DuPont™ Teflon®
INDUSTRIAL COATINGS

Fact Sheet

DuPont™ Teflon® ETFE Coatings

Primer:
- **699N-129 Water-Based, Black**

High-Build Topcoat Powders:
- **532-6310 Clear**
- **532-6314 Green**
- **532-6118 Sparkling Beige**

Ultrasmooth Topcoat Powders:
- **532-6210 Clear**
- **532-6200 White**

Description

Ethylene tetrafluoroethylene (ETFE) is a thermoplastic copolymer derived from the polymerization of ethylene and tetrafluoroethylene (Teflon®) monomers. These materials are extremely tough and abrasion-resistant having excellent chemical resistance and continuous operating temperatures up to 150°C (300°F). ETFE is also an excellent electrical insulator and has good nonstick and low-friction properties.

The Teflon® 532-63xx ETFE coatings listed above represent a new, improved formulation of ETFE resins. All of the ETFE coatings listed above are now suitable for food contact end uses. Refer to **Table 2** for physical property information. Using appropriate product combinations, coating systems are now available for use in a wide variety of applications ranging from thin-film systems (75–250 µm [3–10 mil]) for service involving abrasion resistance or mild chemical service, to thick-film systems (up to 1300 µm [50 mil]) for linings where excellent chemical protection is required.

Thick-film Teflon® ETFE coatings have been improved for application in thicker films per coat and for better sag resistance when approaching the final thickness. The application technique involves a spray-and-bake procedure whereby multiple coats, sprayed and baked individually, are used to achieve the desired final film thickness. The resulting finish is tough, seamless, and without pinholes—perfect for applications in harsh chemical environments. The relative chemical inertness of Teflon® ETFE also makes it ideal for applications where maintaining product purity is critical.

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FDA Status

All Teflon® ETFE coatings listed on the previous page comply with FDA regulations in 21CFR governing components of coatings for direct food contact at temperatures up to 121°C (250°F) when applied according to fact sheet instructions, even when used up to 1300 µm (50 mil) thickness. Please note that topcoats, intermediate coats and primers must all comply for the system to be FDA conforming.

Medical

Do not use DuPont materials in medical applications involving permanent implantation in the human body or permanent contact with body fluids or tissues. For other medical applications, see "DuPont Medical Caution Statement," H-50102.

Typical Product Combination Examples

Thin-Film Systems

75–130 µm (3–5 mil)

699N-129 Primer
532-6210 Topcoat or 532-6200 Topcoat applied "dry on wet".
Black or white, one-bake, smooth, abrasion-resistant, mild chemical service.

Intermediate Systems

250–650 µm (10–25 mil)

1 – 699N-129 Primer
532-6210 Topcoat or 532-6310 Topcoat (multiple coats)
Smooth, black
(Use 532-6210 as a final topcoat for very smooth finish)

2 – 699N-129 Primer
532-6310 Topcoat (multiple coats)
532-6200 Topcoat
Smooth, white

3 – 699N-129 Primer
532-6314 Topcoat (multiple coats)
532-6210 Topcoat or 532-6310 Topcoat (multiple coats)
Smooth, green, chemical service
(Use 532-6210 as a final topcoat for very smooth finish)

4 – 699N-129 Primer
532-6118 Topcoat (multiple coats)
532-6210 Topcoat (one coat)
Sparkling beige, permeation-resistant

High-Build Systems

650–1300 µm (25–50 mil)

1 – 699N-129 Primer
532-6310 Topcoat (multiple coats)
Black
(Use 532-6210 as final topcoat for very smooth finish)

2 – 699N-129 Primer
532-6314 Green Topcoat (multiple coats)
532-6310 Clear Topcoat (multiple coats)
Green, chemical service

3 – 699N-129 Primer
532-6118 Topcoat (multiple coats)
532-6210 Topcoat (one coat)
Sparkling beige, permeation-resistant

Metal Surface Preparation

Best adhesion is obtained by thoroughly cleaning and then roughening the substrate.

Cleaning is preferably done using a commercially available hot alkaline solution. Commercial solvent degreasing is an acceptable alternative, as long as appropriate health and safety precautions are taken. Solvent cleaning by hand is not recommended. It is also the general consensus in the industry that a high-temperature burn-off prior to grit blasting provides improved performance of the final coating system.

Roughening is preferably done by grit blasting with aluminum oxide. New grit will give the best profile because it creates sharper peaks and valleys than can be obtained with old, rounded grit. The blast profile (surface roughness depth) should be at least 75–125 µm (3–5 mil) for intended coating thicknesses above 750 µm (30 mil). This profile can generally be achieved with coarse grit (10–20 mesh) using 620–690 kPa (90–100 psi) air pressure but surface properties of the part to be coated and design of the blasting equipment may require variations for optimal performance. For thin films a lower blast profile is adequate.

Primer Application

Teflon® ETFE has adhesion inherently superior to most other fluoropolymers and has been used without a primer in a variety of applications. However, a Teflon® primer will approximately double the adhesive strength of the bond.

