

# DuPont™ Teflon® FEP TE9494

## fluoropolymer resin

### Brand

*Teflon®* is a registered trademark of DuPont for its brand of fluoropolymer resins, which can only be used when licensed by DuPont. Customers who wish to use the *Teflon®* trademark in connection with DuPont FEP products in approved applications should contact (800) 262-2745. Without a license, customers may not identify their product as containing *Teflon®*, but may refer to the resin as FEP TE9494.

### Description

DuPont™ *Teflon®* FEP TE9494 fluoropolymer resin is a melt-processable fluoropolymer resin specifically designed for high-speed extrusion of thin coatings on small-gauge wires for twisted-pair constructions.

As shown in **Table 1**, this resin provides the electrical and mechanical properties needed for low-voltage applications. In addition, *Teflon®* FEP TE9494 has a higher melt flow rate than most other fluoropolymer resins. This permits higher extrusion speeds and easier processing, making *Teflon®* FEP TE9494 a cost-effective alternative for producing thin-wall extrusions.

*Teflon®* FEP TE9494 is designed and made to have improved dissipation factor at high frequencies and to have significant plate-out resistance in melt extrusion. It is suitable as a solid insulator and as a foamed insulator when used with an appropriate nucleator in a nitrogen gas injection process.

*Teflon®* FEP TE9494 possesses a balance of processing and performance properties, which makes it an excellent choice for many applications. Like

all *Teflon®* fluoropolymer resins, *Teflon®* FEP TE9494 offers an excellent combination of properties:

- low flammability
- exceptional dielectric properties
- heat resistance
- toughness
- flexibility
- low coefficient of friction
- nonstick characteristics
- negligible moisture absorption
- chemical inertness
- performance at temperature extremes
- weather resistance

### Applications

*Teflon®* FEP TE9494 is especially suitable for use in insulating data and telecommunications cables with excellent fire performance and physical properties as well as outstanding electrical performance. Cables insulated with *Teflon®* FEP TE9494 have met the requirements of the NFPA 90A 'Standard for the Installation of Air-conditioning and Ventilating Systems'. To meet these requirements cables are tested using the NFPA 262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables. This standard test method is used to qualify cables for installation in plenum spaces under the provisions of NFPA 90A. *Teflon®* FEP TE9494 complies with ASTM D2116, Type II.

*Teflon®* FEP TE9494 is not recommended as a jacket material or as a heavy-walled insulation in constructions where significant thermal cycling may raise stress-cracking concerns.



**Table 1**  
**Typical Properties of DuPont™ *Teflon*® FEP TE9494 Fluoropolymer Resin**

Property	ASTM Test Method	Unit	Typical Value
<b>Electrical</b>			
Dielectric Constant	D2520		
100 kHz (10 <sup>5</sup> Hz)		—	2.05
1 MHz (10 <sup>6</sup> Hz)		—	2.03
600 MHz		—	2.00
Dissipation Factor	D2520		
100 kHz (10 <sup>5</sup> Hz)		—	0.00006
1 MHz (10 <sup>6</sup> Hz)		—	0.00057
600 MHz (6x10 <sup>8</sup> Hz)		—	0.00088
<b>Physical</b>			
Melt Flow Number	D2116	g/10 min	30
Melting Point	D3418	°C (°F)	264 (507)
Tensile Strength	D1457	MPa (psi)	20 (3,000)
Elongation	D1457	%	300
Flexural Modulus	D790A	MPa (psi)	520 (75,500)
Specific Gravity	D792	—	2.14

## Safety Precautions

### WARNING!

#### VAPORS CAN BE LIBERATED THAT MAY BE HAZARDOUS IF INHALED

Before using *Teflon*®, read the Material Safety Data Sheet 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 — available from your DuPont representative.

Open and use containers in well-ventilated areas using local exhaust ventilation (LEV). Vapors and fumes liberated during hot processing, or from smoking tobacco or cigarettes contaminated with *Teflon*® FEP TE9494, may cause flu-like symptoms (chills, fever, sore throat) that may not occur until several hours after exposure and pass within 36 to 48 hours. Vapors and fumes liberated during hot processing should be exhausted completely from the work area; contamination of tobacco with polymers should be avoided.

