

Reaching new heights in reflection & endurance.

RENOLIT REFLEXOLAR

*The cost-effective
co-extruded PV back sheet*



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Reaching new levels of excellence & profitability

Market dominance in PV modules and panels is all about output and cost-efficiency. Even the slightest improvement in these fields can make a world of difference. **RENOLIT REFLEXOLAR 1500 PO**, a new breed of co-extruded back sheet, has been developed with these considerations in mind. It is ideally suited for the construction of reliable and cost-effective 72 cells 1500 VDC rated PV modules meeting the new IEC 61730 Ed2 requirements.

Minimized warping, enhanced abrasion resistance and an increased output are but a few of its many advantages. It is made from specially developed polymers, recyclable, halogen and solvent free. Thanks to superior water and acetic acid barrier properties, EVA corrosion is further reduced.

With the new RENOLIT REFLEXOLAR 1500 PO back sheet, RENOLIT has reached new heights in reflectance and endurance, thanks to a long term experience in PP alloy roofing membranes and advanced co-extrusion techniques.



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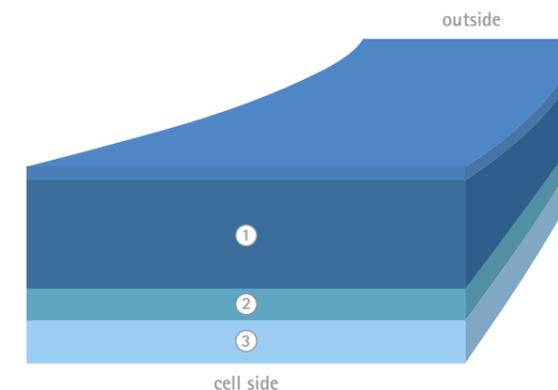
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PolyOlefin co-extrusion

The RENOLIT REFLEXOLAR 1500 PO is a new class of back sheet made by co-extrusion. Through this technique highly reflective and dimensionally stable PP alloy core layers are combined to a proven E-layer, by an innovative TPO binding layer.

No hydrolysis sensitive adhesives are used. The result is a reliable PP alloy foil with optimal sealing behavior with EVA or PO encapsulants. The process allows easy fine-tuning of the E-layer chemistry to achieve optimum sealing behavior with specific encapsulants. The entire PO composition is also designed to maximize recycling and minimize impact on the environment.



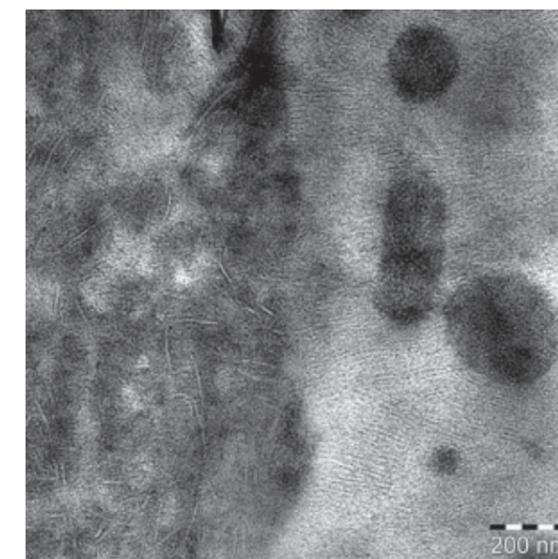
- ① Formulated white PP
- ② White TPO binding layer
- ③ E-layer

New materials, new processes, new opportunities

PP alloy based foils are already widely established in the waterproofing membrane business. Their advantages are obvious: excellent durability, cost-efficiency and optimum resistance to abrasion, sunlight, heat and ponding water.

The problem to be solved however is the lack of reliable adhesion with encapsulant materials (EVA and POE).

Thanks to the use of new Thermoplastic PolyOlefins (TPO) binding materials and advanced co-extrusion processes, we are now able to offer new opportunities to the PV module market.



Transmission Electronic Microscopy showing continuous lamellar crystallization at the interface between the modified PP and TPO binding layers.



