DUPONT

Tedlar®

Advanced Materials

Mold, Mildew and Bacteria Performance of Tedlar® PVF Films

DuPont™ Tedlar® is a versatile polyvinyl fluoride (PVF) film. For more than 60 years, Tedlar® PVF films have provided durable, long-lasting protection and timeless aesthetics to many types of surfaces that are subjected to harsh environments. Available as transparent film or in a variety of colors and gloss levels, it is typically applied to the surface of other materials to provide added durability, cleanability and chemical resistance. Its applications span a range of industries, including transportation, aerospace, building and construction, graphics and signage, electronics and photovoltaics.

Polyvinyl fluoride film is naturally transparent and flexible, enabling its use without addition of any co-resins or plasticizers. It is formulated to provide a desired color, gloss or special functionality using only inert additives that do not sustain the life of microorganisms like mold, mildew, fungus and bacteria. When sterilization is required to remove residual microbes, the films have extremely high resistance to degradation by chemicals and disinfectants for even the most rigorous disinfection protocols.

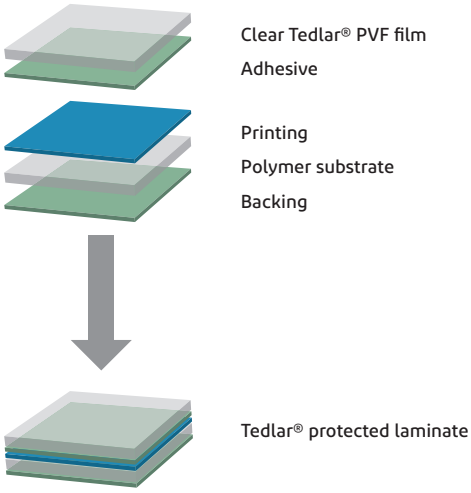


Figure 1: Picture of Tedlar® PVF film and a schematic of a laminated structure including Tedlar® as a protective surface glazing

Mold, Mildew and Fungus Resistance

Tedlar® PVF films do not support the growth of mold, mildew and other fungi, as the films do not contain a nutrient source for these microorganisms. This is demonstrated by two standard tests: ASTM G21 and UL 2824.

- ASTM G21: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- UL 2824: GREENGUARD Certification Program Method for Measuring Microbial Resistance from Various Sources using Static Environmental Chambers.

The ASTM G21 test is conducted by placing samples onto the surface of nutrient agar and spraying with a mixed spore suspension of five fungal strains: Aspergillus brasiliensis, Penicilium funiculosum, Chaetomium globosum, Trichoderma virens, and Aureobasidium pullulans. The samples are then incubated for four weeks and the amount of growth on the samples is observed at the end of each week. While the agar contains all the trace nutritional elements necessary to support fungal growth, it lacks a primary carbon source. For the microorganisms to exhibit substantial growth, the material under test would need to provide this nutrient source. Materials are assigned a rating each week and at the conclusion of the test, based on the criteria in Table 1.

Rating	Observed Growth
0	No Growth
1	Trace of Growth (less than 10% coverage)
2	Light Growth (10-30% coverage)
3	Medium Growth (30-60% coverage)
4	Heavy Growth (60-100% coverage)

Table 1: ASTM G21 rating system for fungal growth

This test was completed on a free-standing white Tedlar® PVF film (TWH15BL3) and a DuPont™ Tedlar® Wallcovering. The wallcovering consists of a transparent Tedlar® film laminated to a PVC substrate with an adhesive. Images of the results are shown in Figures 2 and 3. For each of the four weeks in the test, both samples tested achieved a rating of 1. The materials only exhibited trace growth, indicating that the materials do not contain enough nutrients to sustain substantial growth of fungus, mold and mildew.

Replicate 1 – Rating: 1 Replicate 2 – Rating: 1 Replicate 3 – Rating: 1

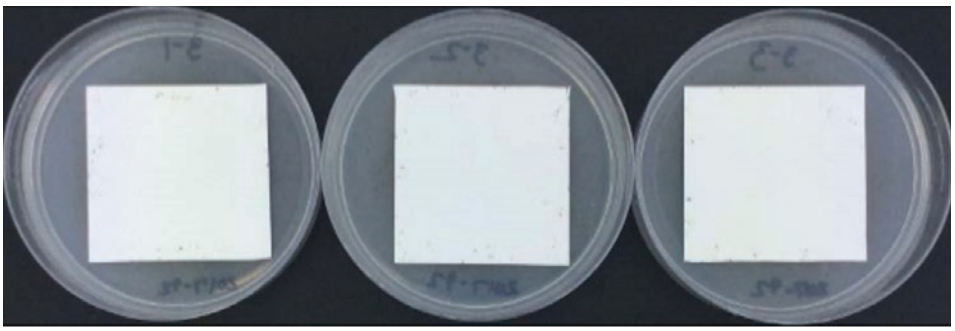


Figure 2: White Tedlar® PVF film (TWH15BL3) after four weeks of incubation in the ASTM G21 test. Trace growth was visible and additional growth was visible at 20X magnification.

