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 TE9495.

Description
DuPont™ Teflon® FEP TE9495 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 TE9495 has a higher melt flow rate than most other fluoropolymer resins. This permits higher extrusion speeds and easier processing, making Teflon® FEP TE9495 a cost-effective alternative for producing thin-wall extrusions.

Teflon® FEP TE9495 is designed and made to have improved adhesion to copper wire under specific wireline process conditions, low 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 nucleant in a nitrogen gas injection process.

Teflon® FEP TE9495 possesses a balance of processing and performance properties, which makes it an excellent choice for many applications. Like all Teflon® fluoropolymer resins, Teflon® FEP TE9495 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
Teflon® FEP TE9495 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 TE9495 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 TE9495 complies with ASTM D2116, Type II.

Teflon® FEP TE9495 is not recommended as a jacket material or as a heavy-walled insulation in constructions where significant thermal cycling may raise stress-cracking concerns.

Applications

**Safety Precautions**

**WARNING!**

VAPORS CAN BE LIBERATED THAT MAY BE HAZARDOUS IF INHALED.

Before using Teflon® FEP TE9495, 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 only in well-ventilated areas using local exhaust ventilation (LEV). Vapors and fumes liberated during hot processing of Teflon® fluoropolymer should be exhausted completely from the work area. Contamination of tobacco with these polymers should be avoided. Vapors and fumes liberated during hot processing and which are not properly exhausted, or from smoking tobacco or cigarettes contaminated with Teflon® fluoropolymer may cause flu-like symptoms such as chills, fever and sore throat. This may not occur until several hours after exposure and will typically pass within about 24 hours.

Mixtures of Teflon® fluoropolymer with some finely divided metals, such as magnesium or aluminum, can be flammable or explosive under some conditions.

References:

- Hastelloy is a registered trademark of Cabot Corporation, Kokomo, IN.
- Inconel and Monel are registered trademarks of International Nickel Company, Huntington, WV.
- Xaloy is a registered trademark of Xaloy Inc., New Brunswick, NJ.

Packaging

Teflon® FEP TE9495 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.

U.S. Freight Classification

For rail shipments, Teflon® FEP TE9495 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 TE9495 is fabricated using the same melt processing techniques as other thermoplastics. A brief description of the extrusion equipment used with Teflon® FEP TE9495 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®, Inconel®, Monel®, and Xaloy® 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® FEP TE9495. Extruder barrels should have four to five independently controlled heater zones with temperature controllers capable of accurate operation (±0.6°C[±1°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.
Table 1
Typical Properties of DuPont™ Teflon® FEP TE9495 Fluoropolymer Resin

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test Method</th>
<th>Unit</th>
<th>Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dielectric Constant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 MHz (10^6 Hz)</td>
<td>D150</td>
<td>—</td>
<td>2.02</td>
</tr>
<tr>
<td>600 MHz</td>
<td>D2520</td>
<td>—</td>
<td>2.02</td>
</tr>
<tr>
<td>Dissipation Factor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 MHz (10^6 Hz)</td>
<td>D150</td>
<td>—</td>
<td>0.0006</td>
</tr>
<tr>
<td>600 MHz (6 x 10^8 Hz)</td>
<td>D2520</td>
<td>—</td>
<td>0.0005</td>
</tr>
<tr>
<td><strong>Physical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melt Flow Rate</td>
<td>D2116</td>
<td>g/10 min</td>
<td>30</td>
</tr>
<tr>
<td>Melting Point</td>
<td>D3418</td>
<td>°C (°F)</td>
<td>264 (507)</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>D1457</td>
<td>MPa (psi)</td>
<td>20 (3,000)</td>
</tr>
<tr>
<td>Elongation</td>
<td>D1457</td>
<td>%</td>
<td>300</td>
</tr>
<tr>
<td>Flexural Modulus</td>
<td>D790A</td>
<td>MPa (psi)</td>
<td>520 (75,500)</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>D792</td>
<td>—</td>
<td>2.14</td>
</tr>
</tbody>
</table>

Degradation of the resin during processing greatly reduces the performance of Teflon® FEP TE9495 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 rate (MFR) 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® FEP TE9495. 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® FEP grades, FEP TE9495 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®/Tefzel® 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® FEP are commercially available from several manufacturers. In-line band marking of Teflon® 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.