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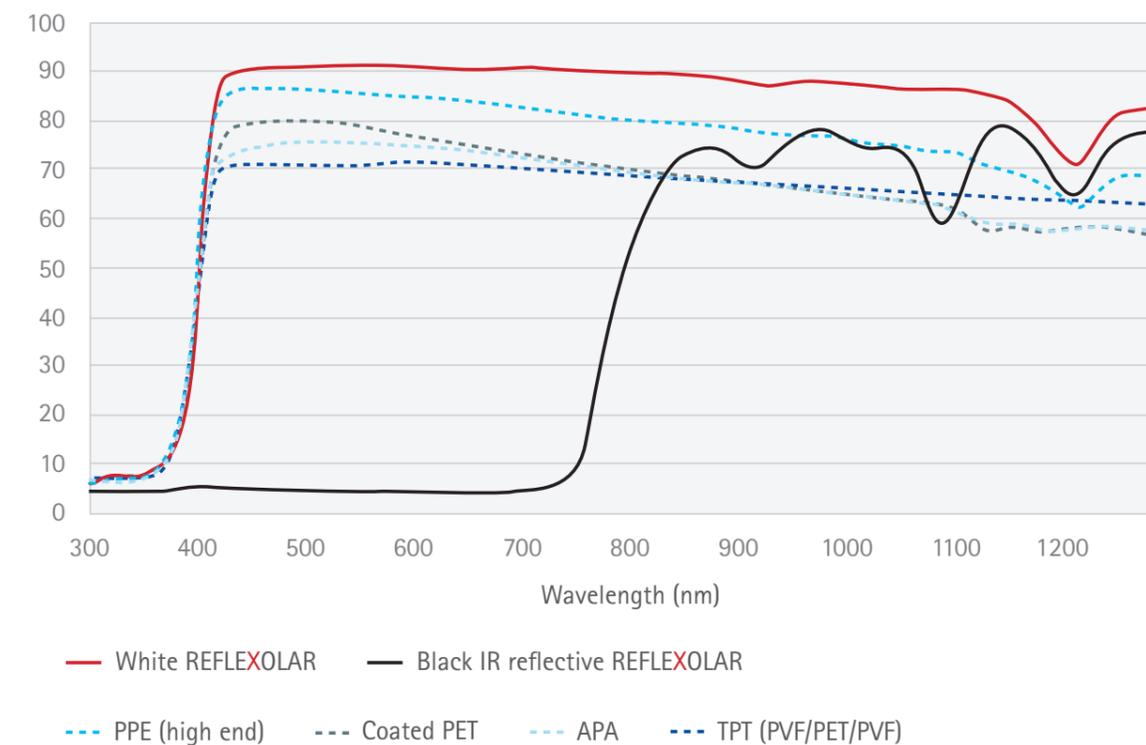
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Increased reflectance & output

Thanks to a highly white pigmented composition, the reflectance of our new back sheet is higher than for transparent core PET layer based back sheet. Being pigmented into the bulk rather than in thin protective layers, our back sheet typically presents

reflectance values of 20% higher than competing products. Furthermore our co-extrusion technology allows for the design of a Black IR reflective back sheet, leading to a module efficiency improvement of up to 1,5% relative.

Reflectance (Several backsheet)



As a result of bulk pigmentation and multi-layer technology, RENOLIT REFLEXOLAR 1500 PO back sheets achieves superior reflectance.



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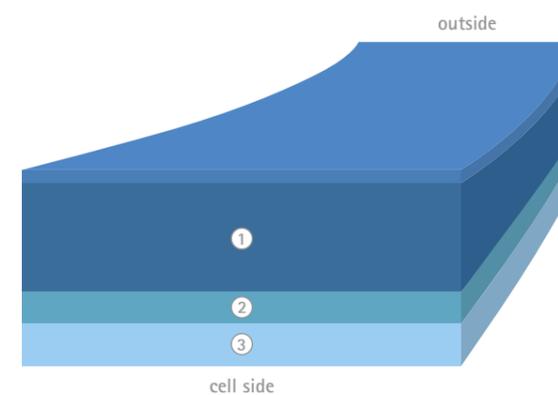
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Improved abrasion resistance

As the RENOLIT REFLEXOLAR 1500 PO back sheet is UV stabilized and pigmented into the bulk, sand abrasion of the air side layer of the back sheet, if any, will only result into exposition of UV stabilized material. The visual effect of extensive sand abrasion is a superficial "sand color" discoloration (figure 1).

In the case of a classical back sheet with a transparent core PET layer, abrasion resistance of the thin UV protective layer is quite critical as un-stabilized PET will eventually be exposed to UV light, leading to back sheet cracking.