## Packaging

*Teflon*® FEP TE9494 fluoropolymer resin is supplied as pellets and is available in 25-kg (55.1-lb) plastic bags. This product is also available in 1000-kg (2204-lb) bulk containers.

<sup>a</sup> Hastelloy is a registered trademark of Cabot Corporation, Kokomo, IN.

<sup>b</sup> Inconel and Monel are registered trademarks of International Nickel Company, Huntington, WV.

<sup>c</sup> Xaloy is a registered trademark of Xaloy Inc., New Brunswick, NJ.

## U.S. Freight Classification

For rail shipments, *Teflon*® FEP TE9494 is classified as “Plastic, Synthetic, O.T.L., NOIBN;” for truck shipments as “Plastic Materials, Granules;” and for express shipments as “Plastics, Synthetic.”

## Processing Guidelines for Wire and Cable Use

### Extrusion Equipment

*Teflon*® FEP TE9494 is fabricated using the same melt processing techniques as other thermoplastics. A brief description of the extrusion equipment used with *Teflon*® FEP TE9494 is given here; for more detailed processing information, consult the DuPont bulletin “*Teflon*®/*Tefzel*® Melt Extrusion Guide,” which can be obtained from your DuPont representative.

Molten fluoropolymer resins are corrosive to many metals; therefore, special corrosion-resistant materials must be used for all parts of extrusion equipment that come into contact with the melt. Corrosion is likely to occur if dead spots exist in the equipment, processing temperatures are too high, or hold-up time is too long. In addition, resin degradation will accelerate corrosion. Nickel-based alloys such as Hastelloy<sup>a</sup>, Inconel<sup>b</sup>, Monel<sup>b</sup>, and Xaloy<sup>c</sup> are the materials of choice. Hardened nickel plate can be used, but even small holes, chips, or cracks in the plating can compromise its performance. Chrome-plated materials are not recommended. Additional information on materials of construction can be obtained from your DuPont representative.

A 1.5- to 2.5-in extruder with a barrel length to diameter ratio of 28:1 or higher is recommended for extruding *Teflon*<sup>®</sup> FEP TE9494. Extruder barrels should have four to five independently controlled heater zones with temperature controllers capable of accurate operation ( $\pm 0.6^{\circ}\text{C}[\pm 1^{\circ}\text{F}]$ ) in the temperature range of 316 to 425°C (600 to 800°F). Heaters should be made of cast bronze or aluminum.

Controllers with proportional-integral-derivative (PID) action or equivalent are recommended.

A 3:1 compression ratio screw consisting of a relatively long feed zone, a 3 to 5 turn transition, and a metering section that comprises 5 to 7 turns is recommended. The addition of a Saxton\* mixing section at the end of the screw can improve processability. Contact your DuPont representative for more information.

A melt thermocouple and melt pressure probe should be installed in the adapter section of the extruder. To obtain an accurate measurement, the thermocouple should protrude into the melt flow sufficient to measure its temperature, not the metal surrounding it.

Degradation of the resin during processing greatly reduces the performance of *Teflon*<sup>®</sup> FEP TE9494 in stringent applications. Degradation is caused by excessively high melt temperatures, long residence time in the extruder, and/or excessive shear from the screw. In general, increases in the melt flow number (MFN) greater than 10% during extrusion should be avoided.

Other processing conditions that can reduce the resin's performance include melt fracture, very low or uneven melt temperatures, and the presence of hydrocarbon or silicone oils, which act as stress-crack promoters.

