

# PTFE Welding Standard:

## TFM™ 1600 PTFE

### Features and Benefits

- Meets ASTM D4894 Type III, Grade 2 resin
- Molding and ram extrusion powder with very good free-flow properties
- Good metering properties
- Good mold filling behavior
- Improved particle coalescence
- Denser polymer structure
- Lower permeability
- Substantially lower deformation under load
- Improved weldability
- Good electrical and mechanical properties
- Increased modulus of elasticity

### Typical properties (Data not for specification purposes)

#### Powder properties

Property	Value	Unit	Test Method
Bulk density	830	g/l	ASTM D 4894-98a
Average particle size	450	μ	ASTM D 4894-98a

#### Mechanical properties, measured at 23°C (73°F) on sintered moldings

Property	Value	Unit	Test Method
Tensile Strength	4600	psi	ASTM D 4894-98a
Elongation at break	450	%	ASTM D 4894-98a
Specific gravity	2.16	g/cc	ASTM D 4894-98a
Shrinkage	3.5	%	ASTM D 4894-98a
Tensile Modulus	94,250	psi	ASTM D 638
Deformation under Load		%	ASTM D 621
2175 psi – 24 hrs	8		
2175 psi – 100 hrs	9		
2175 psi – permanent	4		

#### Thermal properties

Property	Value	Unit	Test Method
Flammability	V-0		UL94
Melt point (initial)	342 ± 10	°C	ASTM D 4894-98a
(second)	327 ± 10	°C	ASTM D 4894-98a
Service Temperature Range	-200°C to 260°C (-328°F to 500°F)		

#### Electrical Properties

Property	Value	Unit	Test Method
Dielectric Strength	2.6	kV/mil	ASTM D149-95a

### TYPICAL PROPERTIES

Property	Nominal value	Units	Test method
Apparent density	470	grams/liter	ASTM-D-4895
Median particle size	475	microns	ASTM-D-4895
Melting point	327 342	°C °C	ASTM-D-4895 Note 1
Color	White	—	—
Specific gravity	2.15 – 2.18	—	ASTM-D-4895
Moisture content (max.)	0.03	%	ASTM-D-4895
External pressure (comparative)	12000	psi	Note 2
Reduction ratio range	100:1 – 500:1	—	Note 3
QC certified external pressure	11200	psi	0.050" die

- Note 1:** D.I. McCane, from an article in *Encyclopedia of Polymer Science and Technology*, 13, 630 (1970): "Contrary to most reports in the literature, the melting point of virgin polytetrafluoroethylene is 342°C and not 327°C. Differential thermal analysis has shown quite conclusively that the first melting of virgin polymer is an irreversible process. Once the polymer has been melted, on remelting it melts at the lower previously reported and widely accepted temperature of about 327°C."
- Note 2:** Based on standard AGC CHEMICALS AMERICAS, INC. extrusion test (20° included die angle, 16% ISOPAR H lubricant, reduction ratio 900:1).
- Note 3:** Reduction ratio equals cross-sectional area of preform in cylinder divided by cross-sectional area of extrudate in die. The usable reduction ratio range depends on a number of variables, including lubricant, content, die design, and extrusion conditions, so the figures given should be taken only as a general guide to the relative performance of the various grades.

<b>ASTM-D-4895</b>	TFE-Fluorocarbon Resin Molding and Extrusion Materials
<b>MIL-W-16878</b>	Wire, Electrical, Insulated, High Temperature
<b>MIL-W-22759</b>	Wire, Electrical, Fluorocarbon Insulated Copper
<b>MIL-W-81822</b>	Wire, Electrical, Solderless Wrap, Insulated and Uninsulated
<b>MIL-C-17</b>	Cables, Radio Frequency, Flexible and Semirigid
<b>ASTM-D-3295</b>	PTFE Tubing
<b>AMS 3653*</b>	Plastic Tubing, Electrical Insulation, Polytetrafluoroethylene
<b>AMS 3654*</b>	Tubing, Electrical Insulation, Light Walled Extruded PTFE
<b>AMS 3655*</b>	Tubing, Electrical Insulation, Thin Walled Extruded PTFE

