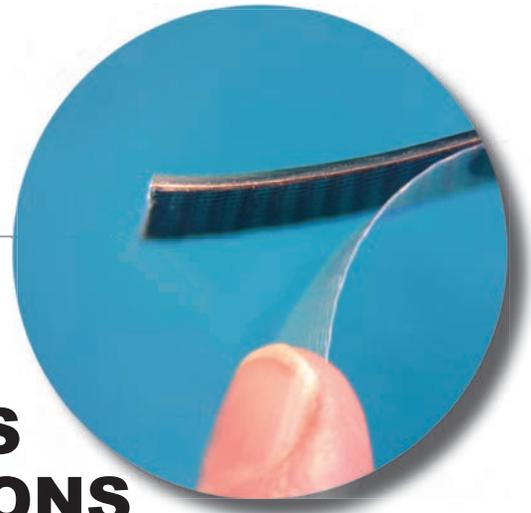


ArgoEdgeSealPLUS®

ENHANCED EDGE SEAL PROTECTION FOR GLASS LAMINATION APPLICATIONS

How SWM developed its revolutionary new TPU-foil-TPU edge seal product for TPU- and PVB-interlayered glass laminates

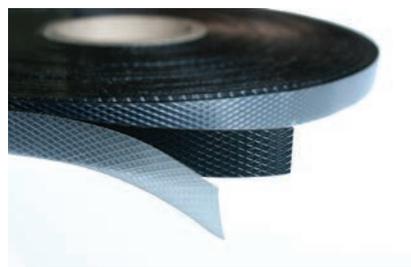


THE OBJECTIVE

Develop an edge seal technology that will allow glass laminators to be able to deliver more durable, longer lasting glass products to their transportation and architectural end-users.

BACKGROUND

In 1995 SWM co-developed and began manufacturing its original multilayer edge seal product, **BOC-9450 Edge Seal™**. Its purpose was to address the problems of chipping during handling and installation of laminated glass products, and to provide some barrier to liquids and gases that could penetrate and damage the glass interlayer while in-service. The edge seal product would protect either TPU or PVB optical interlayers.



The resulting **BOC-9450 Edge Seal** is was multilayer construction consisting of a 35-mil adhesive layer of clear, aliphatic thermoplastic urethane (TPU) film bonded to a second, 15-mil layer of black, temperature-resistant aromatic polyurethane, and capped with an embossed polypropylene carrier sheet. The product is slit to the specific width of the laminated glass composite, affixed to the

laminated edge just prior to autoclaving, and the polypropylene carrier removed before or after the autoclave process, depending on the user's preference regarding surface finish.

At high temperature and vacuum, the 35-mil adhesive layer melts, flows and then bonds to the edges of all the layers in the laminate. The result is a 50-mil TPU "bumper" that reduces the potential for mechanical damage during downstream handling, and a multilayer TPU barrier to the chemical environment of the end use.

NEED FOR IMPROVEMENT

This original **BOC-9450 Edge Seal** product from SWM has performed well over the years and this design is used by over 90% of all laminators using TPU interlayers. As applications have evolved, however, the environments they are exposed to have become harsher and the expectations of the end-users have increased.

Solvents contained in the caulks and sealants used during glass installation can penetrate through the edge and attack the interlayers used to bond the layers of glass and/or polycarbonate to one another. Security glass and other high tech architectural laminates can also be sensitive to attack from moisture and solvent penetration.

End-users demand a longer life expectancy, even from traditional PVB laminates. The root cause of these quality issues is chemical migration through the edges of the laminate. The corrective action required is to improve the

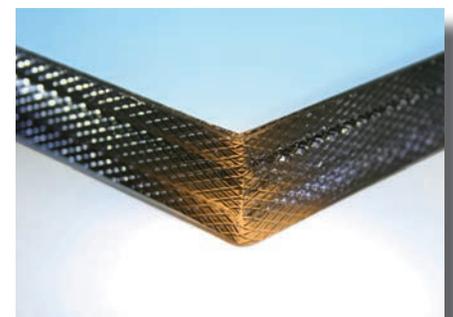
liquid and vapor barrier properties of the existing edge seal. In 2009 SWM took on this challenge.

LABORATORY TEST TO MODEL END-USE ENVIRONMENTS

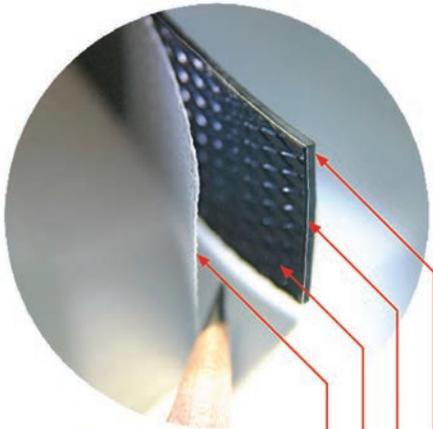
SWM developed a modified version of ASTM E-96 B to measure chemical and permeation through edge-seal designs. The modified method gives a relative, side-by-side comparison of permeation in and through edge-seal designs.