Replicate 1 – Rating: 1 Replicate 2 – Rating: 1 Replicate 3 – Rating: 1

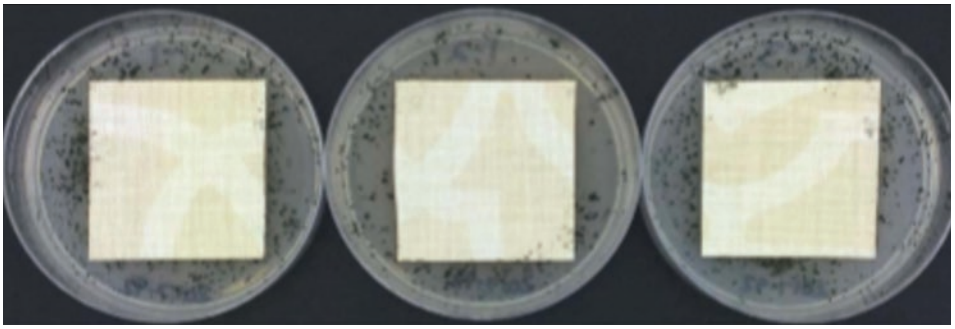


Figure 3: DuPont™ Tedlar™ Wallcovering after four weeks of incubation in the ASTM G21 test. Trace growth was visible and additional growth was visible at 20X magnification.

The UL 2824 test, which meets the requirements of ASTM D6329, is a part of the annual GreenGuard Certification Program by UL that recognizes products that have superior performance for indoor air quality. This test was run on DuPont™ Tedlar™ Wallcovering products as a part of an annual certification. The wallcovering consists of a transparent Tedlar® PVF film laminated to a decorative PVC substrate using an adhesive. The material was placed into a sterile Petri dish, inoculated with a known concentration of Penicillium brevi-compactum, and placed into an environmental chamber at 95% humidity at 25 °C for three weeks. A positive control sample, which is susceptible to fungal growth, was run in parallel to verify the activity of the microbes. The number of colony- forming units (CFUs) are counted at the beginning and end of the test, and a rating provided based on the criteria shown in Table 2. The DuPont™ Tedlar™ Wallcovering achieved the highest rating after the three-week test, indicating that it is highly resistant to mold growth. The number of colony-forming units used to calculate this rating are shown in Table 3 for both the wallcovering and the control material.

Rating	Interpretation	Criteria
4	Highly Resistant to Mold Growth	Log (CFU) ≤ 2.5 at 3 weeks, or Log (CFU) < 5.5 with a decrease of at least 0.5 Log (CFU) after 3 weeks
3	Resistant to Mold Growth	5.5 ≥ Log (CFU) > 2.5 at 3 weeks
2	Susceptible to Mold Growth	7.5 ≥ Log (CFU) > 5.5 at 3 weeks
1	Highly Susceptible to Mold Growth	Log (CFU) > 7.5 at 3 weeks

Table 2: UL 2824 rating criteria.

Material	Initial Log(CFU)	Log(CFU) after 3 week incubation	Rating
DuPont™ Tedlar™ Wallcovering	2.3	1.7	4 – Highly Resistant to Mold Growth
Control	2.5	7.7	1 – Highly Susceptible to Mold Growth

Table 3: UL 2824 results for DuPont™ Tedlar™ Wallcovering.

Resistance to Bacteria

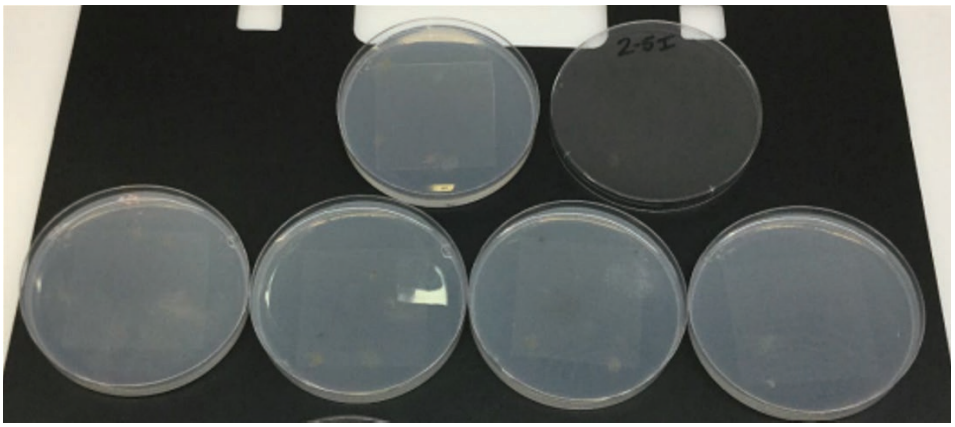
Bacterial growth is also not supported by Tedlar® PVF films which are formulated without plasticizers, processing aids or other additives that can become a nutrient source for microbes. This was demonstrated using ISO 846:2019 Method C: Evaluation of the Action of Microorganisms – Resistance to Bacteria. Several Tedlar® PVF films were tested, along with DuPont™ Tedlar™ Wallcovering. They are listed in Table 4.