The behavior of a commercial PET coated back sheet is shown in figure 2. Already after 500 g of sand abrasion, the coating is eroded, exposing unprotected PET.



- ① Formulated white PP
- ② White TPO binding layer
- ③ E-layer

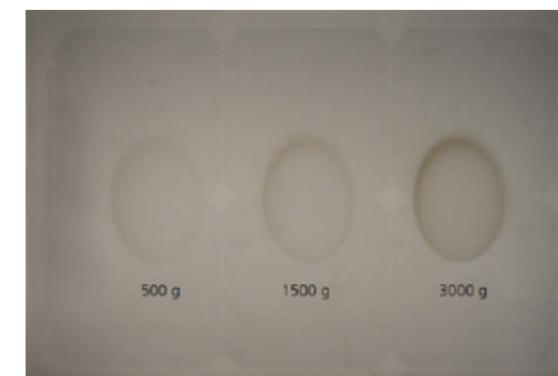
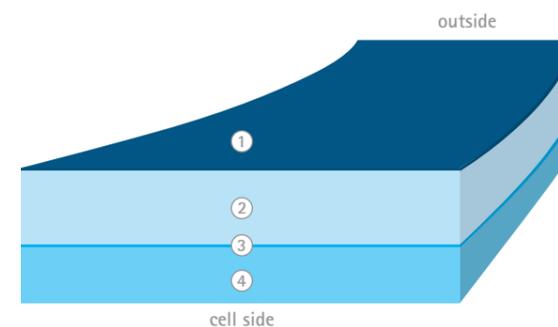


Figure 1: Extensive sand abrasion. The superficial erosion has no impact on UV stability of The RENOLIT REFLEXOLAR 1500 PO back sheet.



- ① Opaque coating
- ② Transparent PET
- ③ 2K adhesive
- ④ E-layer

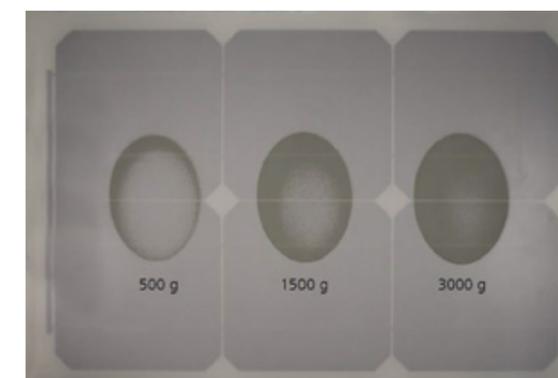


Figure 2: Extensive sand abrasion. The superficial erosion leads to direct exposure of the not UV stable Core PET layer.



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Extreme Endurance - Not a coincidence

2-SUN tested equivalent to > 20 years of Florida Weathering

RENOLIT REFLEXOLAR formulations are extensively tested using a 2-SUN test method for roof membranes for accelerated ageing.

The "2-SUN" Atlas Weather-Ometer is a high irradiation (2.5 SUN at AM 1.5) full sun spectrum, high temperature (Black Standard Temp. 88°C, PV cell at 80°C, Test chamber at 45°C), including a wet-dry moisture cycle accelerated ageing test, well known in the building industry and being one of the most stringent tests for outdoor materials. This test is way beyond the IEC 61215 UV light exposure test standard for PV modules.