### Family grades

#### Test method

	GRANULAR POWDERS (Virgin & Filled)	AQUEOUS DISPERSIONS	FINE COAGULATED POWDERS	MICROPOWDERS
Bulk density	ASTM D4894		ASTM D4895	ASTM D4894
Avg. part. size	Solvay Solexis (Laser)	Solvay Solexis	ASTM D4895	Solexis (Laser & Coulter C.)
Specific surface area				B.E.T.
Melting point	ASTM D3418		ASTM D3418	ASTM D3418
Crystallisation point	ASTM D3418		ASTM D3418	ASTM D3418
Melt flow index				ASTM D1238
Specific gravity	ASTM D792	ASTM D891	ASTM D792	ASTM D792
Tensile strength	ASTM D4894		ASTM D4895	
Elongation at break	ASTM D4894		ASTM D4895	
Hardness	ASTM D2240			
Radial shrinkage	Solvay Solexis		Solvay Solexis	
Permanent deformation	ASTM D621			
Coeff. of linear thermal expansion	ASTM D696			
Wear coefficient	Solvay Solexis			
Dielectric strength	ASTM D149		ASTM D149	
Thermal conductivity	ASTM C177			
Volume resistivity	ASTM D257		ASTM D257	
Electrical conductivity		Solvay Solexis		
Rheometric pressure			ASTM D4895	
PTFE content		ASTM D4441		
Surfactant content		ASTM D4441		
pH		ASTM E70		
Critical thickness		Solvay Solexis		
Brookfield viscosity		ASTM D2196		

## General PTFE Properties

	Units	Test Method	Value
Service Temperature	°C		- 270 to + 260
Heat resistance			Stable until 260°C Weight loss per hour: 0.001% at 350°C - 0.01% at 400°C
Chemical resistance		ASTM D543	High inertness
Solvent resistance		ASTM D543	Insoluble under 300°C
Flammability		UL 94	V-0
Limiting Oxygen Index	%	ASTM D2883	> 95
Water absorption	%	ASTM D570	0.0
Ageing and weatherability			Stable over 20 years of exposure
Radiation resistance (gamma rays)			Low: Electrical properties unchanged Mechanical properties decreased
Thermal conductivity	W/m.K	ASTM C177	0.24
Dielectric constant (ε) from 60 Hz to 2 GHz		ASTM D150	2.1
Dissipation factor (tg δ) from 60 Hz to 2 GHz		ASTM D150	< 3x10 <sup>-4</sup>
Volume resistivity	Ohm.cm	ASTM D257	10 <sup>14</sup>
Friction coefficient		ASTM D1894	Static: 0.08 - Dynamic: 0.06

## GRANULAR POWDERS

PHYSICAL PROPERTIES (nominal value)		Unit	NON FREE FLOWING		
ASTM D 4894 Classification	F Special Type II		F 5 Type II	F 6 Type II	
<b>Powder</b>	Bulk density	g/l	430	380	380
	Avg. part. size	µm	20	15	15
	Flow properties		non free flowing	non free flowing	non free flowing
	Compression ratio		4.9	5.7	5.7
	Molding pressure	MPa	20	15	15
<b>Mechanical<sup>(1)</sup></b>	Specific gravity		2.170	2.170	2.170
	Tensile strength	MPa	38	40	42
	Elongation at break	%	330	350	370
	Radial shrinkage	%	2.8	3.0	3.2
<b>Electric</b>	Dielectric strength <sup>(3)</sup>	kV/mm			65
MAIN PROCESSING TECHNOLOGIES			normal compression molding	filled grades production	normal compression molding
MAIN APPLICATIONS			stock shapes, skived sheets (≥ 0.8 mm) and large size items		skived sheets (≥ 0.5 mm) and medium/large size items

(1) Modified polymer

(2) Measured on a sintered rod (o.d. 100 mm) at 23°C, molding pressure 30 MPa

(3) Tape thickness 125 µm



GRANULAR POWDERS						
PHYSICAL PROPERTIES (nominal value)		Unit	NON FREE FLOWING			
			15 GL	25 GL	25 CAR	25 CAR B
Powder	Bulk density	g/l	500	510	420	430
	Molding pressure	MPa	45	45	45	45
	Filler		fiberglass	fiberglass	petroleum coke and graphite	electrog. carbon and graphite
	Filler content	w/w %	15	25	25	25
Mechanical <sup>®</sup>	Specific gravity		2.210	2.210	2.110	2.100
	Tensile strength	MPa	24	18	20	20
	Elongation at break	%	280	220	130	190
	Permanent deformation	%	6.0	5.5	1.9	1.8
	Wear coefficient (9)	(cm <sup>3</sup> .min/ kg.m.h).10 <sup>-8</sup>	20	15	35	150
	Radial shrinkage	%	1.7	1.4	2.1	2.4
	Hardness	Shore D	58	59	63	61
Thermal	Thermal conductivity	W/m.K	0.34	0.41	0.59	0.60
	Coef. of linear expansion (parallel to molding direction) 25-250°C	10 <sup>-5</sup> /°C	16	15	15	14
Electric	Volume resistivity	Ohm.cm	10 <sup>15</sup>	10 <sup>15</sup>	10 <sup>4</sup>	
MAIN PROCESSING TECHNOLOGIES					Normal	
MAIN APPLICATIONS			pneumatic, hydraulic and mechanical parts		piston rings, bearings, grooved and mechanical supports	slipper rings and ball valve seats
(1) Solvay Solexis can produce a range of Algoflon <sup>®</sup> filled grades with other fillers or filled grades with standard fillers in non standard percentage						

