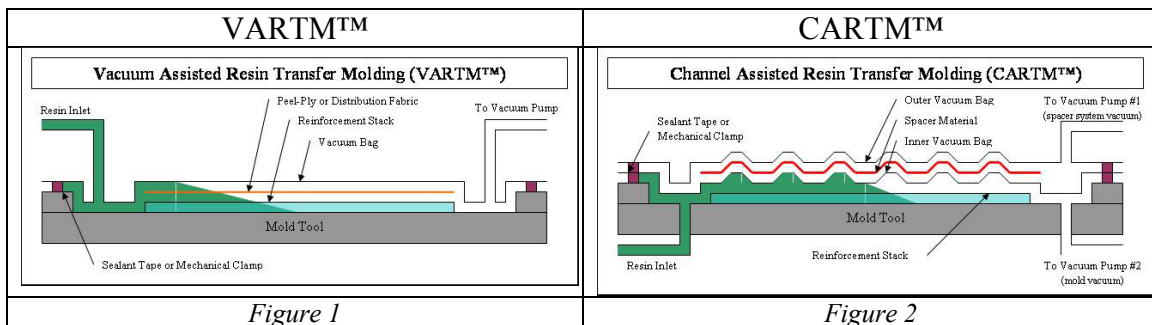


Application Note

Seaming Technique for Chemically Resistant, Reusable, Vacuum Bag Material

Design and construction of vacuum bag material is a fundamental aspect of composite fabrication with aggressive resins, such as epoxy and vinyl ester, in vacuum and channel assisted resin transfer molding processes. To achieve optimal results while maintaining the integrity of the overall assembly, it is important to consider the performance and application of vacuum bag components used in said resin transfer molding methods -- commonly referred to as VARTM™ and CARTM™. It is standard practice to use a pure silicone rubber vacuum bag for resin transfer molding because silicone has excellent thermal stability, flexibility, conformability and release properties. However, in spite of these positive characteristics, aggressive resins will absorb into the silicone polymer matrix in the uncured state and, upon curing, the vacuum bag becomes brittle. Furthermore, this process results in premature cracking and flaking of the bag material and, subsequently, poor release characteristics, reduction in tear strength and loss of transparency. Ultimately, bag failure eventually occurs in the form of vacuum leaks or adhesion to the cured resin, which in turn leads to excess disposal of warped materials and inevitably requires a more viable and cost-effective alternative.



The purpose of this application note is to introduce Arlon's reusable vacuum bag laminate as a beneficial alternative to the typically used components, and to present the results of a study conducted at Arlon comparing the pure silicone bag material to our new laminate. Additionally, included below is a step-by-step procedure for seaming the laminate. While application specific modifications may be necessary, this procedure is generally applicable for seaming the laminate to cover large molds or to conform to complicated geometries.