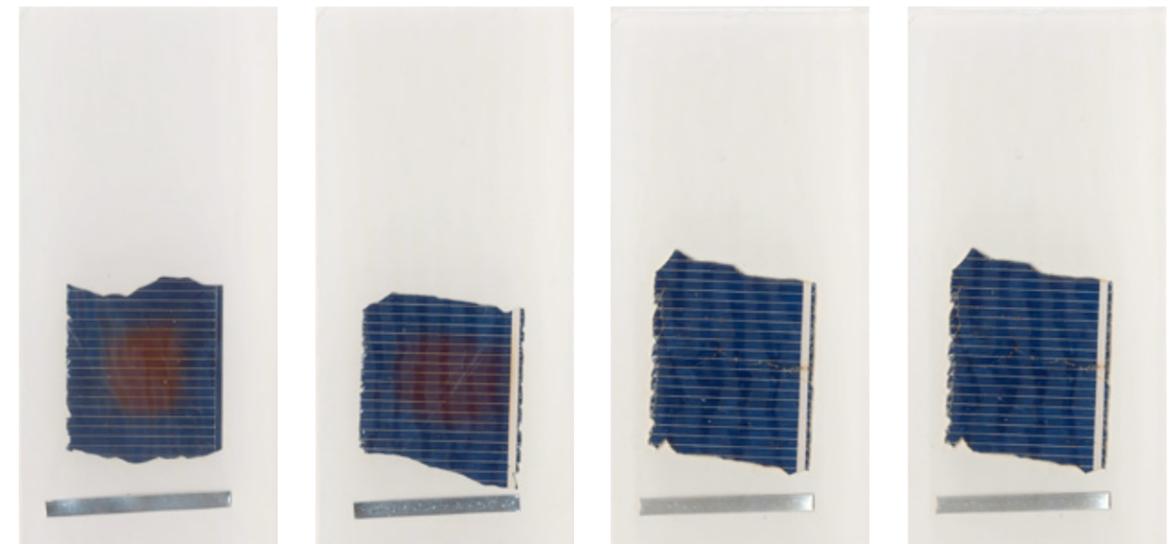
12.000 hours of 2-SUN test is equivalent > 20 years of Florida conditions. Test specimen (see picture below) are composed of a 3.2 mm thick front sheet of solar glass, a first encapsulant, a cell and ribbon, a second encapsulant and finally RENOLIT REFLEXOLAR. Results show a no cracking nor yellowing of the backsheet.

EVA encapsulant system "cracks" first.

Different Ethylene Vinyl Acetate (EVA) encapsulants were tested. Some EVA types started after 12.000 hours to brown in the cell area indicating that the encapsulant system is severely degrading under the 2 SUN conditions.



RENOLIT REFLEXOLAR can be aged up to 21.000 hours and be still intact. Yet the cell and module, by then, due to degradation of the EVA encapsulant may no longer function. This however opens perspective for alternative encapsulant approaches, in combination with RENOLIT REFLEXOLAR for more extended durability.



12.000 hours of 2-SUN comparing different EVA types, using RENOLIT REFLEXOLAR as backsheet

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Superior permeability

The composition of the RENOLIT REFLEXOLAR 1500 PO back sheet is engineered to maximize acetic acid permeability (figure 1) and minimize Water Vapor Transmission Rate (figure 2).

The activation Energy of permeability is such that drying of the inside of the PV modules is superior during sunshine and water vapor ingress is reduced under cold and humid conditions. These properties lead to reduced corrosion and extended electrical production.

