | 3.3 | 2.1 | 1.8 | 1.5 | 1.5 | 1.2 | 1.2 |
| 5 min | 33 | 5.1 | 2.4 | 1.8 | 1.5 | 1.5 | 1.2 | 0.9 | 0.6 |
| 10 min | 23 | 3.9 | 2.4 | 1.8 | 1.5 | 1.2 | 1.2 | 0.9 | 0.6 |
| 30 min | 10 | 2.7 | 1.8 | 1.5 | 1.2 | 1.2 | 0.9 | 0.6 | 0.6 |
| 1 hour | 6.9 | 2.4 | 1.8 | 1.5 | 1.2 | 0.9 | 0.6 | 0.6 | 0.3 |
| 6 hours | 3.3 | 1.8 | 1.5 | 1.2 | 0.9 | 0.6 | 0.3 | 0.3 | 0.3 |
| 12 hours | 2.7 | 1.8 | 1.5 | 1.2 | 0.9 | 0.6 | 0.3 | 0.3 | 0.3 |
| 1 day | 2.4 | 1.8 | 1.2 | 0.9 | 0.6 | 0.3 | 0.3 | 0.3 | -- |
| 5 days | 1.8 | 1.5 | 1.2 | 0.6 | 0.3 | 0.3 | 0.3 | -- | -- |
| 1 week | 1.8 | 1.5 | 0.9 | 0.6 | 0.3 | 0.3 | 0.3 | -- | -- |
| 3 weeks | 1.5 | 1.2 | 0.6 | 0.3 | 0.3 | 0.3 | -- | -- | -- |
| 1 month | 1.5 | 1.2 | 0.6 | 0.3 | 0.3 | -- | -- | -- | -- |
| 1 year | 1.2 | 0.6 | 0.3 | 0.3 | -- | -- | -- | -- | -- |
| 10 years | 0.9 | 0.3 | 0.3 | -- | -- | -- | -- | -- | -- |
| 15 years | 0.9 | 0.3 | 0.3 | -- | -- | -- | -- | -- | -- |
| 50 years | 0.6 | 0.3 | -- | -- | -- | -- | -- | -- | -- |

Young's modulus E' is calculated using formula $E' = 2G'(1+\nu)$ where ν = Poisson's ratio of approximately 0.50 for isotropic polymeric material.

Saflex Storm has been physically tested and subsequently modeled at various temperatures for glass strength. The glass strength charts developed for 8 in 1000 probability of failure for Saflex Storm (VSO2) are provided below. Due to the increased nominal thickness of the interlayer (1.91 mm (0.075 in)) versus standard product (0.76 mm (0.030 in)), the glass thickness designations on the charts have been revised to reflect the actual nominal thickness. Laminated glass is constructed with standard nominal thicknesses from 2.5 through 12 mm glass in symmetrical configurations as is acceptable practice for designation in ASTM E1300; however significant additional strength can be gained with this product using the effective thickness calculation (or the charts below). The glass strength continues at the same level as standard Saflex PVB interlayers when the design load is acting on the laminate at temperatures above 35°C.

