SOLVAY

asking more from chemistry®

Solef® PVDF

Typical Properties

SPECIALTY POLYMERS

Solef® PVDF
Polyvinylidene Fluoride

Solef® PVDF is a fluorinated semi-crystalline thermoplastic which is obtained by polymerizing vinylidene fluoride. This fluorinated polymer has been manufactured and marketed for more than 30 years, using both suspension and emulsion process developed and perfected by Solvay Specialty Polymers.

Solef® PVDF, without any additives, has the intrinsic stability inherent to fluoropolymers, even when exposed to harsh environments. It provides the user with a unique combination of properties leading to longer equipment life. The most important properties of Solef® PVDF are listed below:

- Excellent chemical resistance to most aggressive substances and solvents
- Excellent mechanical strength and toughness
- High abrasion resistance
- High temperature capabilities: continuous use service temperature up to 150 °C/302 °F
- Excellent ageing resistance
- High purity
- Resistance to UV and nuclear radiations
- Excellent intrinsic fire resistance
- Low permeability to most gases and liquids
- Easily melt-processed by standard methods of extrusion and molding
- Wide range of rigid and flexible grades available

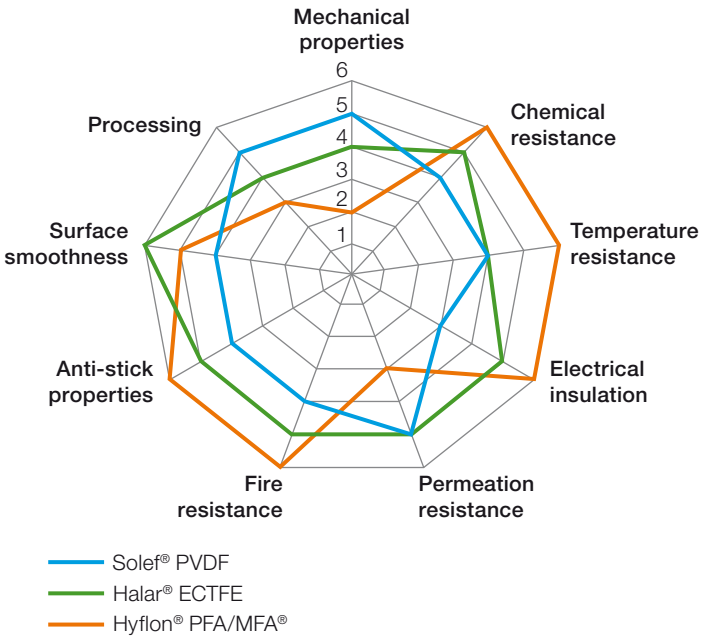
Besides the PVDF homopolymers, Solvay Specialty Polymers offers a wide products range of VF2-HFP copolymers, and VF2-CTFE copolymers which stand out for their better cold temperature behavior. The VF2-CTFE range comprises the Solef® 60000 series, which offers an improved balance between good cold temperature properties and thermomechanical properties of the homopolymers.

PVDF is extensively used in the general chemical processing industry, the high purity semiconductor market, and the wire and cable industry. Solvay Specialty Polymers today offers a growing choice of PVDF grades which are associated with new applications such as the Oil & Gas industry, Automotive, Building industry, Electronics, Chimney linings, Lithium Batteries, Fuel cells, Food and Pharmaceutical industries.

In addition to the Solef® resins, Solvay Specialty Polymers offers a wide range of other fluoropolymers which are also easily processable by injection, extrusion, and all conventional processing techniques:

- Halar® ECTFE (copolymer of ethylene and chlorotrifluoroethylene)
- Hyflon® PFA/MFA® (copolymer of tetrafluoroethylene and perfluoroalkylvinylethers)
- Hylar® PVDF for coating applications

Relative performance of melt processable fluoropolymers



Solef® PVDF grades

Grade	Form	Description
Homopolymers		
Solef® 6008	Powder and granules	Low molecular weight PVDF homopolymer
Solef® 6010	Powder and granules	Medium molecular weight PVDF homopolymer
Solef® 6012	Powder and granules	High molecular weight PVDF homopolymer
Solef® 1015	Powder	Very high molecular weight PVDF homopolymer
Solef® 6020	Powder	Ultra high molecular weight PVDF homopolymer
Solef® 5130	Powder	Ultra high molecular weight functionalized PVDF homopolymer
Solef® 9007	Powder and granules	Low molecular weight PVDF homopolymer
Solef® 9009	Powder and granules	Medium molecular weight PVDF homopolymer
Solef® 460	Powder and granules	Branched high molecular weight PVDF homopolymer
Solef® 41308	Powder and granules	Enhanced adhesion PVDF for multilayer structures
Copolymers		
Solef® 11010	Powder and granules	Flexible PVDF copolymer
Solef® 21510	Powder and granules	Very flexible PVDF copolymer
Solef® 31508	Powder and granules	Improved low-temperature flexibility PVDF copolymer
Solef® 60512	Granules	Special PVDF grade for high-pressure flexible piping