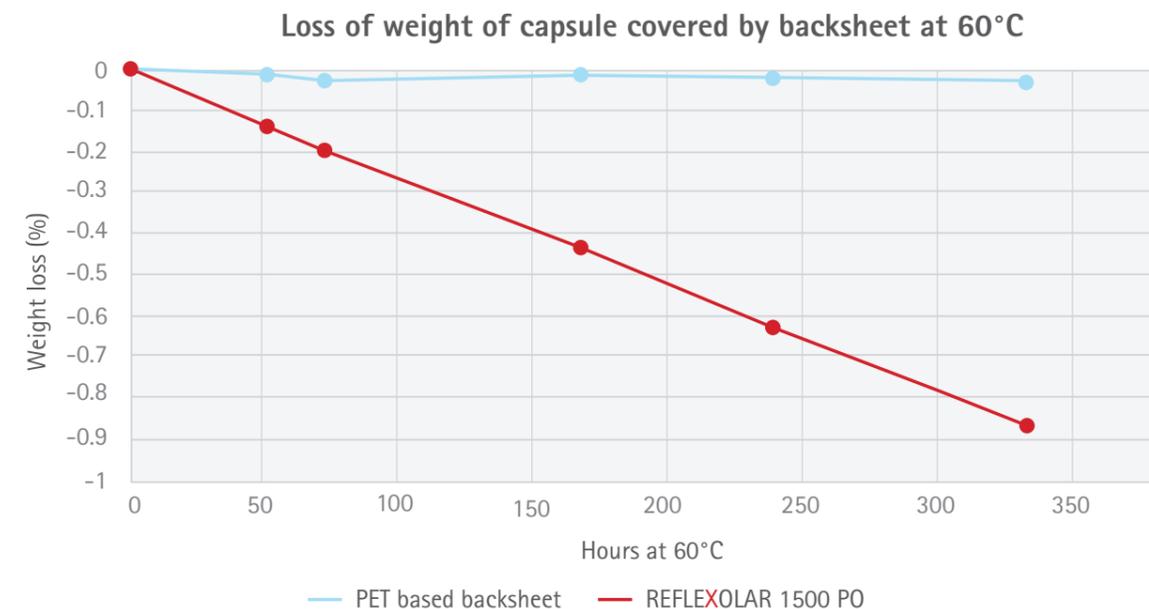


Figure 1: The acetic acid permeability of RENOLIT REFLEXOLAR 1500 PO back sheets is much higher than the one of PET based back sheet (measurements by loss of weight of cups, sealed with the back sheet - 60°C).

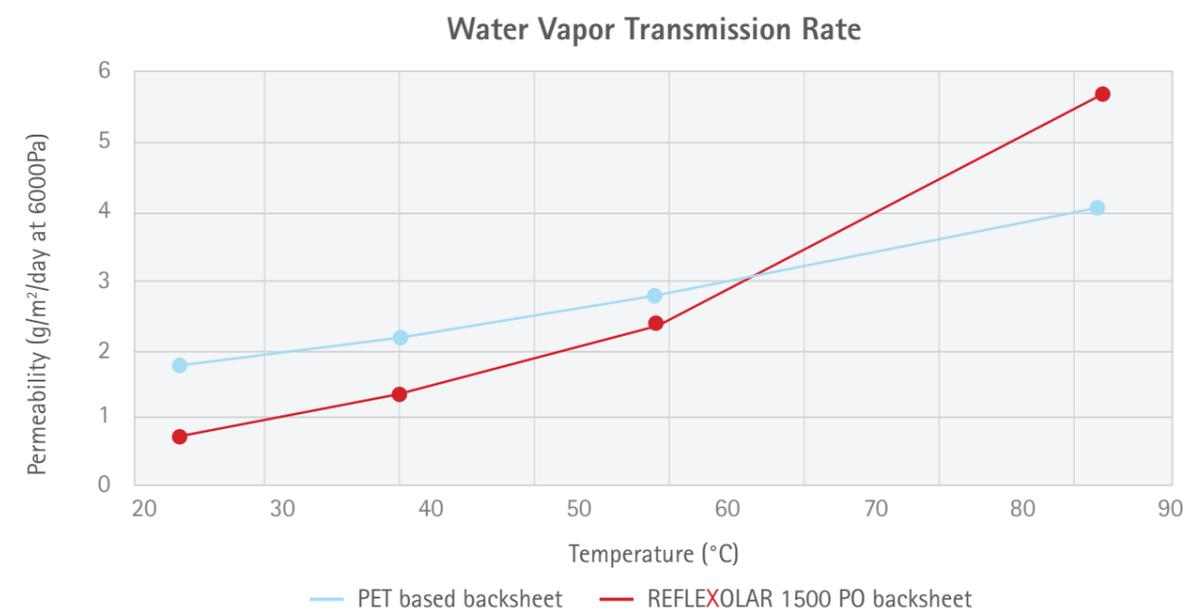


Figure 2: The RENOLIT REFLEXOLAR 1500 PO back sheets achieve a better balance of Water Vapor Permeability, reducing water ingress in humid (cold) conditions and allowing better water egress in drying (hot) conditions.

