A Comparative Study:
Architectural Fabric Top Finish Performance

Introduction

Designers of architectural fabric structures have a variety of choices available based on strength, aesthetic requirements, fire code issues, and more. Once a decision is made to use a PVC-coated polyester fabric for the structure, still another important choice needs to be made—what top finish is best for the application.

The choice of the top finish is important because this finish protects the underlayers of the PVC-coated fabric from UV degradation, water, and wind, and has a major impact on the aesthetic performance of the structure in particular. Under normal use conditions, this top finish can erode and even disappear, exposing the PVC coating, which attracts and holds dirt. If aesthetics are an important criteria, the goal is to have the top finish resist environmental elements and retain a bright, clean appearance over the expected life of the structure.

This comparative study focuses on the choice of the top finish, and will show conclusively that PVC-coated fabrics bonded with DuPont Tedlar® PVF (polyvinyl fluoride) film resist dirt, pollution, and solar radiation far better than commonly available acrylic and polyvinylidene fluoride (PVDF) liquid surface coating systems.

What are the top finish choices available?

These three products are typically available as top finishes for vinyl-coated fabric:

1. **Acrylic topcoat** is a thin liquid coating applied to the surface of the PVC-coated fabric. Acrylics are generally known to have fair resistance to deterioration by UV light, so this thin coating is expected to erode and wear away relatively quickly, exposing the PVC and the fabric to the elements. As the plasticizers in the PVC migrate to the surface and attract and hold dirt, resulting discoloration of the fabric structure may be a sign that failure of the PVC coating is progressing.
2. **PVDF** (polyvinylidene fluoride) is also applied as a thin liquid to the surface of the PVC-coated fabric. The PVDF polymer has better resistance to UV light than acrylics, but generally it is compounded with acrylics to reduce cost and make it heat sealable.
3. **DuPont Tedlar® PVF film** is not a liquid topcoat. It is a film layer that is bonded to the vinyl fabric in the manufacturing process. It is in the same polymer family as *Teflon*®, and proven in demanding applications such as awnings, outdoor signs, solar collectors, roofing, exterior truck/trailer panels, highway sound barriers, and commercial building panels for over 30 years. Well known for its durability, inertness, cleanability, and easy-care attributes, Tedlar® is inherently flexible and contains no plasticizers. It provides a clean, slippery surface that naturally resists dirt and is essentially "self-cleaning."

Why is thickness of the top finish so important?

It is important to measure thickness over time. Top finish can erode due to UV degradation combined with the effects of water and wind. This finish can disappear entirely, exposing the PVC beneath it, which will begin to attract dirt. If the top finish is no longer present, the fabric structure *will get dirty* and lose its aesthetic benefit. Note in particular the differences in thickness among the three top finish products throughout this study.

These studies were conducted to show the relative ability of commercially available surface finishes to protect PVC-coated polyester fabrics and their installed beauty. Accelerated weathering tests have been completed and natural weathering tests are underway. Although only the accelerated weathering final results are available at this time, interim photos are included to show that the natural weathering tests are consistent with the accelerated results in this document. A complete report of the natural weathering tests will be issued at approximately a 5-year testing interval.

Measurements are taken to determine changes in thickness, color, and gloss of the protective top finishes over time. Visual inspections are also made to assess dirt resistance and accumulation.

Test Methodologies

Accelerated Weathering

With the luxury of time, it would be best to conduct natural weathering studies over extended periods. Fortunately, where time periods of several years or even decades may be involved, accelerated weathering tests have been developed and accepted as reasonable predictors of long-term performance.

One such accelerated weathering test was first developed by the Society of Automotive Engineers for automotive paints. This test allows us to study the effects of ultraviolet and visible light, heat, and moisture in a relatively short time using commercially available weatherometers to assess the probable long-term effects of weathering.

In our accelerated study, exposures of 1200 kilojoules are equivalent to one year of South Florida exposure at an angle of 45 degrees from horizontal. This equivalency has been corroborated in other DuPont studies comparing accelerated and natural weathering of Tedlar® PVF film.

