Teflon™ AF

Amorphous Fluoroplastic Resins

Processing and Use

Product names may be followed by an X. Products labeled AF 1600 and AF 1600 X are equivalent, as are AF 2400 and AF 2400 X.

Description

Teflon™ AF is a family of amorphous fluoroplastics. These materials are similar to other amorphous polymers in optical clarity and mechanical properties, including strength. They also resemble fluoroplastics in their performance over a wide range of temperatures, outstanding electrical properties, and chemical resistance. They are distinct from other fluoroplastics in that they are soluble in selected solvents, have high gas permeability, high compressibility, high creep resistance, and low thermal conductivity. They have the lowest dielectric constant and refractive index of any known fluoroplastic.

Processing

Teflon™ AF can be compression molded, injection molded, or extruded. Through these processes, various solid shapes can be formed using the product. Forms include rods, tubes, bars, and sheet of various thicknesses.

In addition, Teflon™ AF can be dissolved in certain perfluorinated solvents for the production of highly uniform thin films and coatings. Methods used to produce such forms include spin, spray, and dip coating.

Typical molding temperatures for Teflon™ AF 1600 range from 240–275 °C (464–527 °F); for Teflon™ AF 2400, the range is 340–360 °C (644–680 °F). The polymer begins to decompose above 360 °C (680 °F). so processing above that temperature should be avoided. Corrosion-resistant tooling is recommended, as it is for Teflon™ FEP and Teflon™ PFA fluoroplastic resins.

Safety Precautions

WARNING! VAPORS CAN BE LIBERATED THAT MAY BE HAZARDOUS IF INHALED.

Before using Teflon™ AF, read the Safety Data Sheet and detailed information in the latest edition of the "Guide to the Safe Handling of Fluoropolymer Resins," published by the Fluoropolymers Division of The Society of the Plastics Industry (www.fluoropolymers.org) or by PlasticsEurope (www.plasticseurope.org).

Handling Practices

Teflon™ AF resins may contain parts per million of residual hexafluoroacetone (HFA). Because HFA hydrates are readily absorbed through the skin, it is necessary to avoid skin contact with the resin during processing. Chemours recommends the use of protective gloves when handling resin during manufacturing operations.

Residual gases (including HF, COF_2, CO, and HFA) that diffuse from Teflon™ AF resins, even at room temperature, may be harmful. To avoid exposure, all resin containers should be opened and used only in well-ventilated areas using local exhaust ventilation (LEV).

Extrusion

Teflon™ AF may be extruded. The precautions in the bulletin "Guide to the Safe Handling of Fluoropolymer Resins" should be followed carefully. The polymer should be completely dried before extrusion. As a guide for establishing extrusion conditions, piston rheometer data for Teflon™ AF 1600 and 2400 at several temperatures and shear rates are included as Figures 1 and 2.

Coatings

Because Teflon™ AF is soluble in selected perfluorinated solvents, it can be cast into thin-film, pinhole-free coatings with no sintering. It can be applied using spin, spray, brush, or dipping techniques.

Whichever coating methods are used, the coated product must be heated above the Tg to remove all solvent. This gives a smoother coating and improves the polymer's adherence to the surface.

The choice of solvent depends upon the application. A partial list of possible solvents is included as Table 1.

Table 1. Solvents for Teflon™ AF

	Designations	Boiling Point, °C (°F)	Manufacturer
Fluorinert®			
	FC-72	56 (133)	3M
	FC-40	155 (311)	3M
	FC-43	174 (345)	3M
Flutec®			
	PP50	29 (84)	Rhone Poulenc
	PP2	76 (169)	Rhone Poulenc
	PP6	142 (288)	Rhone Poulenc
Galden®			
	HT-110	110 (230)	Solvay Solexis
	HT-135	135 (275)	Solvay Solexis
	D02, D03,D05	165-230 (329–446)	Solvay Solexis
Vertrel™			
	XF	55 (130)	Chemours

Adhesion

Teflon™ AF has limited adhesion to substrates. Surface treatment may be necessary to alter and enhance adhesion. However, whatever adhesion is obtained is not chemical in nature. When applied from solution, adhesion is generally improved by heating the coated surface above the Tg.

Fluorosilanes have been used to improve adhesion to glass and silicon. The substrate's surface is coated with fluorosilane and baked for 10 min at 110 °C (230 °F). It is then coated with Teflon™ AF in solution (with Fluorinert®), baked at 10 °C (18 °F) above the boiling point of the solvent for 5–10 min. It is then baked at 165 °C (329 °F) for 5 min for Teflon™ AF 1600; 245 °C (473 °F) for Teflon™ AF 2400. After that, bake at 330 °C (626 °F) for 15 min.