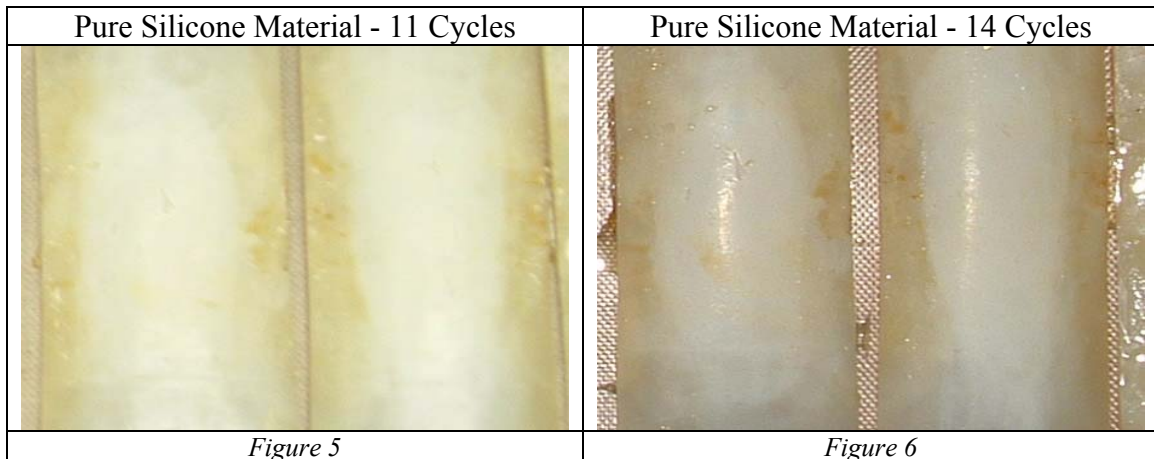
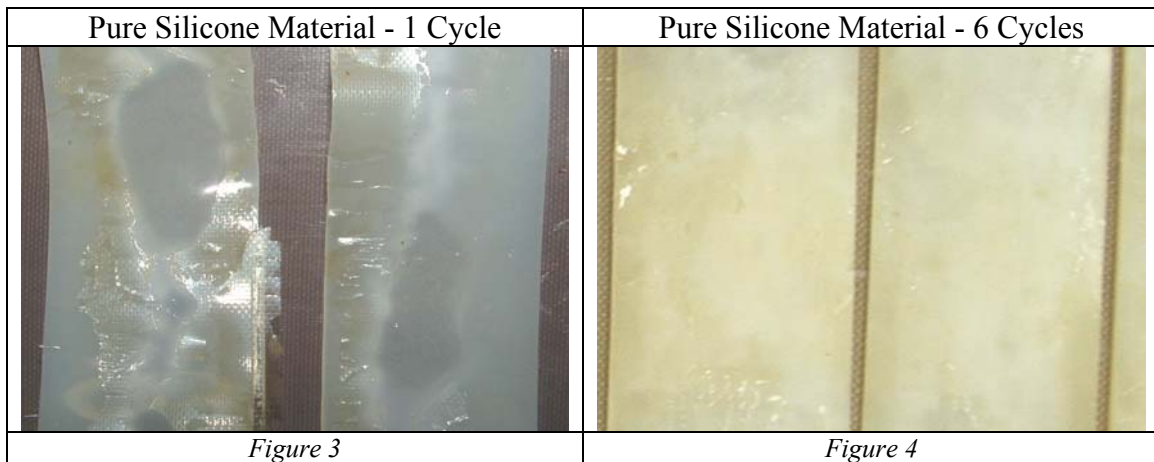
Arlon's chemically resistant, reusable laminate for vacuum bags offers a design solution to the fundamental problems engendered by the aforementioned pure silicone bag material. This new vacuum bag material is a composite of silicone rubber with a fluoropolymer film chemically bonded on one side. The fluoropolymer film side used in direct contact with resin effectively protects the silicone rubber from rapid chemical