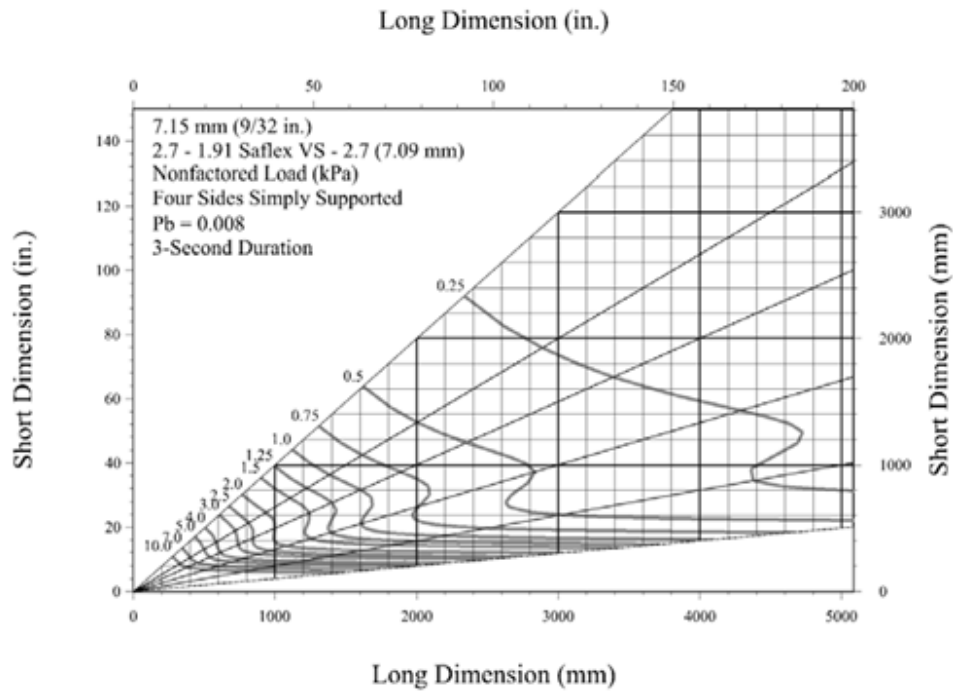


Figure 1: Glass strength chart Saflex Storm/VSO2 with 2.7 mm glass

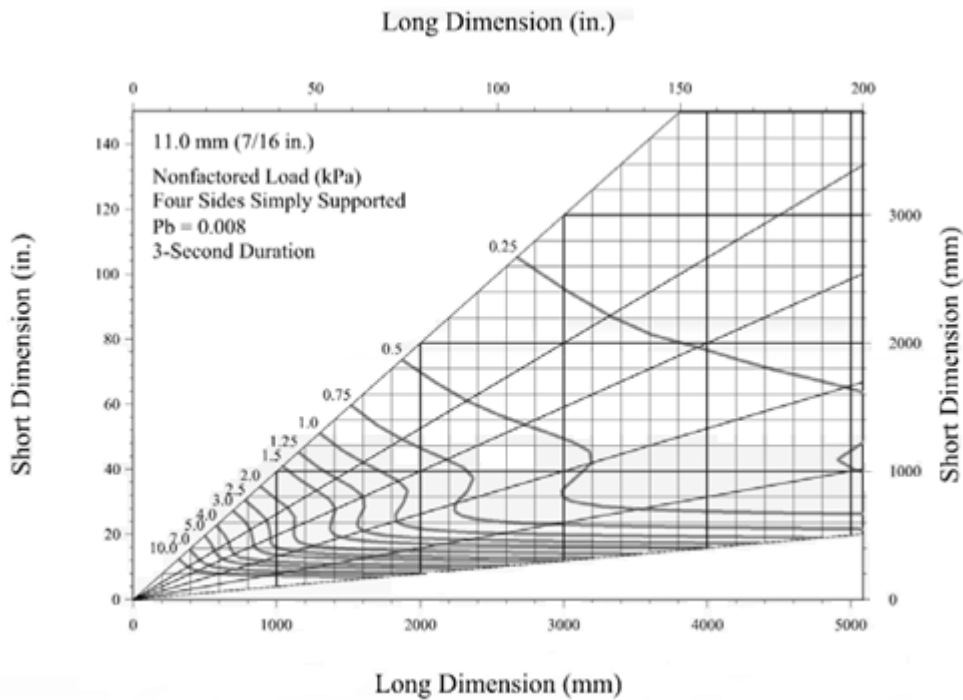


Figure 2: Glass strength chart Saflex® Storm/VSO2 with 5 mm glass

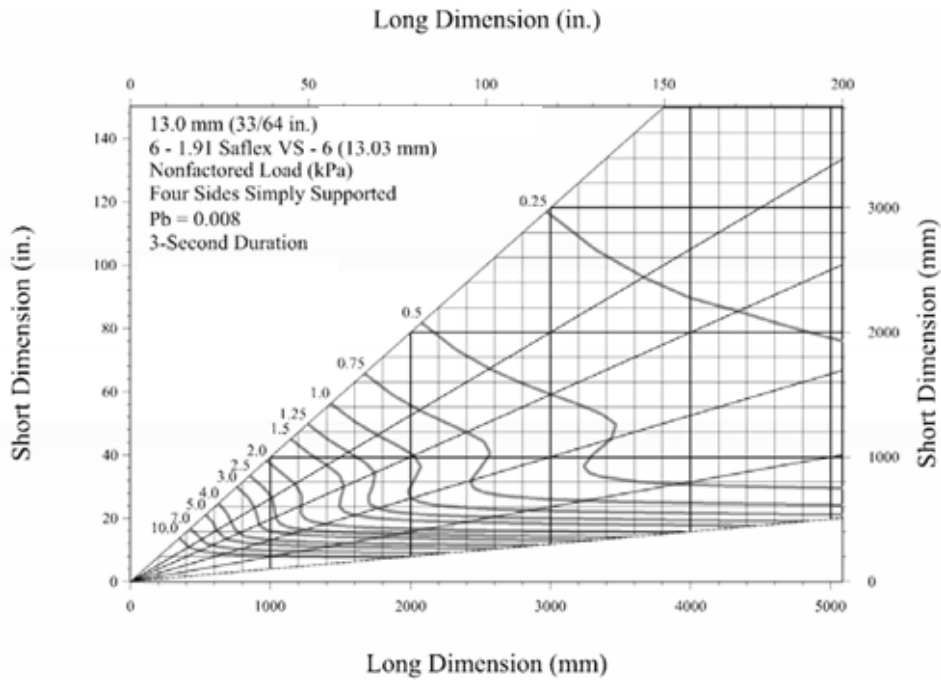


Figure 3: Glass strength chart Saflex® Storm/VSO2 with 6 mm glass