Typical Properties of Solef® PVDF Homopolymer Grades

	Unit	Solef® 6008	Solef® 6010	Solef® 6012	Solef® 1015	Test Method
Physical properties						
Density at 23 °C/73 °F	g/cm³ (lb/ft³)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	ASTM D792
Water absorption (24 h at 23 °C/73 °F)	%	< 0.04	< 0.04	< 0.04	< 0.04	ASTM D570
Melt flow index (230 °C/446 °F)	g/10 min					ASTM D1238
21.6 kg		–	–	–	2.8–4.6	
10 kg		–	–	4–6	–	
5 kg		16–30	4–8	–	–	
3.8 kg		–	–	–	–	
2.16 kg		5.5–11	–	–	–	
Mechanical properties						
Tensile at 23 °C/73 °F (Type IV specimen, 2 mm thick)						ASTM D638
Stress at yield (50 mm/min)	MPa (psi)	50–60 (7,200–8,700)	50–60 (7,200–8,700)	50–60 (7,200–8,700)	50–60 (7,200–8,700)	
Stress at break (50 mm/min)	MPa (psi)	30–50 (4,400–7,300)	30–50 (4,400–7,300)	30–50 (4,400–7,300)	30–50 (4,400–7,300)	
Elongation at yield (50 mm/min)	%	5–10	5–10	5–10	5–10	
Elongation at break (50 mm/min)	%	20–300	20–300	20–300	20–300	
Modulus (1 mm/min)	MPa (kpsi)	1,800–2,500 (260–360)	1,700–2,500 (250–360)	1,700–2,500 (250–360)	1,700–2,500 (250–360)	
Notched charpy strength (4 mm thick, 2 m/s, 23 °C/73 °F)	J/m (ft·lbf/in)	40–120 (0.7–2.0)	100–200 (2–4)	150–250 (3–5)	400–500 (7.5–10)	ASTM D6110
IZOD impact (notched V 10 mm, 23 °C/73 °F, 4 mm thick)	J/m (ft·lbf/in)	–	–	–	–	ASTM D256
Shore D hardness (2 mm thick)		73–80	73–80	72–78	72–78	ASTM D2240
Abrasion resistance	mg/1,000 rev	5–10	5–10	5–10	5–10	TABER CS 17, 1 kg
Friction coefficient	static dynamic	0.2–0.4 0.15–0.35	0.2–0.4 0.15–0.35	0.2–0.4 0.15–0.35	0.2–0.4 0.15–0.35	ASTM D1894

	Unit	Solef® 6008	Solef® 6010	Solef® 6012	Solef® 1015	Test Method
Thermal properties						
Crystallinity by DSC						ASTM D3418
Melting point	°C (°F)	170–175 (338–347)	170–175 (338–347)	170–175 (338–347)	170–175 (338–347)	
Heat of fusion (80 °C/176 °F to end of melting)	J/g (BTU/lb)	58–67 (25–29)	58–66 (25–28)	55–65 (23–28)	57–66 (24–28)	
Crystallization point	°C (°F)	134–144 (273–291)	137–144 (279–291)	137–145 (279–293)	137–144 (279–291)	
Crystallization heat	J/g (BTU/lb)	54–60 (23–26)	54–60 (23–26)	50–60 (21–26)	50–56 (21–24)	
VICAT point	°C (°F)	135–145 (275–295)	135–145 (275–295)	135–145 (275–295)	135–145 (275–295)	ASTM D1525 2A
Glass transition (Tg)	°C (°F)	–40 (–40)	–40 (–40)	–40 (–40)	–40 (–40)	ASTM D4065
Molding shrinkage (linear)	%	2–3	2–3	2–3	–	
Thermal stability	°C (°F)	375–400 (707–752)	>400 (>752)[1]	>400 (>752)[1]	375–400 (707–752)	TGA. T° for 1 % w loss in air
Linear thermal expansion coefficient	10^{-6}/K (10^{-6}/°F)	140 (78)	140 (78)	140 (78)	140 (78)	ASTM D696
Thermal conductivity at 23 °C/73 °F	W/m·K (BTU·in/h·ft²·°F)	0.2 (1.4)	0.2 (1.4)	0.2 (1.4)	0.2 (1.4)	ASTM C177
Specific heat						
at 23 °C/73 °F	J/g·K (BTU/lb·°F)	1.2 (0.28)	1.2 (0.28)	1.2 (0.28)	1.2 (0.28)	
at 100 °C/212 °F	J/g·K (BTU/lb·°F)	1.6 (0.38)	1.6 (0.38)	1.6 (0.38)	1.6 (0.38)	
Electrical properties						
Surface resistivity (voltage < 1 V, after 2 min, 500 V at 23 °C/73 °F)	Ω	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	ASTM D257
Volume resistivity (intensity = 10 mA, after 2 min at 23 °C/73 °F)	Ω·cm	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	ASTM D257
Dielectric strength at 23 °C/73 °F, 1 mm thick	kV/mm	20–25	20–25	20–25	20–25	ASTM D149
Fire resistance						
UL-94 flammability test	Class	V–0	V–0	–	V–0	UL-94
Limiting oxygen index (sheet 3 mm thick)	%	44	44	44	44	ASTM D2863

