DUPONT

Advanced Materials

Tedlar®

Chemical Resistance of Tedlar® PVF Films

DuPont™ Tedlar® Overview

DuPont™ Tedlar® is a versatile film made from polyvinyl fluoride. 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 is naturally transparent and flexible, enabling its use without addition of any co-resins or plasticizers which can be susceptible to UV degradation, chemical attack, or provide nutrients to microbes. Most Tedlar® films can be stretched in any dimension to more than twice their original length without breaking, giving them superior formability, durability, and resistance to impact damage.

The chemical resistance of Tedlar® originates from its highly inert chemistry. The incorporation of fluorine into the monomer unit draws electron density away from the linear carbon backbone, effectively creating stronger bonds throughout the entire polymer chain. As a result, the PVF resin does not dissolve in any known solvent at room temperature, does not absorb water, and is inert to attack by strong acids and alkalis, providing the highest level of resistance to chemicals, pollutants, corrosive agents, cleaners, and disinfectants. The chemical resistance also prevents the ingress of staining agents and enables the removal of stains or graffiti from the surface without ghosting, using a wide range of cleaners and solvents.

Tedlar® is an excellent choice for use in high traffic areas that require frequent cleaning and disinfection, such as hospitals, healthcare centers, hotels, aircraft, and other public transportation. The cleanability ensures that the intended aesthetics are maintained for many years despite high levels of use. The chemical resistance ensures that the widest variety of disinfectants can be used to kill bacteria, viruses, fungi, and other pathogens without adversely affecting the material or the surface aesthetics.

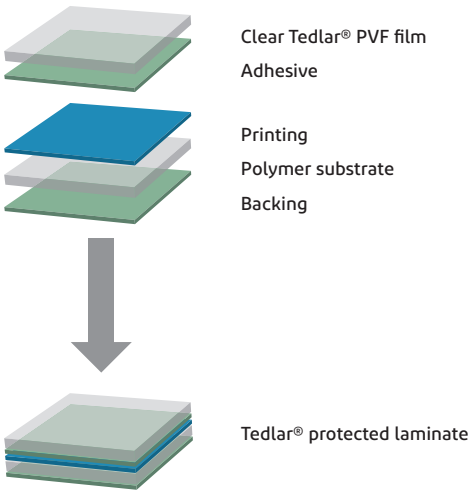

Figure 1: Picture of Tedlar® PVF film and a schematic of a laminated structure including Tedlar® as a protective surface glazing

Chemical Resistance and Compatibility of Tedlar®

Chemical resistance refers to the ability of a material to maintain its color, gloss, dimensions and mechanical properties during and after contact with chemicals. Chemical compatibility further details the lack of chemical reaction between a material and a chemical under consideration. Tedlar® PVF films have extremely high chemical resistance and compatibility with acids, bases, oxidizers, a variety of solvents including polar, non-polar, aromatic, aliphatic, hydrocarbon and chlorinated solvents, and other harsh chemicals. Even under extreme conditions with high concentrations, extended exposure times, and high temperatures, the Tedlar® film retains all or most of its original properties and appearance. In fact, there are no known solvents for Tedlar® films at temperatures below 149 °C.

Table 1 shows the resistance to acids, bases, solvents and miscellaneous chemicals after various immersion times between 25 °C and boiling temperatures. A rating of 'E' denotes that there was no perceptible change of either appearance or mechanical properties after the exposure, while a rating of 'G' denotes a slight or minimal change. While the list is not exhaustive, it shows both resistance and compatibility of a broad range of chemistries in long-term tests and tests accelerated with elevated temperature. These conditions are well in excess of many real exposure conditions and demonstrate the extreme robustness of the Tedlar® surface.

Product	Immersion time	Temperature	Rating
Acids			
Acetic acid (glacial)	1 year	21 °C	E
	1 month	75 °C	E
Hydrochloric Acid (10%)	1 year	21 °C	E
	1 month	75 °C	E
	2 hours	Boiling	E
Hydrochloric Acid (30%)	1 month	75 °C	E
Nitric Acid (10%)	1 month	75 °C	E
Nitric Acid (20%)	1 year	21 °C	E
Nitric Acid (40%)	1 month	75 °C	E
Phosphoric Acid (20%)	1 year	21 °C	E
Sulfuric Acid (20%)	1 year	21 °C	E
Sulfuric Acid (30%)	1 month	75 °C	E
Bases			
Ammonium Hydroxide (10%)	1 month	75 °C	E
Ammonium Hydroxide (12%)	1 year	21 °C	E
Ammonium Hydroxide (39%)	1 year	21 °C	E
Sodium Hydroxide (10%)	1 month	75 °C	E
	1 year	21 °C	E
	2 hours	Boiling	E
Sodium Hydroxide (54%)	1 month	75 °C	E
Solvents			
Acetone	1 year	21 °C	E
	2 hours	Boiling	E
Acetonitrile	1 month	75 °C	E
Benzene	1 year	21 °C	E
	2 hours	Boiling	E

Table 1: General chemical resistance performance of Tedlar® PVF Films with regards to most common cleaners