Natural Weathering (under way)

In addition to the effects of light, heat, and moisture cited above, other factors such as dirt, acid rain, and other pollution in the environment can have deleterious effects on fabric structure coatings over time. To determine these effects, ongoing exposure tests have been underway for 2.5 years at the DuPont natural weathering facility in Hialeah, Florida. Specimens are again angled 45 degrees from horizontal.

Materials Tested and Measurements Recorded

Seven different commercially available materials are being evaluated. All are white and are promoted by their manufacturers as architectural fabrics for commercial use today.

Samples were tested in the following categories:

- Three of the sample fabrics have acrylic surface topcoats, labeled Acrylic “A”, “B”, and “C”.
- Three of the sample fabrics have PVDF surface topcoats, labeled PVDF “A”, “B”, and “C”. Of the PVDF topcoats, the PVDF “B” sample is nonweldable and confirmed by infrared analysis to be essentially pure PVDF; PVDF “A” and “C” are weldable and confirmed by infrared analysis to be blends of acrylic and PVDF.
- One sample fabric was bonded with Tedlar® PVF film, labeled “Tedlar® PVF”.

All seven samples were subjected to accelerated weathering and were monitored at selected intervals. Thickness of the protective layer was measured by optical microscopy or by transmission electron microscopy (TEM). Color and 60-degree gloss change were recorded as well.

Accelerated Weathering Test Results

Thickness Change

Figure 1 shows the changes in top finish thickness over the equivalent of nearly 10 years for all samples. These results are of great importance, because a reduction in thickness can compromise protection over time.

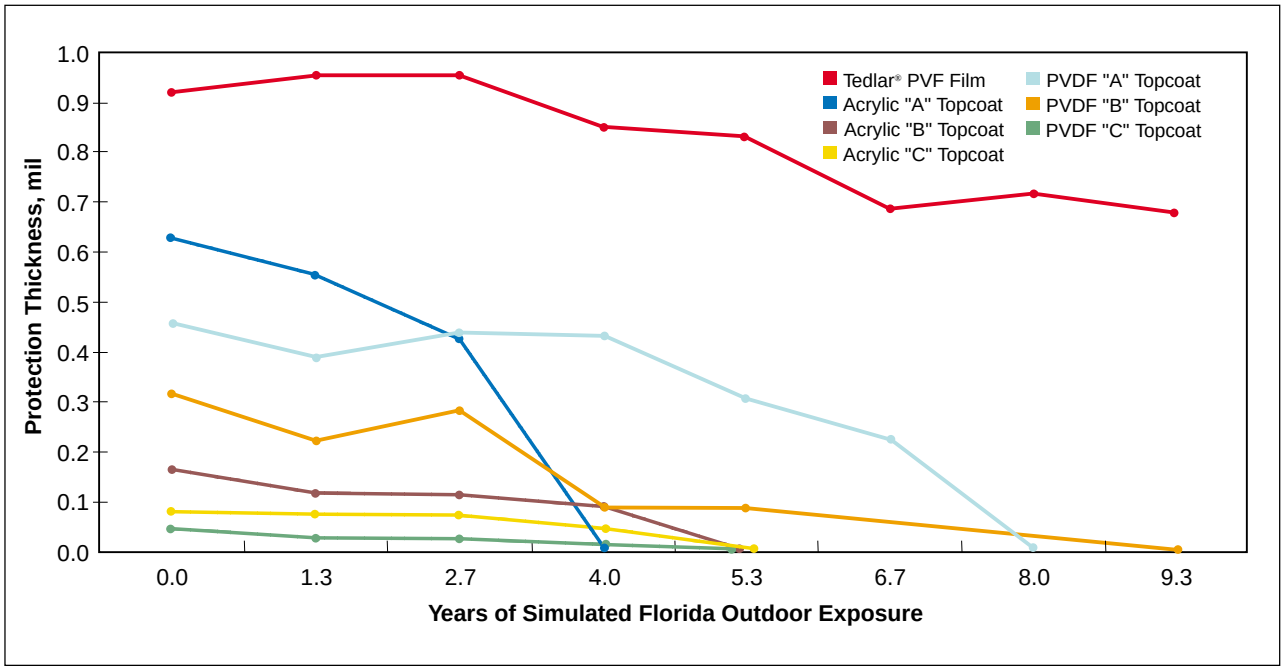
Note the following:

- Before any testing, the acrylic and PVDF surface coatings are relatively thin in comparison to the 1-mil (.03 mm) thick Tedlar® PVF film, and their thicknesses vary depending on the material source.
- Acrylic “A”, the thickest of the coating materials initially, deteriorates fairly rapidly and, as with the other acrylic coatings, is virtually gone in 5 years.
- PVDF coatings “A” and “B” are depleted between 7 and 9 years, while PVDF “C” is depleted in 5 years.
- After 11,200 kilojoules of exposure, or the equivalent of 9.3 years, the Tedlar® PVF film remains intact, has retained more than 72% of its thickness, and is still thicker than the acrylic and PVDF coatings were at the *start* of testing.

Color Change

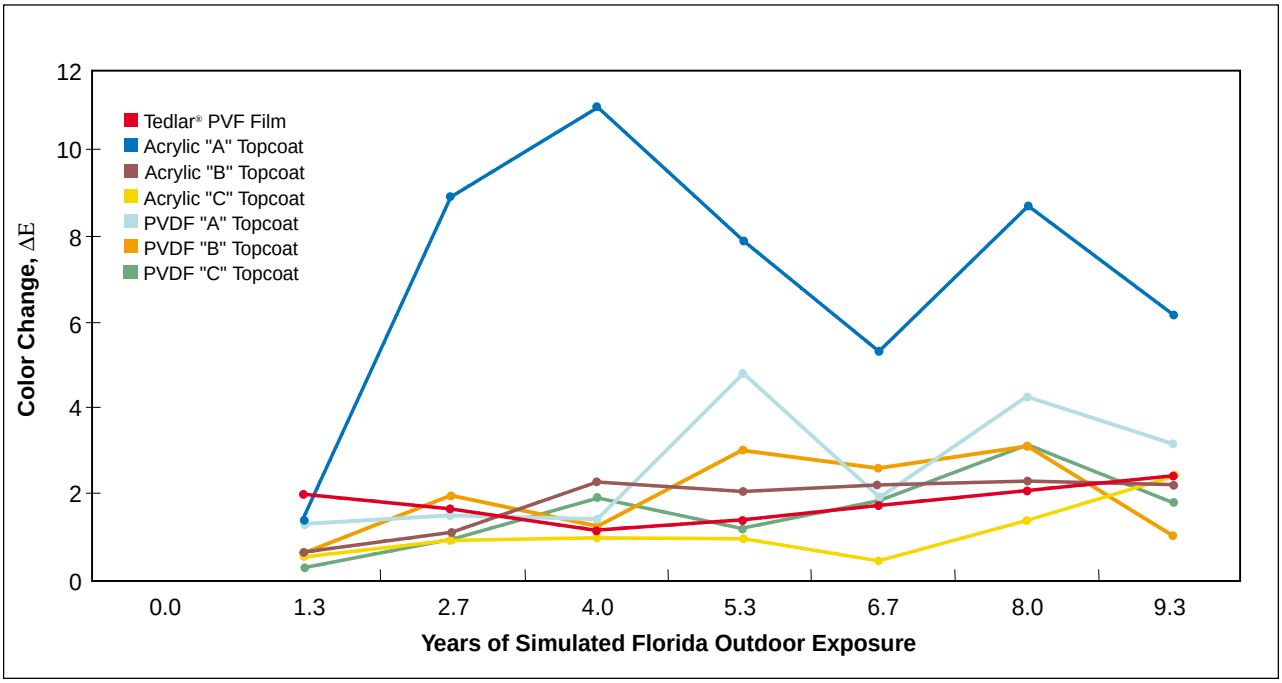
Figure 2 shows the top finishes compared with respect to color change. For any application where aesthetics are important, a dramatic color shift would, of course, be unacceptable.

