DuPont™ ETFE Coatings

532-6410 High-Build Topcoat Powder 532-6405 Powder Primer and 699N-129 Liquid Primer

Industrial Nonstick Coatings

Product Information

Ethylene tetrafluoroethylene (ETFE) is a thermoplastic copolymer derived from the polymerization of ethylene and tetrafluoroethylene monomers. These materials are extremely tough and abrasion-resistant having excellent chemical resistance and continuous operating temperatures up to 150 °C (302 °F). ETFE is also an excellent electrical insulator and has good nonstick and low-friction properties.

The high-build 532-6410 ETFE coating represents a new, improved formulation of ETFE resin. 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 2000 µm [80 mil]) for linings where excellent chemical protection is required. Thick-film ETFE coatings have been improved for application in thicker films per coat. 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 ETFE also makes it ideal for applications where maintaining product purity is critical.

Property Data

Product Code	699N-129 Liquid Primer	532-6405 Powder Primer	532-6410 High-Build Topcoat
Properties[1]			
Color	Black	Green	Clear
Coverage,[2] ft^2/gal (m^2/kg)	339 (7.22)	1629 (22.4)	1629 (23.0)
Weight Solids, %	30.4	100	100
Volume Solids, %	20.8	100	100
Density, lb/gal (kg/L)	9.45 (1.13)	14.67 (1.76)	14.26 (1.71)
Viscosity[3], cP	100 – 700	N.A.	N.A.
Maximum In-Use Temperature, °F (°C) [4]	302 (150)	302 (150)	302 (150)

[1] Physical constants are averages only and are not to be used as product specifications. They may vary up to 5% of the values shown

[2] Theoretical coverage at dry film thickness (DFT) of 1.0 mils (25µ) based on 100% application efficiency. It does not take normal production losses into account

[3] Brookfield RVT (Measured with spindle 2 at 20 RPM/25 °C)

[4] ETFE, 532-6410, Topcoat only, no primer.

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Application Method

Substrate	Carbon steel, stainless steel, aluminum, except high copper containing alloys
Surface Preparation – Primer	Apply appropriate primer over clean, grit-blasted surface, per instruction for the primer. Degreasing, gritblasting (recommended Ra = 4 µm minimum). Screen through a 50 mesh (approx. 300 µm) stainless steel or nylon.
Surface Preparation – Topcoat	Powder: Through a 30 mesh (approx. 550 µ) screen.
Application	
Electrostatic Voltage	24 – 35kV 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 µm of liquid primer; 25–50 um of powder primer. 200–250 µm coat for the powder topcoat.
Powder Primer / Powder Topcoat	Apply 532-6405 Primer as a thin layer of approximately 25 - 50 µm [1-2 mils]. The actual thickness will (and should) vary depending on the depth of blast profile. Avoid excessive thickness, which can lead to intercoat adhesion failure. The first powder topcoat can be applied directly over the dry primer, however, a thin coat, less than 75 µm [3 mil] is recommended without electrostatic repulsion. Then cure at recommended conditions.
Curing (Metal temperature)	
Drying	Air dry the primer or force dry 5–10 min. at 100–110 °C. (Optional)
Curing (metal temp.)	Recommended: 580 °F ± 15 °F for 30 minutes 305 °C ± 8 °C for 30 minutes
Multiple Coats	Second and subsequent coats can be hot flocked.

All recommendations are based upon best knowledge.

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

Primer: 532-6405, Green

ETFE has inherently superior adhesion when compared to most other fluoropolymers, and has been used without a primer in a variety of applications. However, the ETFE primer approximately doubles the adhesive strength of the bond.

Primer: 699N-129, Black

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 18 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

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.

High Build Films

Use 532-6410 Clear Topcoat for all high-build applications where the intended final film thickness exceeds 635 μm (25 mil).

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.

Comparison of ETFE and ECTFE Fluoropolymer Resins

Electrical Properties

Both are good electrical insulators. They have similar nominal values for:

- Low Dielectric Constant
- High Dielectric Strength
- Low Dissipation Factors over a wide range of frequencies
- High Volume and Surface Resistivities

Thermal Properties

Both have high use temperatures. They have similar nominal values for:

- Maximum Service Temperature 302 °F (150 °C),
- Coefficient of Linear Thermal Expansion
- Deflection Temperature
- Thermal Conductivity

ETFE Thermal Advantages:

- Higher Melting Point

  The melting point of ETFE, 500 °F (260 °C), is higher than ECTFE, 473 °F (245 °C), ETFE thus provides a higher margin of safety in the event of an accident (for example, a "runaway" chemical reaction that could develop temperatures much higher than normal).
- Higher Thermal Stability
- Lower Low Temperature Embrittlement

ETFE is More Thermally Stable than ECTFE

Chemical Properties

ETFE is affected by strong oxidizing acids, strong organic bases and sulfonic acids at elevated temperatures.