## High-Speed Wire Coating Techniques

Considerable experimentation has gone into the development of *Teflon*<sup>®</sup> FEP TE9494. This work has resulted in a resin which when processed within the recommended processing parameters will give a reliable, consistent manufacturing process for insulating wire. As with other *Teflon*<sup>®</sup> FEP grades, FEP TE9494 is applied as a wire insulation using tubing extrusion techniques. The Draw Down Ratio (DDR) aim should be 90:1 centering it in the window 80 to 100 DDR. The Draw Ratio Balance (DRB) should be in the range of 1.04 to 1.10. There is a complete discussion of DDR and DRB, including how they can be calculated, in the DuPont bulletin, "*Teflon*<sup>®</sup>/*Tefzel*<sup>®</sup> Melt Extrusion Guide".

The melt temperature of the extrudate is critically important to the wire coating process. The melt temperature aim should be 394°C (741°F), centered in the window 390°C (734°F) to 398°C (748°F). Melt temperature cannot be reliably predicted by temperature profiles, as it will also vary with throughput. Melt temperature should be independently measured by an in-stream probe at the adapter, or by some other proven reliable means. An electronic wire preheater (or in-line wire draw annealer), located as close to the crosshead as possible, is recommended for preheating the wire to 105 to 176°C (220 to 350°F). A controlled vacuum is required at the rear of the crosshead to adjust the melt cone to the desired length. Experiments have shown cone lengths from 38 mm to 57 mm (1.5 to 2.25 inch) yield satisfactory results with 80 to 100 DDR.

Stationary pulleys should be located on both sides of the crosshead to reduce wire flutter. The wire should pass through the crosshead without touching the inside of the head or the extrusion tooling. Sponges should not be used to reduce flutter downstream from the crosshead because they tend to cause insulation faults.

The coated wire should pass through a long, air-filled, ventilated by LEV, cooling trough. Where the trough cannot be long enough to cool the FEP sufficiently to avoid deformation on wind-up, consideration should be given to the use of a short hot water bath at the extruder end of the trough. Processing conditions will depend on the equipment used, the product being made and the production rates needed. Further advice is available through a DuPont Sales Representative.

## Color Concentrates

Your DuPont representative can provide information on suppliers of color concentrates.

## Band Marking

Band marking inks for *Teflon*<sup>®</sup> FEP are commercially available from several manufacturers. In-line band marking of *Teflon*<sup>®</sup> FEP can be accomplished by positioning the band-marking unit as close to the crosshead as possible and by using inks with high-boiling solvents. Your DuPont representative can provide additional information on suppliers.

\* Ask your DuPont representative for details

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**For more information on Fluoroproducts:**

**(302) 479-7731**

DuPont Fluoroproducts  
P.O. Box 80713  
Wilmington, DE 19880-0713  
[www.teflon.com](http://www.teflon.com)

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**Europe**

DuPont de Nemours Int'l SA  
DuPont Fluoroproducts  
2, chemin du Pavillon  
P.O. Box 50  
CH-1218 Le Grand-Saconnex  
Geneva, Switzerland  
(022) 7175111

**Japan**

DuPont Mitsui  
Fluorochemicals Co., Ltd.  
Chiyoda Honsha Building  
5-18, Sarugaku-cho 1-chome  
Chiyoda-ku, Tokyo 101 Japan  
81-3-5281-5872

**Asia Pacific**

DuPont China, Limited  
26/F., Tower 6, The Gateway  
9 Canton Road, Tsimshatsui  
Kowloon, Hong Kong  
(852) 27341948  
Tim-S.T.Leung@hkg.dupont.com

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**Canada**

DuPont Canada, Inc.  
DuPont Fluoroproducts  
P.O. Box 2200, Streetsville  
7070 Mississauga Road  
Mississauga, Ontario,  
Canada  
L5M2H3  
(905) 821-5194

**South America**

DuPont do Brasil S/A  
Fluoropolymers  
Alameda Itapecuru, 506  
06454-080 - Alphaville  
P.O. Box 263  
Barueri, Sao Paulo, Brazil  
0800-171715  
Produtos.Brazil@bra.dupont.com

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**CAUTION:** Do not use in medical applications involving permanent implantation in the human body. For other medical applications, see "DuPont Medical Caution Statement," H-50102.

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