Teflon™ AF adheres well to titanium, aluminum, and electrolytic copper.

Compression Molded Sheet

Teflon™ AF can be readily compression molded into various shapes. The equipment necessary is a press capable of heating to at least 100 °C (180 °F) above the polymer glass transition temperature (i.e., 260 °C [500 °F] for AF 1600 and 340 °C [644 °F] for AF 2400) and an appropriate mold. It is also convenient if the press platens can be cooled, but this is not absolutely necessary. It is important to realize that the surface finish on the mold will determine the smoothness of the surface of the molded part. The polymer must be dried before molding, because even trace quantities of water or volatile organic liquids can cause bubbles in the molded part. Three to four hours drying at 135 °C (275 °F) is usually sufficient.

Because Teflon™ AF is a granular powder, it is sometimes easier to first mold this powder into "preforms" by compacting it in a cold mold under pressure. For final molding, the press should be heated to 100 °C (180 °F) above the polymer glass transition temperature. The mold should be loaded with polymer or preform and placed in the heated press. Close the press, but do not apply pressure to the mold. Wait until the temperature of the press returns to 100 °C (180 °F) above the glass transition temperature. Pressure should now be applied to the mold in stages, rather than all at once, to allow entrapped air to escape from the mold. Typically the pressure might be increased in increments of 22 kN (5,000 lb force). After each pressure increase, the pressure is allowed to stabilize before increasing pressure again. The final molding pressure will depend on the press, the size of the mold, and the temperature, but a typical value would be sufficient to give a pressure on the polymer in the range of 4–7 MPa (500–1,000 psi). When final pressure is reached, hold it for 2–5 min; then, turn off the heat, and either cool the platens under pressure or allow them to cool naturally. Do not remove pressure until the polymer is about 50 °C (90 °F) or more below the glass transition temperature. This molding cycle is typical, but other cycles may be developed to meet particular needs.

Figure 1. Melt Rheology of Teflon™ AF 1600

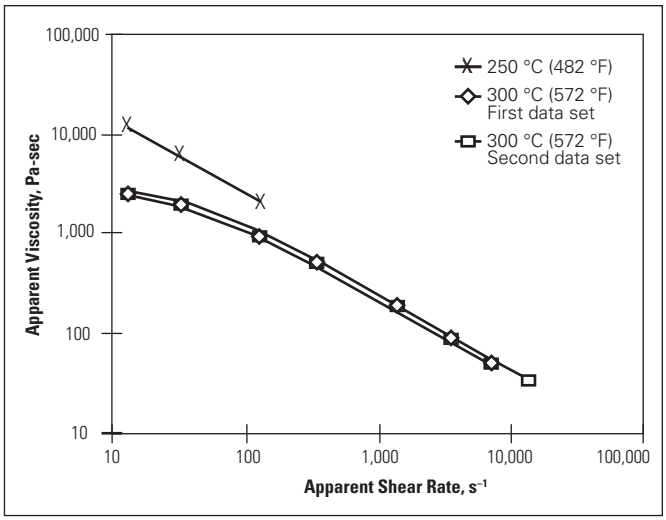
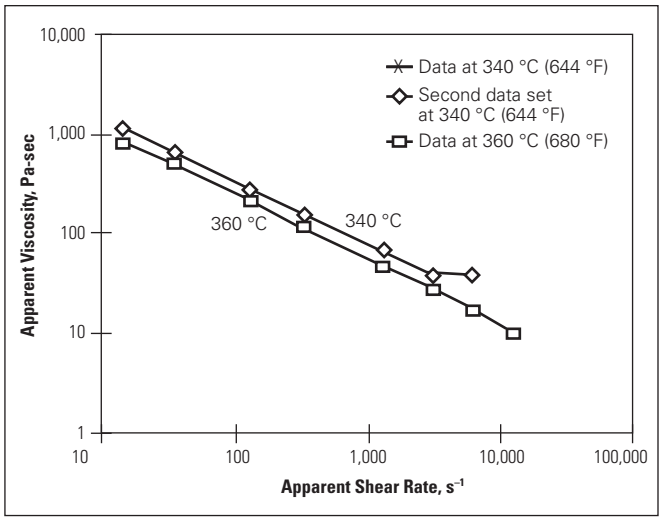


Figure 2. Melt Rheology of Teflon™ AF 2400



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