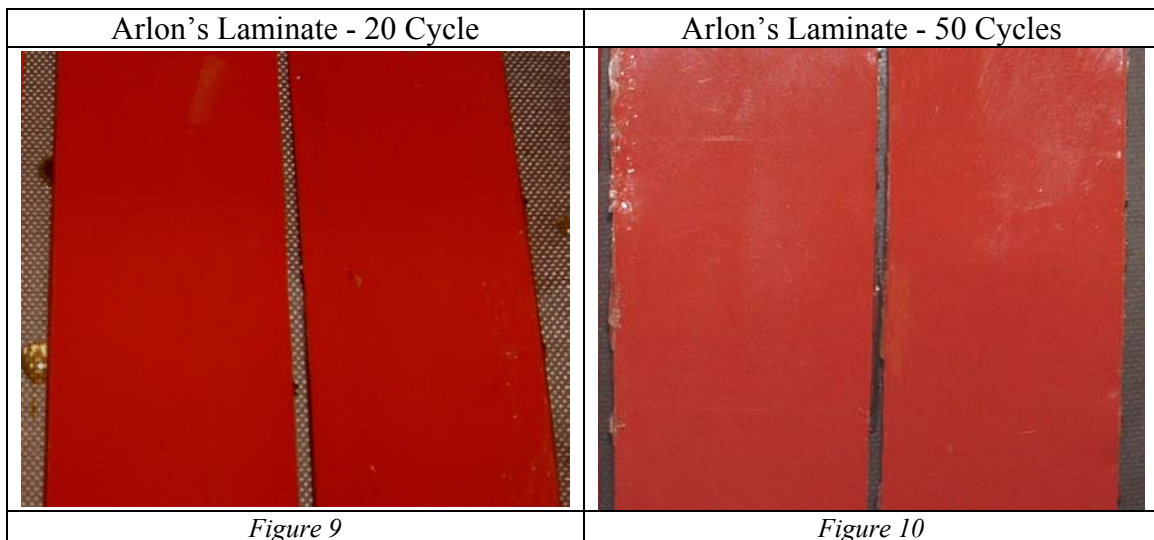
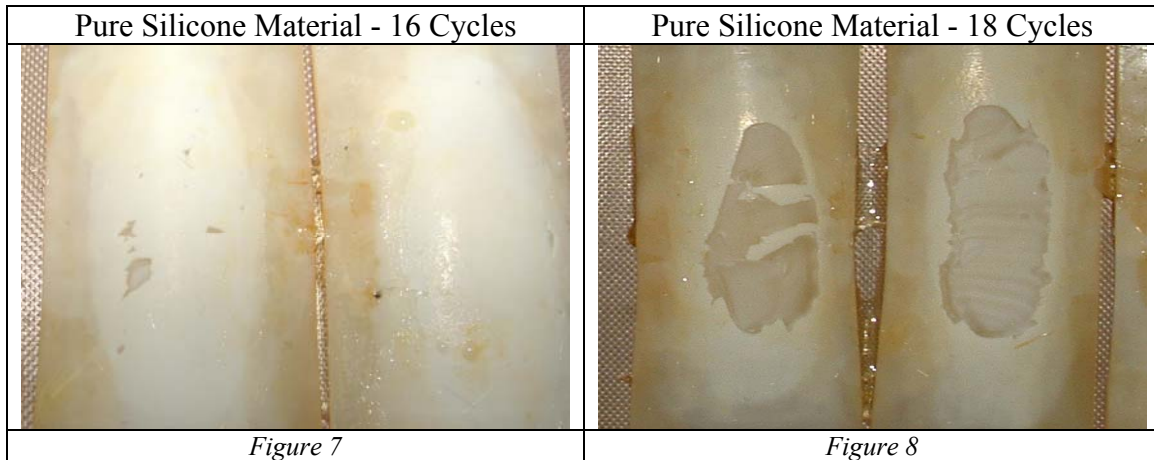


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degradation. The silicone rubber side improves handleability, strength at elevated temperatures and yields a creep-free, thermally stable seaming method for large applications. The composite construction gives long cycle life and excellent release characteristics for resin transfer molding to 154°C (310°F).

Arlon performed a side-by-side comparison of the new laminate versus a pure silicone bag material utilizing an aggressive epoxy resin. Specimens elongated 20% were placed in contact with uncured resin for 30 minutes, followed by a two-hour cure cycle at 110°C and ambient pressure. After 50 cycles at 110°C, Arlon's laminate showed no significant degradation of release properties or transparency. When the testing was performed on the pure silicone bag, the material began to cloud after only one cycle at 110°C with a complete loss of transparency after 8 cycles. Cured resin began to adhere after 15 cycles with minor pitting of the pure silicone bag material occurring during the removal of the resin. Catastrophic failure occurred in the form of material rips and tears during the resin removal at 18 cycles.





Note: Laminate was pigmented red for display purposes; the actual laminate is transparent

In addition to this comparison study, seamed laminate prepared in accordance with this procedure was tested for 30 cycles at 110°C under vacuum pressure. Specimens were placed in contact with uncured resin for 30 minutes, followed by a two-hour cure cycle at 110°C. The barrier tape adhesive did not discolor, nor did the barrier tape de-bond from the laminate despite removal of the seamed laminate at elevated temperatures when the barrier tape adhesive is at its weakest.