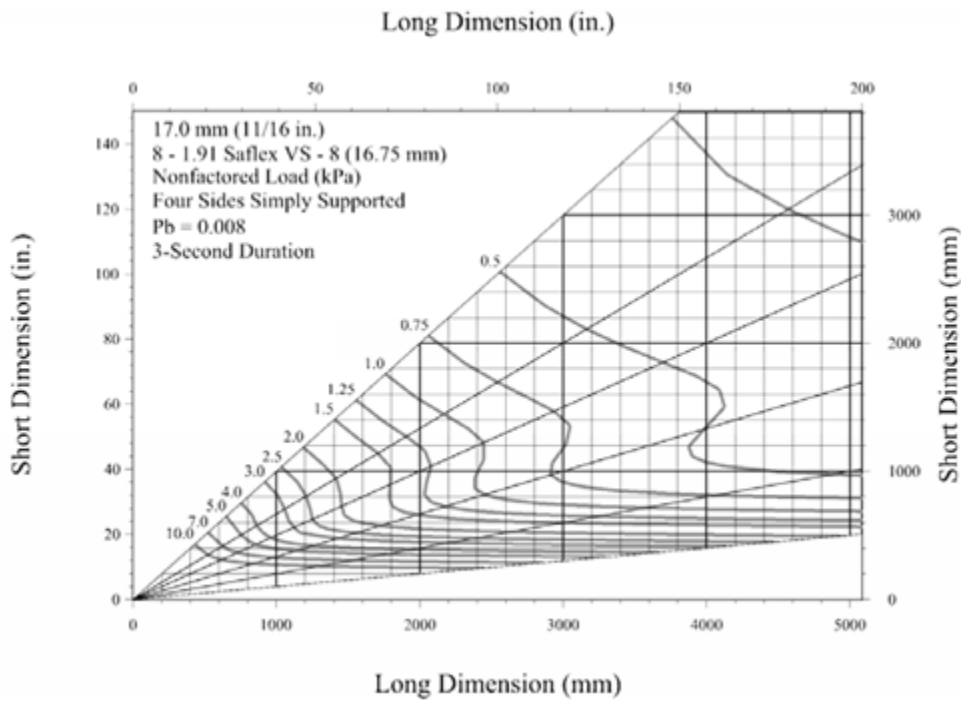


Figure 4: Glass strength chart Saflex® Storm/VSO2 with 8 mm glass

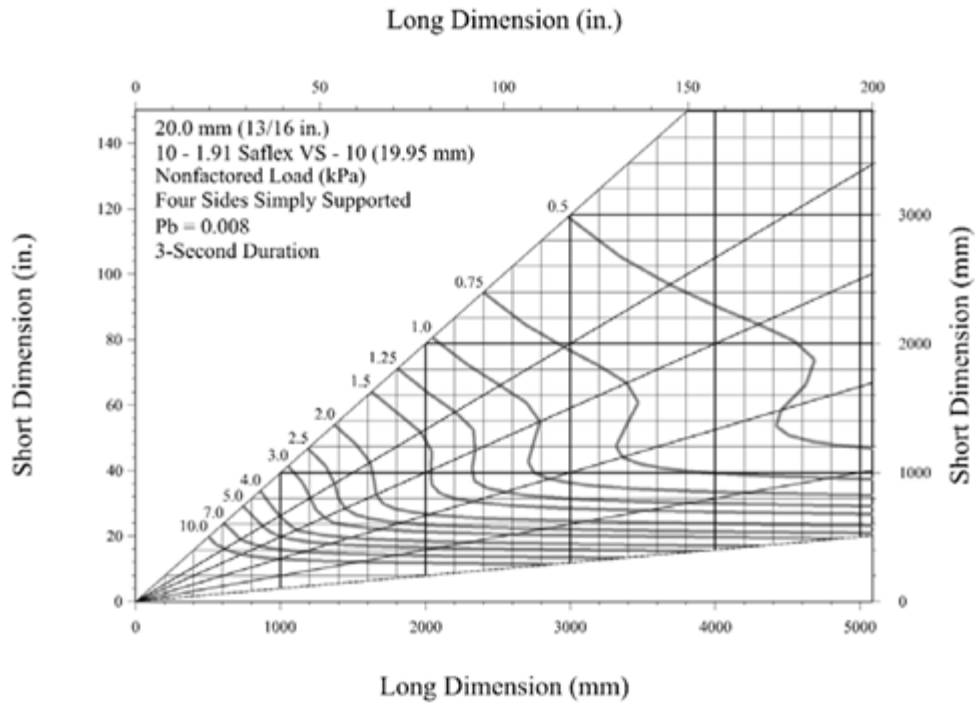


Figure 5: Glass strength chart Saflex® Storm/VSO2 with 10 mm glass

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