The 699N-129 Liquid Primer is recommended for all coating systems. It is formulated with adhesive resins having outstanding resistance to high temperatures and can withstand the thermal abuse from multiple bakes during topcoat application.

Apply the 699N-129 Black Primer in a thin layer such that it just barely hides the blasted substrate when wet. (A blast profile of 75 µm [3 mil] will provide a primer thickness of approximately 14 µm [0.5 mil]). The actual thickness will (and should) vary depending on the depth of blast profile. Avoid excessive thickness, which can lead to intercoat adhesion failure. After air drying, the primer should visually appear to be slightly rough with a dull, mottled look. Small white specs (ETFE particles) may be visible, which is normal.

Carbon steel substrates are sensitive to rusting; the 699N-129 Liquid Primer is formulated with antiflash-rust additives. Preheating to 50°C (120°F) will minimize this problem, especially during humid weather or cool, damp, early morning start-ups.

The first powder topcoat can be applied directly over the wet, air-dried, or force-dried (66°C [150°F]) primer. Do not fully pre-bake the primer.

Powder Topcoat Application

Teflon® ETFE Powder can be applied using any commercially available powder coating equipment. The powder is given an electrostatic charge, which results in an attraction to the grounded metal part. Use the maximum charging voltage that provides a good electrostatic attraction without repulsion. This voltage is usually in the 20–30 kV range, but varies with the specific equipment used. Adjust delivery air pressure to produce a cloud of powder that does not excessively blow past the part.

After the first coat is applied, the part becomes electrically insulated and subsequent coats are poorly attracted, leading to thin films per coat. Thus, after the first coat, the hot flocking method (applying the powder to a hot part, immediately after it is removed from the baking oven) is combined with the electrostatic application. The resulting film builds will vary, depending on the temperature of the part and its mass (ability to hold heat). Spraying a hot part will always yield thicker films per coat than spraying a cold part. It may be necessary to decrease the application voltage after the first coat to avoid the formation of pits on the coating surface. These pits are caused by excessive charge and build.

CAUTION: Hot flocking procedures may result in overexposure to decomposition fumes. Adequate ventilation is an absolute necessity.

Another alternative is to use triboelectric spray equipment. These devices create an electrostatic charge (positive) by virtue of motion through tubes made of nylon or other material. The advantage of triboelectric spraying is that thicker film builds per coat are obtained compared to standard electrostatic equipment.

Thin Films

Use 532-6210 Clear or 532-6200 White Topcoats for all thin-film applications. These products have a high melt flow value and will provide smoother and glossier films. When using 532-6200 over 699N-129, a minimum of 100 µm (4 mil) of 532-6200 is recommended for complete hiding. Electrostatic application of a second coat on a thin-metal part is difficult. The first coat electrically insulates the part and the thin metal will not hold heat long enough to melt-fuse a second coat. Triboelectric spray equipment will provide better results.

CAUTION: Blistering may occur with these thin film topcoats if a total film build thickness of 150–175 µm (6–8 mil) is exceeded.

High Build Films

Use 532-6310 Clear, 532-6314 Green, or 532-6118 Sparkling Beige Topcoat for all high-build applications where the intended final film thickness exceeds 635 µm (25 mil). These coatings resist sagging and pulling away from sharp edges. The 532-6314 Green is preferred for all general purpose CPI applications due to its versatility to build thickness. The 532-6118 Sparkling Beige is specially formulated and provides tremendous benefit versus the 532-6310 or 532-6314 in permeation resistant applications. However exercise care when choosing this system due to risk of blistering at thicknesses above 750 µm (30 mil). Also note that topcoat adhesion is not as good as with the 532-6310 and 532-6314 systems. When using these topcoats, finish the part with a final coating of 532-6310 or 532-6210 Clear as recommended on page 5. A smoother final finish can be obtained by using 532-6210 Clear for the final coat.

When using 699N-129 liquid primer, apply the first powder topcoat electrostatically to the cold part and then place into a warm oven, approximately 300°F. Once the part reaches 300°F then step up to the recommended bake temperature. Do not load a cold part into an oven set for final bake temperature. This will cause the surface of the first coat to see high temperature longer than it should. This is especially important on thick parts that take a long time to heat up.

The film build per coat during hot flocking application is typically 75–250 µm (3–10 mil). However, this is only a guideline. Hot flocking can yield highly variable builds per coat depending on the mass and size of the parts coated.

Baking

Teflon® ETFE can be cured within a range of bake temperatures (metal temperatures), shown in **Table 1**.

Table 1
Teflon® ETFE Bake Temperatures

	532-6210 Metal Temp.*	532-63xx Metal Temp.*	532-6118 Metal Temp.*	Time at Metal Temp.
Recommended	274°C (525°F)	302°C (575°F)	315°C (600°F)	20 min
Minimum	268°C (515°F)	293°C (560°F)	305°C (580°F)	20 min
Maximum	282°C (540°F)	315°C (600°F)	330°C (625°F)	10 min

*Oven temperatures may need to be slightly higher.