As previously noted, a step-by-step procedure for seaming the new laminate is included below. Although application specific modifications may be necessary, this outlined procedure is generally applicable for seaming the laminate to cover large molds or to conform to complicated geometries. Arlon's laminate is available in widths to 48 inches and continuous roll lengths to 250 yards. Seaming is accomplished with seaming tape and barrier tape used on opposite sides of the laminate to produce a strong, robust and chemically resistant seam (see Figure 26). The seaming tape is an uncured, unsupported



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silicone rubber tape that readily bonds to the silicone rubber side of the laminate to produce the load bearing portion of the seam. The barrier tape is a chemically resistant, pressure sensitive adhesive tape that is applied to the fluoropolymer side of the laminate. The barrier tape protects the vacuum bag seams from chemical degradation.

Step 1 Determine which side of the laminate has the fluoropolymer film by folding a section 180° onto itself. If the sides in contact slip across one another easily, the fluoropolymer film sides are in contact. If the sides in contact do not slip across one another easily, either the silicone rubber sides are in contact or a silicone rubber side is in contact with a fluoropolymer side.

Step 2 Apply the laminate to the mold surface, rubber side out. Overlap sections of the laminate by ~1 inch where seams are to be constructed. Double-sided tape may be used between the mold and the laminate to maintain placement during subsequent fabrication steps.

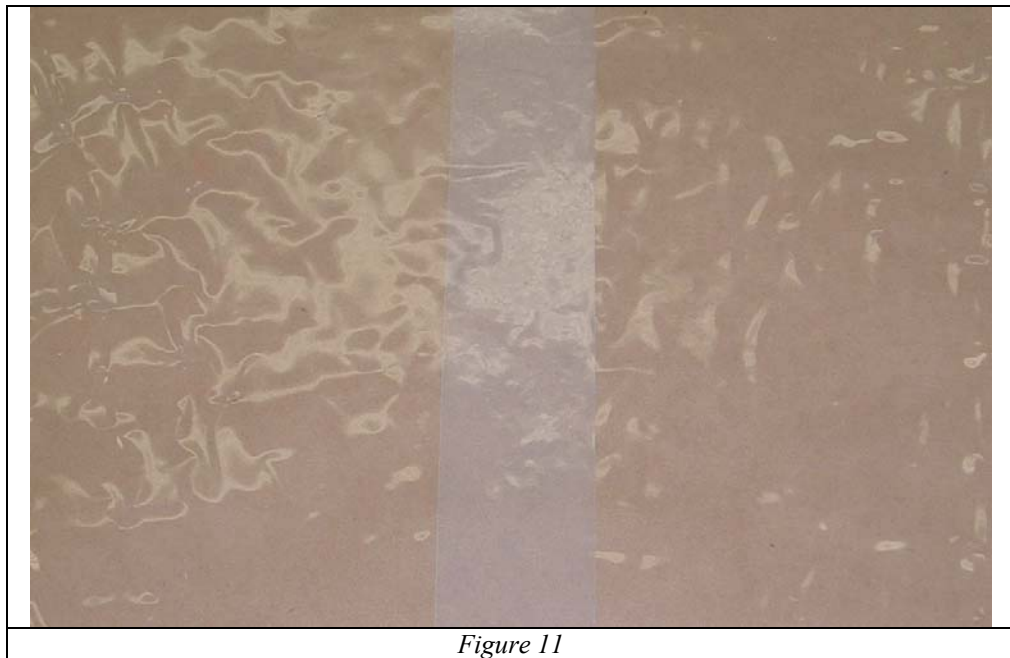
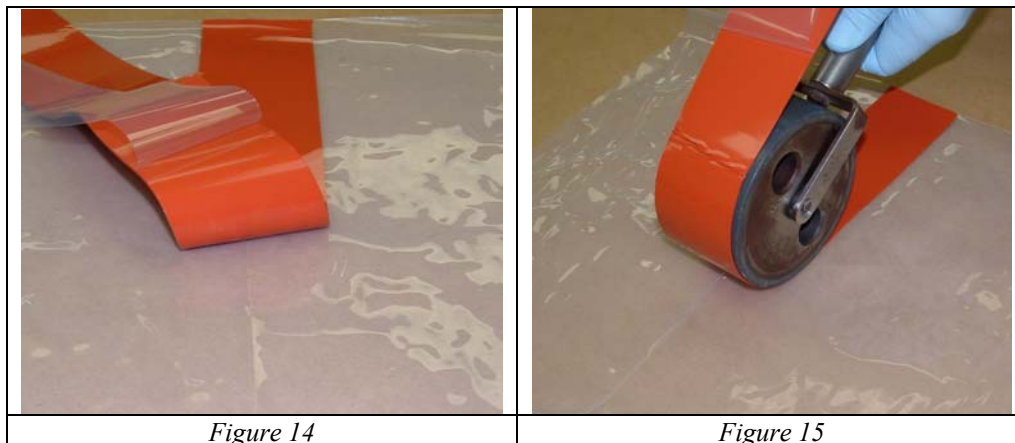