Samples were placed on agar that was previously inoculated with Pseudomonas aeruginosa at the desired concentration and covered with additional inoculated agar. Negative control samples were also prepared with non-inoculated agar to facilitate comparison to inoculated samples. The samples and control were incubated for 28 days at 28-30 ˚C and evaluated for visible evidence of growth. The results for all the Tedlar® PVF films and DuPont™ Tedlar™ Wallcovering showed the same result; there was no growth on or around all five replicate samples and therefore the specimens do not contain nutritive components for this bacterium. This is illustrated in Figures 4 and 5 for the transparent Tedlar® PVF film and the wallcovering.

Tedlar® PVF Film or Product	Typical End Use
TTR10BM3 1 mil clear Tedlar® film	Aerospace, Building & Construction
TCP10BG3 1 mil UV clear Tedlar® film	Graphics Protection
TWH15BL3 1.5 mil white Tedlar® film	Architectural Fabrics, Building & Construction
TWH10BS1 1 mil white Tedlar® film	Building & Construction
TWH10SS1 1 mil white Tedlar® film	Healthcare, Building Interiors
TWH10SS3 1 mil white Tedlar® film	Building & Construction
DuPont™ Tedlar™ Wallcovering Type II	Hospitality, Healthcare, Building & Construction

Table 4: Tedlar®-based products tested via ISO 846:2019 Method C.

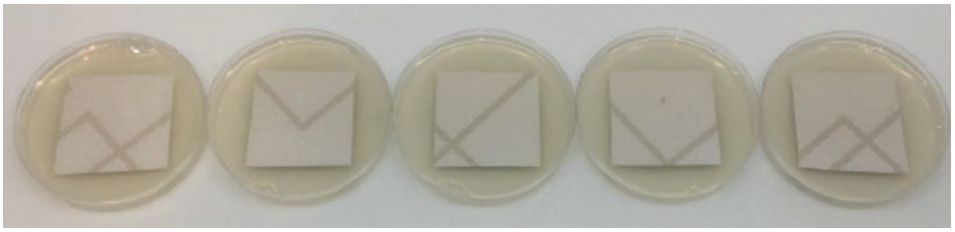
Inoculated specimens at Day 28



No bacterial growth in the agar or around the specimens. The specimen does not contain nutritive components.

Figure 4: Transparent Tedlar® (TTR10BM3) after 28 days of incubation in ISO 846 Method C, showing no bacterial growth in the agar or around the specimens.

Inoculated specimens at Day 28



No bacterial growth in the agar or around the specimens. The specimen does not contain nutritive components.

Figure 5: DuPont™ Tedlar™ Wallcovering after 28 days of incubation in ISO 846 Method C, showing no bacterial growth in the agar or around the specimens.

Cleaning and Disinfection

While Tedlar® PVF films do not contain nutritive components that support the growth of mold, mildew, fungus and bacteria, microbes may still find their way to the surface of the material from the environment. To eliminate these microorganisms from the surface, the surface must be cleaned and disinfected. Tedlar® PVF films have outstanding chemical resistance and durability to withstand repeated cleanings with even the harshest chemicals and disinfectants. The resistance of Tedlar® films to several common disinfectants used in a healthcare setting is shown in Table 5. The surface exhibited no cracking, delamination or changes in either color or gloss after five days of continuous contact.

The resistance to growth of mold, mildew, fungus and bacteria is complemented by the outstanding chemical resistance and ease of cleaning and disinfecting. This combines with the durability, versatility and timeless aesthetics to provide unique surface protection with unparalleled performance, indoors and out.

Disinfectant	Rating
Oxycide: Hydrogen Peroxide + Peroxyacetic Acid	E
Oxivir TB: Hydrogen Peroxide (0.5%)	E
Clorox Healthcare bleach solution (10%)	E
Virex II 256: Quaternary ammonium	E
Hand Sanitizer – 70% IPA	E
JF2 Glance: Non-ammoniated	E
JF3 Stride Citrus Neutral Cleaner	E

Table 5: Resistance of Tedlar® PVF film to common disinfectant solutions. The 'E' rating denotes that there was no perceptible change of appearance or mechanical properties when 2.5 mL were deposited on the surface each day for five days and cleaned off only at the end of the test.

For more information visit: **tedlar.com**

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