(VIRGIN)					
		FREE FLOWING		PRESINTERED	
F 5/S	F 7	S 121	S 131	E 2	E 2 BP
Type II	Type II	Type IV G.2	Type IV G.2	Type V	Type V
410	410	810	880	640	660
15	15	550	650	550	700
non free flowing	non free flowing	good flow	very good flow	good flow	very good flow
5.3	5.3	2.7	2.5	3.4	3.3
15	15	20	30		
2.160	2.170	2.170	2.170	2.150	2.150
44	44	37	35	20	24
400	400	340	310	280	280
3.1	3.0	2.7	2.5		
	75	70	65		
filled grades production	normal compression molding	normal and isostatic molding	automatic molding, ram extrusion	ram extrusion (continuous process)	
compounds with higher filler content	thin skived tapes down to 20 ± 50 µm	stock shapes, skived sheets (≥ 1 mm) and complex shapes	small components, gaskets and valve seats	rods, tubes and profiles with different sizes	

**( F I L L E D )**

MOST IMPORTANT GRADES <sup>(1)</sup>					
15 GR	40 BZ	60 BZ	25CAR 5CER	15GL 5MOS	55BZ 5MOS
410	700	910	410	490	910
30	40	40	45	30	35
graphite	bronze	bronze	petroleum coke and ceramic	fiberglass and molybdenum disulphide	bronze and molybdenum disulphide
15	40	60	25 + 5	15 + 5	55 + 5
2,170	3,100	3,940	2,050	2,280	3,850
25	28	20	14	24	16
270	340	260	50	220	70
5.0	3.5	1.9	1.2	3.5	1.4
1,750	10	10	30	15	8
2.2	2.2	2.0	3.7	2.4	1.8
57	63	65	63	58	62
0.75	0.63	0.65			
19	14	12	9.9	16	14
10 <sup>7</sup>	10 <sup>7</sup>	10 <sup>7</sup>	10 <sup>4</sup>		
compression molding					
steering and shock absorber gaskets	slidways, compression rings and bearings		pistons rings and bearings	dynamic seal applications where self-lubricating properties are required at starting point	
(2) Measured on a sintered rod (o.d. 100 mm) at 23°C, molding pressure 50MPa			(3) At PV = 100		

**( F I L L E D )**

MOST IMPORTANT GRADES <sup>(1)</sup>					
15 GR	40 BZ	60 BZ	25CAR 5CER	15GL 5MOS	55BZ 5MOS
410	700	910	410	490	910
30	40	40	45	30	35
graphite	bronze	bronze	petroleum coke and ceramic	fiberglass and molybdenum disulphide	bronze and molybdenum disulphide
15	40	60	25 + 5	15 + 5	55 + 5
2,170	3,100	3,940	2,050	2,280	3,850
25	28	20	14	24	16
270	340	260	50	220	70
5.0	3.5	1.9	1.2	3.5	1.4
1,750	10	10	30	15	8
2.2	2.2	2.0	3.7	2.4	1.8
57	63	65	63	58	62
0.75	0.63	0.65			
19	14	12	9.9	16	14
10 <sup>7</sup>	10 <sup>7</sup>	10 <sup>7</sup>	10 <sup>4</sup>		
compression molding					
steering and shock absorber gaskets	slidways, compression rings and bearings		pistons rings and bearings	dynamic seal applications where self-lubricating properties are required at starting point	
(2) Measured on a sintered rod (o.d. 100 mm) at 23°C, molding pressure 50MPa			(3) At PV = 100		