Figure 11

Step 3 Using a razor blade, cut through both layers of the laminate where seams are to be constructed. Cutting through both layers will ensure that areas to be seamed will fit tightly without any gaps that could weaken the overall integrity of the vacuum bag.



Step 4 Clean the surfaces to be seamed with isopropyl alcohol to remove any contamination introduced during previous steps. Remove the liner from the seaming tape and apply the tape to the silicone rubber side of the laminate where seams are to be constructed. The seaming tape should be centered on the joint so that equal amounts of material are applied to each side of the joint. Remove the rigid substrate from the seaming tape. Care should be taken to minimize air entrapment during application.



Note: In the following series of photographs, the seaming tape has been pigmented red to distinguish it from the laminate. The actual seaming tape is translucent.

Step 5 Cover the seam with an appropriate release liner and enclose the mold with a disposable Nylon or Polyester vacuum bag or a previously constructed, reusable silicone vacuum bag. Draw vacuum and cure for 30 minutes at 177°C. Note: Actual cure time will vary depending upon application specific details.

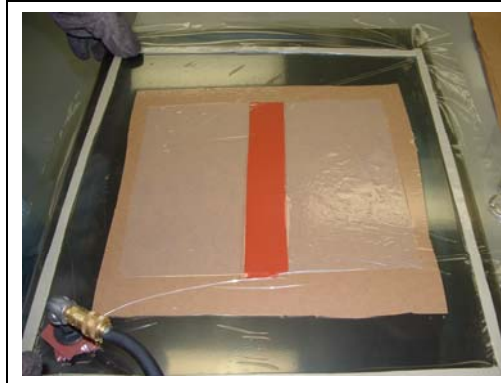


Figure 16

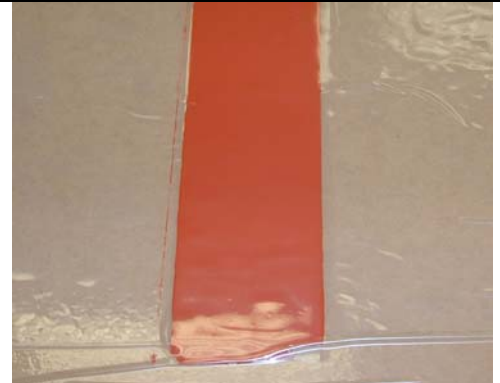


Figure 17

- Step 6 Remove the molding vacuum bag and invert the newly seamed molded vacuum bag with the fluoropolymer film side facing up. Apply masking tape parallel to the seams so that an area 2 inches wide is exposed with the seam centered.