ECTFE is affected by acids, bases and halogens at elevated temperatures, is attacked by amines, esters, and ketones, and is plasticized by halogenated solvents.

ETFE is More Chemically Resistant than ECTFE…
In Virtually All Classes of Compounds
At Higher Temperatures

SUMMARY

ETFE and ECTFE polymers are both used commercially as the base resins for thick film coatings used in the Chemical Processing Industry. ETFE has better chemical resistance and higher temperature resistance, as determined empirically and supported by a sound basis in chemical principles. These primary advantages not only provide an extra margin of performance in chemical service, but also contribute to a more reliable application process and improved quality of the final coating.

Item	Unit	Method	ETFE	ECTFE	PVdF	FEP	PTFE
Mechanical properties							
Specific gravity	-	ASTM D792	1.74	1.69	1.77	2.16	2.1
Melt velocity	Pa·s	-	10^3		10^3	10^3	-
Tensile strength	MPa	ASTM D638	48	41	55	20	22
Tensile elongation	%	ASTM D638	430	250	250	280	380
Tensile modulus	MPa	ASTM D638	800	1650	970	350	400
Flex modulus	MPa	ASTM D790	900	670	1550	610	520
Izod impact	J/m	ASTM D256	non-breakable	non-breakable	250	non-breakable	160
Rockwell hardness	-	ASTM D785	50	93	110	25	18
Durometer D hardness	-	ASTM D785	67	-	-	55	58
Friction coefficient	-	-	0.20	-	0.21	0.20	0.09
Thermal Properties							
Melting point	°C	-	260	245	180	290	327
Linear thermal expansion coefficient	10^{-5}/°C	ASTM D696	9.4		12.8	10.5	10.0
Flammability	-	UL-94	V-0	V-0	V-0	V-0	V-0
Continuous service temperature	°C		150	150	150	200	260
Chemical Properties							
Water absorption	%	ASTM D570	0.03	0.01	0.05	0.01	0.01
Chemical resistance	-	ASTM D543	excellent	good	good	excellent	excellent
Gas permeation		ASTM D1434					
– O_2			3.1		1.8	12	21
– N_2			1.0		0.1	3.2	7.9
Electrical Properties							
Volume specific resistance	(V·cm)/A	ASTM D257	10^{17}	10^{18}	$2*10^{14}$	10^{18}	10^{18}
Dielectric constant	-	ASTM D150	2.6	2.6	6.4	2.1	2.1
Dielectric tangent	-	ASTM D150					
60Hz			0.0006	0.0006	0.05	0.0003	0.0001>
1kHz			0.0008	0.0015	0.018	0.0002	0.0001>
1MHz			0.005	0.015	0.16	0.0007	0.0001>
Break-down voltage	kV/0.1mm	ASTM D149	12	12	9	12	9
Arc resistance	s	ASTM D495	120	18	60	165	300

Handling and Storage

ETFE coatings should be stored in their original plastic bags to avoid moisture pickup or contamination. 532-6410 is stable indefinitely, while the 532-6405 has a shelf life of 18 months. 532-6405 is sensitive to extreme temperature variations.

ETFE liquid primer, 699N-129, is 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.

For detailed information on health and safety, refer to the Material Safety Data Sheet and the latest edition of "The Guide to the Safe Handling of Fluoropolymer Resins," published by The Society of the Plastics Industry, Inc. (**www.fluoropolymers.org**) or by PlasticsEurope (**www.plasticseurope.org**).

Food Contact

These ETFE coatings do not comply with FDA regulations in 21CFR governing components of coatings for direct food contact.

Disposal and Other Considerations

Please follow these disposal guidelines as outlined in "The Guide to the Safe Handling of Fluoropolymer Resins," (available at **www.fluoropolymers.org** for download):

- All treatment, storage, transportation, and disposal of this product and/or container must be in accordance with applicable national and local regulations.
- Do not discharge aqueous dispersions to lakes, streams or waterways.
- Separate solids from liquid by precipitation and decanting or filtering. Dispose of dry solids in a landfill that is permitted, licensed or registered to manage industrial solid waste. Discharge liquid filtrate to a wastewater treatment system.
- Incinerate only if incinerator operates at 800 °C or higher and is capable of scrubbing out hydrogen fluoride and other acidic combustion products.
- Industrial fluoropolymer waste containing additives such as solvents, primers or thinners must be regarded as special waste. Companies should contact their local waste disposal authorities for details of the relevant waste disposal regulations.
- Empty containers should preferably be cleaned and recycled. If this is not possible, the containers should be punctured or otherwise destroyed before disposal.

For more information on
DuPont Industrial Nonstick Coatings, please visit
www.teflon.com/industrialglobalsupport

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