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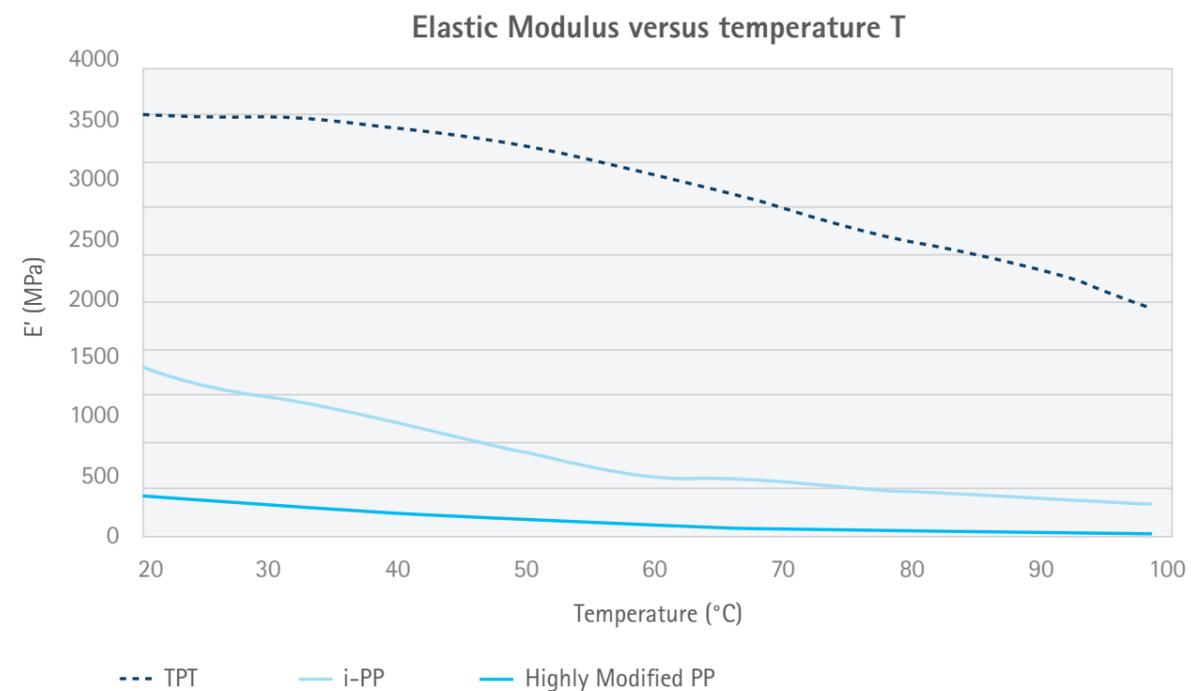
Better warpage control

The raw materials (PolyPropylene alloys) of the **RENOLIT REFLEXOLAR 1500 PO** back sheets are selected to minimize cooling forces after laminate production. The result is less warpage and less glass bending of the laminate.

This is very important to achieve bigger modules (72 cells or more), using thinner glass (weight reduction) and thicker back sheet (1500 VDC market).

Specific back sheet designs are possible (freedom of choice of raw materials and alloys) on request to further reduce shrinkage forces.

The figure below shows the elastic modulus of core PET and PP alloys based layers. Depending on the PP alloy, the E modulus can be reduced by a factor of 6 to 50.



Elastic Modulus of PET and Specific PP formulations. Formulations can be selected to minimize shrinkage forces.



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New designs & manufacturing possibilities

The backside of the RENOLIT REFLEXOLAR 1500 PO back sheet is based on PolyPropylene alloys, which lend themselves ideally for welding (figure 1) and additive manufacturing (3D printing). By using these techniques, the backside can be attached to and combined with reinforcing, mounting or integration elements. The same goes for the junction box (figure 2) and framing. In any case, welded joints are far more durable and waterproof than glued ones (figure 3).



Figure 1: Detail of welded sealant Polymer.



Figure 2: Junction Box (black) overmolded with sealant Polymer (gray), compatible with RENOLIT REFLEXOLAR.

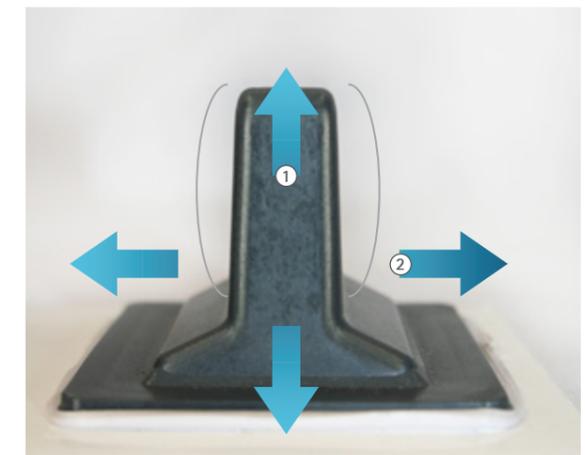


Figure 3:

- ① Tensile strength of > 240 kg. No adhesive failure with well selected polymers and RENOLIT REFLEXOLAR.
- ② 6 Bar of overpressure (!) demonstrates leak tight sealing to component to RENOLIT REFLEXOLAR.



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