Figure 18

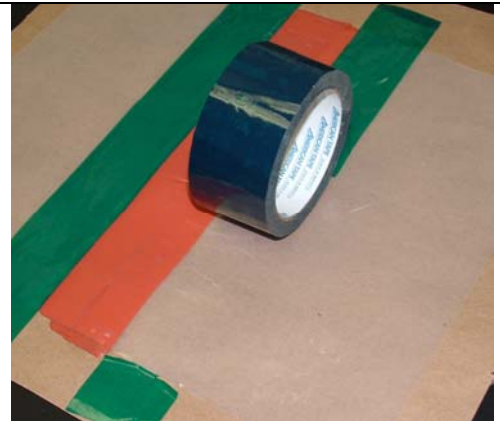


Figure 19

- Step 7 Treat the exposed fluoropolymer surface with either low pressure plasma or corona to raise the surface energy and increase adhesion of the barrier tape. Care must be taken to only treat areas where the barrier tape will be applied. Treatment outside of this area may result in adhesion of the resin to the fluoropolymer film side of the laminate.



Figure 20

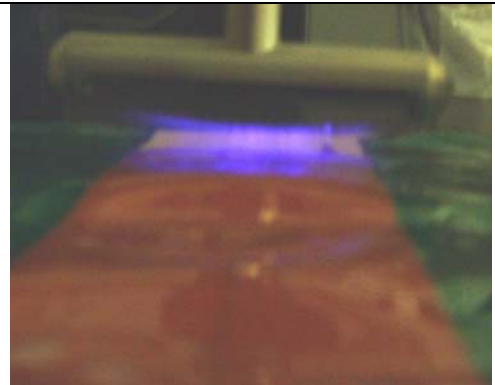


Figure 21

Plasma and corona treatments are similar processes that are used to increase surface energies, which in turn increase adhesion. Corona uses an electrical discharge (see Figure 22) to ionize air whereas plasma ionizes a low pressure feed gas (see Figure 23). Electron bombardment can occur much faster with plasma than corona allowing significantly shorter dwell times and increased etching at the surface.¹

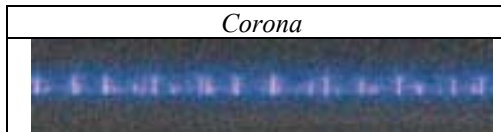


Figure 22¹

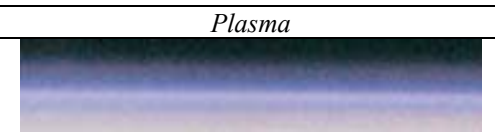


Figure 23¹

Step 8 Apply barrier tape to the recently treated area using a roller to prevent air entrapment. Remove the masking tape and the double-sided tape that were used to secure the vacuum bag to the mold surface, and clean with isopropyl alcohol prior to using the seam or the bag in an application.