Figure 1. Comparison of Thickness Change in Top Finish Materials



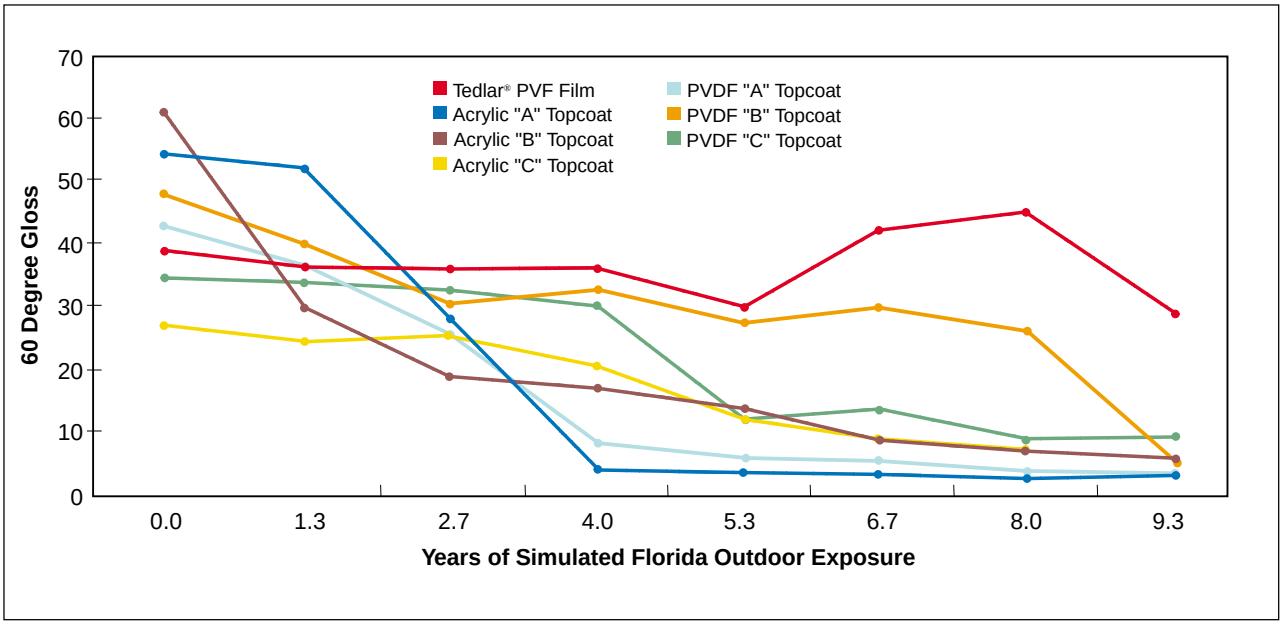
Note: This simulation shows that Tedlar® protective film not only starts out thicker than any of the other protective coatings, but retains superior thickness long after the others eroded completely.

Figure 2. Comparison of Color Change in Top Finish Materials



Color change can be attributed to degradation by UV light and dirt pickup. Note that the Tedlar® PVF film shows no color change after the equivalent of nearly 10 years of exposure.

Figure 3. Comparison of Gloss Change in Top Finish Materials



The Tedlar® PVF film shows excellent gloss retention after the equivalent of nearly 10 years of exposure, while the coating materials have failed to maintain their integrity. In fact, because the protective layers of the coating materials have been essentially depleted, both color and gloss measurements on these systems are probably the properties of the PVC substrate alone.

Gloss Change

The loss of gloss, in addition to being aesthetically displeasing, results in greater surface roughness, which leads to dirt retention.

Natural Weathering Test Results

This testing is ongoing to study the dirt resistance/accumulation of selected samples as well as to demonstrate correlation with accelerated weathering. As of this writing, 2.5 years of natural weathering have occurred.

Figure 4 shows samples after only 2.5 years of natural exposure. The color change and dirt retention alone suggest that the samples with both the acrylic and PVDF surface coatings are deteriorating much faster than the sample bonded with Tedlar® PVF film.