AQUEOUS DISPER						
PHYSICAL PROPERTIES (nominal value)	Unit	D 1214X	D 1220X	D1226X	D3220X	
Very low APFO Content		•	•	•	•	
Green surfactant			•	•	•	
Modified PTFE					•	
Bimodal dispersion					•	
Additional info					designed for high-yield processes	
Dispersion properties	PTFE content (on the mixture) <sup>0</sup>	% by weight	60	60	60	61
	Surfactant content (on the mixture) <sup>2)</sup>	% by weight	3.5	2.8	3.5	5.0
	Surfactant content (on the solid) <sup>1)</sup>	% by weight	5.8	4.7	5.8	8.2
	APFO content (on the mixture)	ppm by weight	<50	<50	<50	<50
	pH		9 min	9 min	9 min	9 min
	Density @ 20°C	g/cm <sup>3</sup>	1.51	1.51	1.51	1.52
	Conductivity	µS/cm	1000	700	1000	700
	Avg. part. size	µm	0.24	0.24	0.24	0.24
	Critical thickness	µm	-	-	-	-
Brookfield viscosity @ 20°C	mPa.s	20	20	20	50	
MAIN PROCESSING TECHNOLOGIES		impregnation				
MAIN APPLICATIONS		impregnated woven packings, and yarns, additives	glass fabrics (first and intermediate passes) for food and industrial markets, cast films	glass fabrics for food and industrial markets, laminates	very high demanding glass fabrics for food and industrial markets	

## SION GRADES

D3222	D3224X	D1222	D1251X	D1223X	D3211	D 3221X
•	•	•	•	•	•	•
•	•	•		•	•	•
•	•				•	•
	•				•	•
			*unstabilized" dispersion			
59	59	60	28	60	59	59
3.5	3.8	2.8	0.4	3.0	3.5	3.5
5.9	6.4	4.7	1.5	5.0	5.9	5.9
<50	<50	<50	<50	<50	<50	<50
9 min	9 min	9 min	9 min	9 min	9 min	9 min
1.49	1.49	1.51	1.19	1.51	1.49	1.49
700	400	700	600	600	1000	1000
0.24	0.24	0.24	0.24	0.24	0.24	0.24
-	-	20	-	10	15	15
20	20	20	-	20	20	20
impregnation		Polymer Additivations	Co-coagulation	coating		
high performance glass fabrics for food and industrial markets, laminates	very high demanding glass fabrics for food and industrial markets	antidripping agent	mechanical components (bearings and seals)	basecoat formulations for cookware and industrial coatings	topcoat formulations for high performance cookware and industrial coatings	



## FINE COAGULATED

<i>PHYSICAL PROPERTIES</i> (nominal value)		Unit	DF 110	DF 130	DF 132X	DF 133X	DF 210	DF 230
Classification (ASTM D4895-98)			I 1A	I 1A	I 1A	I 1A	I 1A	I 1A
<b>Powder</b>	Bulk density	g/l	600	600	600	600	600	600
	Avg. part. size	µm	600	600	600	600	600	600
	Particles < 300 µm	%	<15	<15	<15	<15	<15	<15
	Rheometer pressure @	MPa						
	RR 20					2.8		
	RR 100		7.5	10.5	12.5	13		9.5
	RR 400							
	RR 1600							
	Min. RR		50	30	10	10		50
	Max. RR		300	300	300	300		300
Longitudinal Shrinkage (@RR 20:1)	%	31			32			
Stretchability	%	1100 min	1500 min	1500 min			1100 min	
<b>Mechanical</b>	Specific gravity		2.17	2.16	2.15	2.16	2.17	2.16
	Tensile strength	MPa	30	30	30	30		30
	Elongation at break	%	300	300	300	350		300
<b>MAIN PROCESSING TECHNOLOGIES</b>			paste extrusion					
<b>MAIN APPLICATIONS</b>			unsintered tapes and cords, porous items, small pipe liners	fibers, porous items	expanded film, high tenacity tapes and porous items	large pipe liners	anti-drip through low shear mixing	medium tenacity tape and porous items

## POWDERS

DF 260X	DF 290	DF 291X	DF 330	DF 360X	DF 380.AP	DF 381	DF 680	DF 681
I 1B	I 3D	I 3D	I 1A	I 1A	I 1B	I 1B	I 2C	I 2C
500	500	500	500	500	450	500	500	500
600	600	600	600	600	550	600	600	600
<15	<15	<15	<15	<15	<15	<15	<15	<15
			2.8	2.8				
			12.5	12.5				
50				55		27		
	57	50					55	40
10	100	100	10	10		80	100	100
300	1200	2000	300	300		800	1600	3000
24			27	27				
1500 min								
2.15	2.16	2.17	2.15	2.14	2.16	2.16	2.18	2.18
30	30	30	30	30		30	30	30
350	350	350	350	350		350	350	350
paste extrusion								
high tenacity fibers	medium RR W&C, tape for wrapping	tapes for wrapping, medium RR tubing and W&C	low RR tubing and pipe liners	low permeability and high weldability pipe liners, convoluted tubing	anti-drip through high shear mixing	flexible and convoluted tubing	medium RR tubing, heat-shrinkable tubing	high RR tubing and W&C, heat-shrinkable tubing