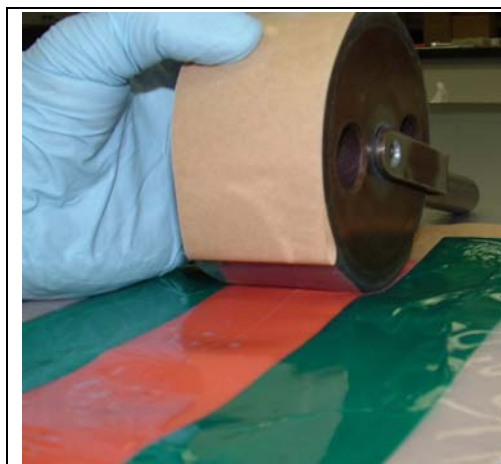


Figure 24



Figure 25



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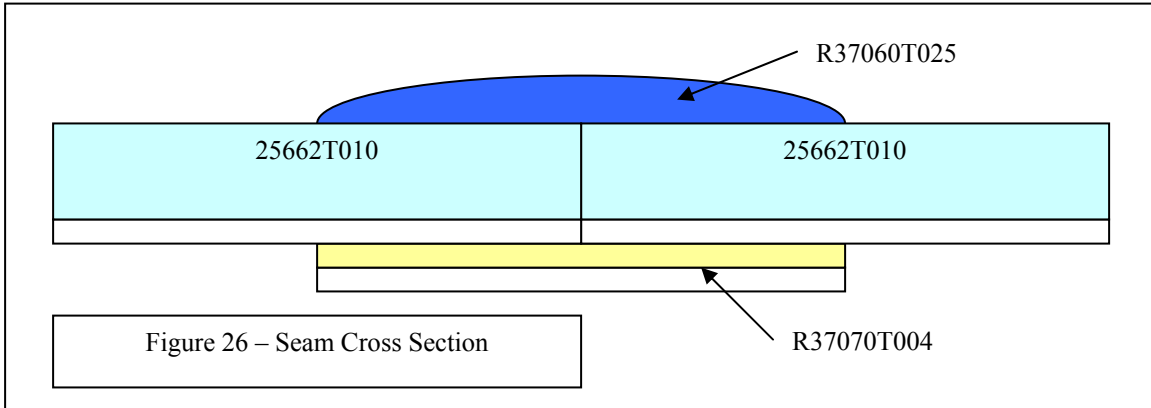


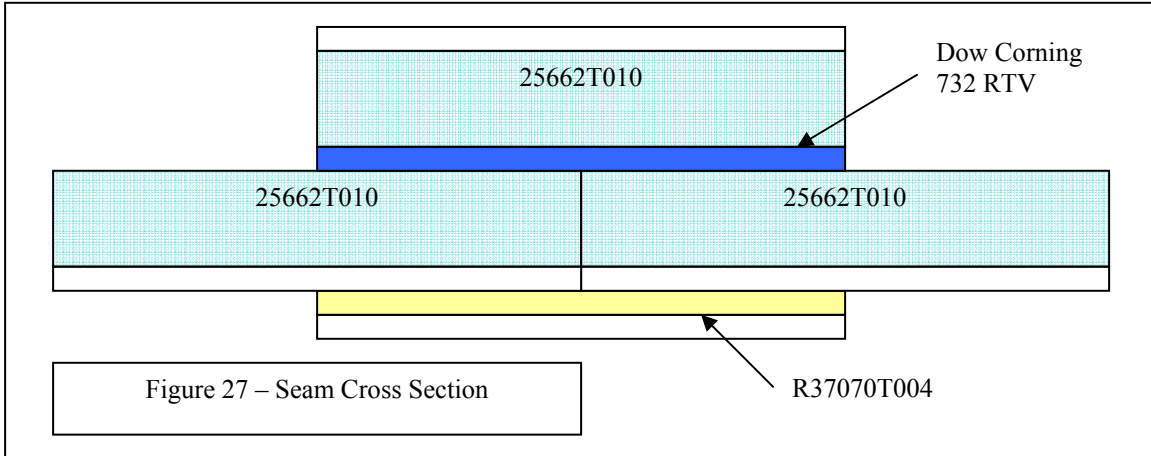
Figure 26 – Seam Cross Section

Application Note Reference	Arlon Part Number	Description
Laminate	25662T010	0.002 inch thick fluoropolymer film chemically bonded to 0.008 inch thick of fully cured silicone rubber.
Seaming Tape	R37060T025	0.025 inch thick unsupported silicone rubber
Barrier Tape	R37070T004	0.002 inch pressure sensitive adhesive chemically bonded to 0.002 inch. fluoropolymer film.



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Note: For customers who do not have elevated curing temperature capabilities, ovens, the R37060T025 Seaming Tape can be replaced with a silicone RTV capped with the 25662T010 laminate. Dow Corning 732 is an appropriate RTV for this seaming method.



For additional information visit www.Arlon-STD.com or call Arlon Customer Service at 1-800-635-9333.

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End Notes

1. Rory A. Wolf, "Plasma Treatment Boosts Adhesion," BNP Media (2004):
http://www.adhesivesmag.com/CDA/ArticleInformation/features/BNP__Features__Item/0,2101,123458,00.html