Conclusions

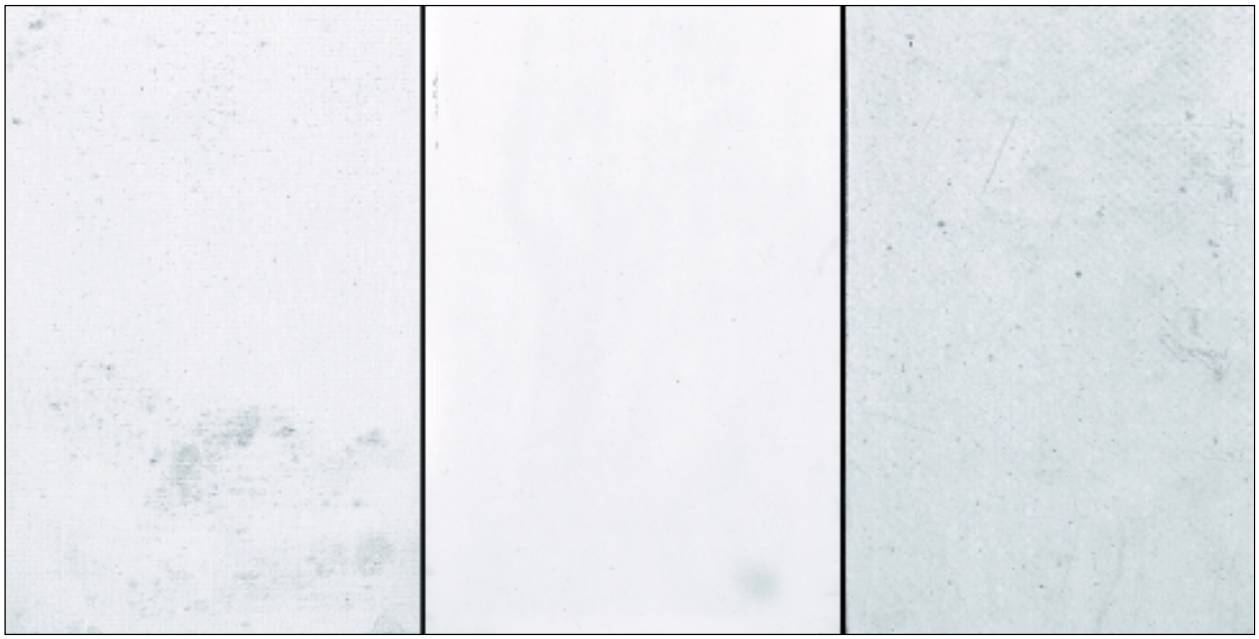
These accelerated and natural weathering studies indicate that of the seven commercially available architectural fabrics tested, the top finish of Tedlar® PVF film is significantly more durable. Its protection thickness after the equivalent of nearly 10 years of accelerated aging still surpasses the *original thickness* of all the liquid coating systems.

Most of the acrylic and PVDF coatings are so depleted that they provide no protection beyond 5 years in accelerated weathering.

After 2.5 years of natural weathering, the acrylic and PVDF coatings show significant dirt accumulation and discoloration, while the fabric bonded with Tedlar® shows no signs of discoloration or significant dirt accumulation.

These studies confirm that for the best long-term durability and aesthetics, it makes sense to choose fabric structures bonded with Tedlar® PVF film. **Figure 5** shows examples of existing structures using fabrics bonded with Tedlar®.

Figure 4. Side-by-Side Photo of Three Top Finish Materials After 2.5 Years of Natural Exposure



PVDF **Tedlar® PVF** **Acrylic**

Figure 5. Three of the Many Fabric Structures Worldwide That Have Been Constructed to Meet Specific Usage Needs and Environmental Conditions

Shelter-Rite® fabric coated with Tedlar® provides protection from the elements in Sault Ste. Marie, Ontario, Canada. This pavilion houses hospitality and meeting space on an Indian reservation.

This multipurpose sports complex in Guanare, Venezuela will keep 7,000 fans comfortable for basketball. Its huge clear span tension membrane roof is Shelter-Rite® fabric with bright white Tedlar® PVF film.

Construction costs were a major concern for the air-conditioned Green Valley Athletic Club in Henderson, Nevada, which accommodates four tennis courts under the air-supported structure protected by Tedlar®.

Shelter-Rite® is a registered trademark of Seaman Corporation.

All the results in this document were obtained using commercially available PVC-coated fabric. Weatherometer tests were performed by DuPont at their testing facility in Wilmington, Delaware.

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