## POLYMIST MICROPOWDERS

PHYSICAL PROPERTIES (nominal value)	Unit	XPA 213	F5	F5A	F5A EX	F510	F284 (1)
Bulk density	g/l	350	450	400	500	500	400
Avg. part. size	µm	3.5	5.5	4.0	12	14	9
Part. less than 20 µm	%	98	97	96	75	70	93
Specific surface area	m <sup>2</sup> /g	3	3	3	3	3	3
Colour		white	white	white	white	white	white
Melting point	°C	320-330	320-330	320-330	325-335	325-335	325-335
Melt flow index @ 380° C, 21 kg, 1mm die	g/10 min	40	40	40	0.25	0.25	0.05
Specific gravity at 23°C		2.2	2.2	2.2	2.2	2.2	2.2

### MAIN APPLICATIONS

powders used as additive for oils, greases, dry lubricants, printing inks, coatings, thermoplastics, thermosettings and elastomers

(1) Meets the requirements of FDA 21 CFR 177.1550 and European Directive 2002/72/EC

### Technical Information and Test Data

Technical information, test data, and advice provided by Dyneon personnel are based on information and tests we believe are reliable and are intended for persons with knowledge and technical skill sufficient to analyze tests types and conditions, and to handle and use raw polymers and related compounding ingredients. No license under any Dyneon or third party intellectual rights is granted or implied by virtue of this information.

### Processing Information

If transport or storage temperatures are too high the material can agglomerate in its container. In such cases, it is advisable to store the material for 48 hours at below 23°C (73°F) and then sieve it (mesh size 4 mm) (.16 in) before filling the mold. To achieve optimum properties, compression molding should be carried out within a temperature range of 23°C to 26°C (73°F to 78°F) at a pressure of 20-25 MPa (2900-5100 psi). The sintering temperature should be in the range of 375°C to 380°C (707°F to 716°F).

### Product Form and Packaging

Dyneon TFM 1600 PTFE is supplied in moisture and dust-tight plastic drums with a polyethylene liner.  
Quantity per drum: 50 kg (110 lbs.)  
Order quantity per pallet: 330 kg (660 lbs.)

### Storage and Material Handling

Dyneon TFM 1600 PTFE has an unlimited shelf life provided it is stored in a clean, dry place. Dyneon TFM 1600 PTFE is hydrophobic, and generally do not require drying before processing unless high humidity conditions create surface moisture adsorption.

### Management System - ISO 9001 and ISO 14001

All Dyneon design, development, production and service facilities have achieved a global ISO 9001 registration for their quality management system. In addition, our Gendorf, Germany location has achieved ISO 14001 for its environmental management system.

### Regulatory

Dyneon TFM 1600 PTFE is in compliance with FDA regulation 21 CFR 177.1550. It is the responsibility of the user to determine whether its specific formulation and intended use comply with applicable laws and are suitable for its intended applications.

### Safety/Toxicology

These are fluoroplastic materials, so normal precautions observed with fluoroplastics should be followed. Before processing these products, consult the Material Safety Data Sheet and follow all label directions and handling precautions. General handling/processing precautions include: (1) Process only in well-ventilated areas; (2) Do not smoke in areas contaminated with powder/residue from these products; (3) Avoid eye contact; (4) After handling these products wash any contacted skin with soap and water. Potential hazards, including evolution of toxic vapors, can exist if processing occurs under excessively high temperature conditions. Vapor extractor units should be installed above processing equipment. When cleaning processing equipment, do not burn off any of this product with an open flame or in a furnace.



**Applications:**

- Using in hydrostatic pressure reservoirs
- Using in fluid pipes
- Using in flanges (symmetrical welding system)
- Using in pumps up to 12-bar pressure
- Using in fluid transmission tanks
- Using in fluid transmission channels
- Using in fuel cells up to 280°C temperature
- Using in valves up to 12-bar pressure
- Using in connectors up to 12-bar pressure

Due to PTFE doesn't combine with other materials (except welding interfaces) to prepare PTFE sheets for stick to another materials we can use MOX materials.

Usually MOX application is interface for stick PTFE to metals.

PFA material could be a best option in PTFE welding and metal sticking

One of the most important applications for this method was used in storage tanks and that performance has been excellent if welding geometric tolerances be conform and is recommended for storage tanks with dual designing.