Product	Immersion time	Temperature	Rating
Solvents (cont.)			
Benzyl Alcohol	1 month	75 °C	E
Butyl Carbitol	1 month	75 °C	E
Butyl Carbitol Acetate	1 month	75 °C	E
Dioxane (14)	1 month	75 °C	E
Ethyl Acetate	1 month	75 °C	E
Ethyl Alcohol	1 month	75 °C	E
n-Heptane	1 year	21 °C	E
Isopropanol	1 month	75 °C	E
Kerosene	1 year	21 °C	E
Methyl Ethyl Ketone	1 month	75 °C	E
Toluene	1 month	75 °C	E
Trichloroethylene	1 month	75 °C	E
Xylenes	1 month	75 °C	E
Miscellaneous			
Bleach	1 month	75 °C	G
Phenol (5%)	1 year	21 °C	E
	1 month	75 °C	E
Sodium Chloride (10%)	1 year	21 °C	E
Sodium Sulfide (9%)	1 month	75 °C	E
Tricresyl Phosphate	1 month	75 °C	E

Table 1 (cont.): General chemical resistance performance of Tedlar® PVF Films with regards to most common cleaners

In addition to the chemical resistance and compatibility, the films are impermeable to greases and oils. This makes the films easy to clean as many common staining agents will remain on the surface of the film where they can be easily removed by cleaning, restoring the original surface aesthetic completely with no shadowing orghosting.

Hydrolysis Resistance of Tedlar®

Tedlar® PVF films do not readily absorb water and are highly resistant to degradation by hydrolysis. Even under an extremely harsh Highly Accelerated Stress Test (HAST) at 121 °C and 100% relative humidity, the films have no change in mechanical properties and no visible color change after 100hrs. In a longer-term damp heat aging test at 85 °C and 100% relative humidity, the films exhibit similar mechanical and color stability even after 4000hrs of exposure. Typical hydrolysis resistance results are shown in Figure 2.

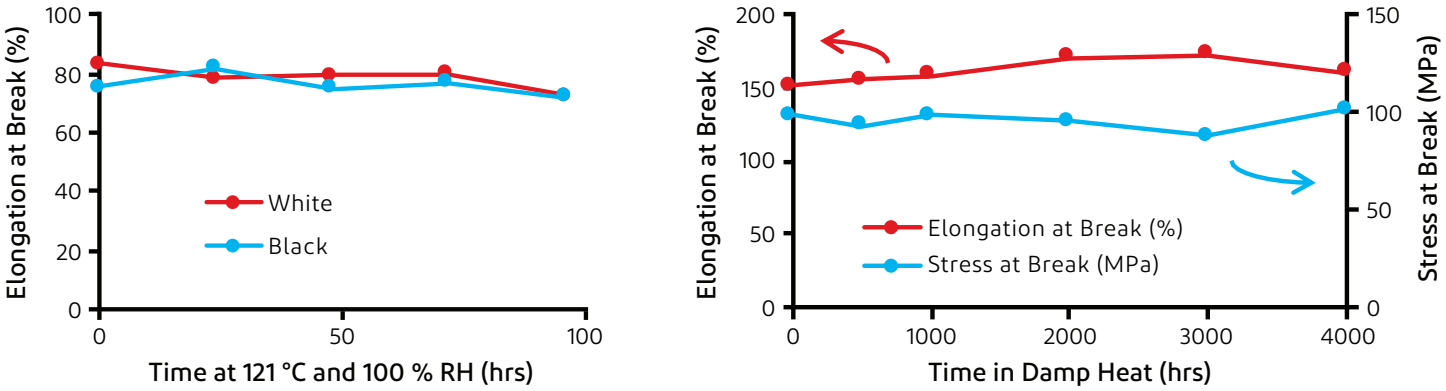

Figure 2: (left) The mechanical properties of white and black PVF films are unchanged after HAST testing at 121 °C and 100% RH for 4 days. (right) The mechanical properties of UV blocking transparent PVF film are unchanged after 6 months of damp heat testing at 85 °C and 85% relative humidity.

The Importance of Proper Protective Overlay Film Selection

Figure 3 shows a photo from a test where a permanent marker was applied to a sign whose right side is laminated with Tedlar® PVF film and left side is a premium cast PVC vinyl. A 100% acetone nail polish remover was used to attempt to clean off the permanent marker. The side with Tedlar® PVF film was successfully cleaned with the acetone, while the ink penetrated the vinyl laminate leaving permanent stains. When cleaning, the stains were smeared over the surface and the vinyl eventually was irreversibly damaged.

Figure 3: Extreme case demonstrating poor chemical compatibility of PVC and the exceptional cleanability and chemical resistance of Tedlar® PVF films.

Resistance to Disinfecting Solutions

While cleaning agents can easily restore the original surface aesthetic of Tedlar® films, most cleaners do not destroy viruses, bacteria, and fungal pathogens. For this, disinfecting solutions are often required. While these solutions can be highly detrimental to many materials after repeated application, causing discoloration or permanent structural damage, Tedlar® PVF films have outstanding resistance to the whole range of commonly used disinfectants.

Table 2 shows the resistance of a PVC substrate protected with Tedlar® PVF film. The disinfectants used represent the most commonly used classes of disinfectant solutions used in hospital environments. A 2.5 mL solution was deposited and left on the surface each day for 5 days. At the end of the five-day test, the surface was cleaned to remove any residues and assess the impact on the surface. A rating of 'E' denotes that there was no perceptible change of either appearance or mechanical properties after the exposure.

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

Table 2: Resistance of Tedlar® PVF films to common disinfectant solutions

Tedlar® PVF film has unique properties that make it an ideal surface protection material. No other surface protective film can offer the level of chemical resistance and compatibility that Tedlar® PVF films can offer. The durability of the films will ensure that the underlying materials look good and function well for decades even in the harshest chemical environments.

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

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