Adherence to the recommended bake schedules is crucial to final performance for the high-build systems. These coatings have outstanding resistance to heat and are specially formulated to resist sagging in thick films, which is achieved by modifying the flowability of the molten material over time. The molten ETFE flows well initially, but the rate of flow decreases with increasing time. Insufficient dwell time in the molten state, therefore, can result in a film with pinholes. If encountered, this condition can be corrected by rebaking the part. Adjust the process time and/or temperature accordingly for subsequent parts.

Prolonged exposure at or above the maximum bake temperature can cause brown discoloration, polymer sagging, and blistering.

Safety

Follow normal industry safety procedures for handling and applying Teflon® products. Industrial experience has clearly shown that Teflon® ETFE coatings can be processed and used at elevated temperatures without hazard to personnel provided that adequate ventilation is used. Oven ventilation should be available at baking temperatures of 275°C (525°F) and above. Spray booth ventilation should be sufficient to capture all the overspray from powders or liquids.

CAUTION: Hot flocking procedures may result in overexposure to decomposition fumes. Adequate ventilation is an absolute necessity.

When handling powders, care should be taken to avoid powder inhalation. Care should be exercised to avoid contamination of cigarettes and other forms of smoking tobacco. This is especially important when handling powders. Wash hands before smoking or eating.

Before using Teflon® ETFE, read the Material Safety Data Sheet (MSDS) and the detailed information in the "Guide to the Safe Handling of Fluoropolymer Resins," latest edition, published by the Fluoropolymers Division of The Society of the Plastics Industry.

Storage

Teflon® ETFE powder coatings should be stored in their original plastic bags to avoid moisture pickup or contamination. These powders are stable indefinitely and are not sensitive to typical room temperature variations.

Teflon® ETFE liquid coatings are stable for 18 months from the date of manufacture when stored at normal room temperatures of 16–38°C (60–100°F). Do not allow to freeze.

Table 2
DuPont™ Teflon® 532-52xx ETFE Thin Film System
• System • Waterbased + Powders • Food Contact: No • Fluoropolymer: ETFE

Product Code	532-6200 Intermediate	532-6210 Topcoat	699N-129 Primer
Physical Properties			
Product Type	Powder	Powder	Liquid
Color	White	Clear	Black
Theoretical Coverage, $m^2/kg/25\ \mu$	23.1	23.4	7.22
Average Particle Size, µ	20–30	20–30	–
*Viscosity: Brookfield, cps sp # 2 at 20 rpm @ 25°C	N.A.	N.A.	100–700
Volume Solids, %	100	100	20.8
*Weight Solids, %	100	100	30.4
Density, gr/cm^3 (lbs/gal)	1.73 (14.44))	1.71 (14.27)	1.132 (9.45)
Flash Point, Seta °C	N.A.	N.A.	N.A.
Max. In-Use Temperature, °C (°F)	150 (302)	150 (302)	–
Coverage, sq.ft./gal (m^2/l)	–	–	326

– **Physical constants** are averages and are not to be used as product specifications. They may vary up to 5% of the values shown. This product is experimental and we did not manufacture enough batches to set specifications.

– **Storage life** is 12 months at 18–27°C (room temperature).

– For more information on health & safety refer to technical bulletin or follow normal industrial safety practices for handling and applying Teflon® products "Safe handling practices bulletin", label and MSDS for more information.

– For any medical application or development, please consult DuPont first.

– **Food Contact:** the compliance with the various national regulations existing in this field should be reviewed case by case.

Application

Substrate	Aluminum, stainless steel, and carbon steel.
Surface Preparation	Degreasing, gritblasting (recommended Ra = 4 µ minimum).
Screen	Primer: Through a 50 mesh (approx. 300 µ) stainless steel or nylon. Powder: Through a 30 mesh (approx. 550 µ) screen.
Electrostatic Voltage	24 kV for the powders; important to avoid repulsion.
Conveying Air	1.5–2 bar
Dosing Air	9.5–9 bar: To avoid blowing off the powder: The gun settings depend on the gun type and the complexity of the part. The given settings are indicative for Gema electrostatic gun.
Recommended DFT	18 µ of primer; 100 µ per coat for the powders.
Drying	Air dry the primer or force dry 5–10 min. at 100–110°C.
Curing (metal temp.)	10–15 min. at 280°C, the last cure can be longer to improve the flow of the resin.
Multiple Coats	Second and subsequent coats can be hot flocked. Finishing with 532-6210 gives a very smooth glossy appearance to the system.
Clean-up/Thinner	Water for the primer.

For additional information

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CAUTION: Do not use in medical applications involving permanent implantation in the human body or contact with internal body fluids or tissues. For other medical applications, see "DuPont Medical Caution Statement," H-50102.

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