Specifically, SWM used MEK, a solvent commonly used in sealants, as the chemicals. Eight-ounce glass jars, 2.5-inches in diameter, are filled half way with MEK. A four-inch square of edge-seal material is sealed to the lid of the jar and weighed. The jar is placed in a laboratory maintained at 72 degrees Fahrenheit and 50 percent relative humidity.

The jar is then weighed every 24 hours for 7 days. The difference in the



New ArgoEdgeSealPLUS provides enhanced protection against window cleaning solutions and the solvents found in caulks and sealants.

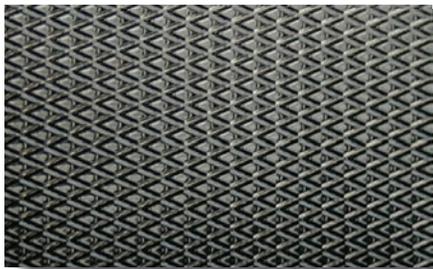


The clear, diamond-pattern-embossed carrier may be removed following lamination to the composite edge

A thinner layer of black polyurethane cushions the edge of the glass composite and accepts the embossed pattern of the carrier through the autoclaving process for an aesthetically pleasing appearance

The foil layer provides dramatically enhanced moisture and solvent resistance

A thick adhesive layer of clear TPU bonds ArgoEdgeSealPLUS® to the glass laminate



weight of the jar is reported in grams lost. The area of the edge seal barrier is πr -squared or 4.9 square-inches.

The permeation is then reported as g/area-time. To correlate with the scale of glass applications, the units are converted to grams/sq-meter-week.

For moisture-vapor permeation, SWM used ASTM F-1249/Tappi T-557:

Temperature: 37C

Test/carrier gas: Dry nitrogen with 90% RH

PHYSICAL PROPERTIES

Property	Test Method	Value
Adhesive layer melt index	ASTM D-1238	5g/10 min. @ 350°F (177°C)
Average peel	ASTM D-3167	>150 pli
Permeation (method)	Material Tested	g/m-week
Moisture ASTM F-1249	BOC-9450 Edge Seal	250
	ArgoEdgeSealPLUS	1.2
Solvent-MEK ASTM E-96B	BOC-9450 Edge Seal	20
	ArgoEdgeSealPLUS	2

NEW DESIGN

SWM immediately recognized that metal foils can provide dramatically enhanced resistance to moisture and solvent permeation. Standard BOC-9450 Edge Seal and concept samples of standard edge with a 1.0-mil layer of foil inserted between the black temperature-resistant-TPU layer and 35-mil adhesive-TPU layers were prepared. The resulting new foil version is aptly named **ArgoEdgeSealPLUS**.

The original and new designs were tested per the procedure detailed above. As expected, the foil layer provided the significantly improved chemical resistance shown in the table above.

MANUFACTURING

The next step was to develop an extrusion and slitting process to deliver **ArgoEdgeSealPLUS** to laminators. By careful selection and handling of the proprietary foil layer, a finished master roll is produced: 35-mil aliphatic TPU adhesive layer, 1.0-mil foil layer, 15-mil black temperature-resistant aromatic layer, capped with an embossed polypropylene carrier. The product is extruded in a clean environment. It is then slit and packaged in another clean environment, ready for shipment and autoclaving.

CONCLUSION

As glass lamination applications and market demands have evolved, end users require longer-lasting, more durable laminates. SWM has developed **ArgoEdgeSealPLUS**, incorporating metal foil for improved resistance to chemicals and solvent that can reduce the life span of TPU- and PVB-interlayered laminates.

ABOUT SWM

SWM is the largest manufacturer of aliphatic polyurethane optical interlayer films, extruding over 50 percent of the world's total usage. A privately held company, SWM also provides custom engineered, precision-extruded film and sheet for a wide variety of other critical applications using flat-die, cast-on-carrier and blown-film-extrusion technologies.



All statements, product characteristics, and performance data contained herein are believed to be reliable based on observation and testing, but no representations, guarantees, or warranties of any kind are made as to accuracy, suitability for particular applications, or the results to be obtained. Nothing contained herein is to be considered to be permission or a recommendation to use any proprietary process or technology without permission of the owner. No warranty of any kind, expressed or implied, is made or intended.