[1] *Results achieved with formulated grade (code: XXXX/0000)*

Mechanical properties are significantly affected by the sample preparation method.
Typical property values are reported in this document. They should not be interpreted as sales specifications.

	Unit	Solef® 6020	Solef® 5130	Solef® 9007	Test Method
Physical properties					
Density at 23 °C/73 °F	g/cm³ (lb/ft³)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	ASTM D792
Water absorption (24 h at 23 °C/73 °F)	%	< 0.04	< 0.2	< 0.04	ASTM D570
Melt flow index (230 °C/446 °F)	g/10 min				ASTM D1238
21.6 kg		≤ 0.2	–	–	
10 kg		–	–	–	
5 kg		–	–	20–38	
3.8 kg		–	–	16–26	
2.16 kg		–	–	–	
Mechanical properties					
Tensile at 23 °C/73 °F (Type IV specimen, 2 mm thick)					ASTM D638
Stress at yield (50 mm/min)	MPa (psi)	–	–	45–60 (6,500–8,700)	
Stress at break (50 mm/min)	MPa (psi)	–	–	30–50 (4,400–7,300)	
Elongation at yield (50 mm/min)	%	–	–	5–10	
Elongation at break (50 mm/min)	%	–	–	20–300	
Modulus (1 mm/min)	MPa (kpsi)	1,300–2,000 (188–290)	1,000–1,500 (145–218)	1,400–2,200 (200–320)	
Notched charpy strength (4 mm thick, 2 m/s, 23 °C/73 °F)	J/m (ft·lbf/in)	–	–	40–120 (0.7–2.0)	ASTM D6110
IZOD impact (notched V 10 mm, 23 °C/73 °F, 4 mm thick)	J/m (ft·lbf/in)	–	–	–	ASTM D256
Shore D hardness (2 mm thick)		–	–	73–80	ASTM D2240
Abrasion resistance	mg/1,000 rev	–	–	5–10	TABER CS 17, 1 kg
Friction coefficient	static dynamic	–	–	0.2–0.4 0.15–0.35	ASTM D1894

	Unit	Solef® 6020	Solef® 5130	Solef® 9007	Test Method
Thermal properties					
Crystallinity by DSC					ASTM D3418
Melting point	°C (°F)	171–175 (340–347)	158–166 (316–331)	162–168 (324–334)	
Heat of fusion (80 °C/176 °F to end of melting)	J/g (BTU/lb)	55–65 (23–28)	40–48 (17–21)	53–60 (22–26)	
Crystallization point	°C (°F)	133–138 (271–280)	124–130 (255–266)	133–140 (271–284)	
Crystallization heat	J/g (BTU/lb)	48–55 (21–24)	37–45 (16–19)	53–60 (22–26)	
VICAT point	°C (°F)	135–145 (275–295)	–	–	ASTM D1525 2A
Glass transition (Tg)	°C (°F)	–40 (–40)	–40 (–40)	–40 (–40)	ASTM D4065
Molding shrinkage (linear)	%	–	–	2–3	
Thermal stability	°C (°F)	375–400 (707–752)	>375 (>707)	375–400 (707–752)	TGA. T° for 1 % w loss in air
Linear thermal expansion coefficient	10^{-6}/K (10^{-6}/°F)	140 (78)	–	140 (78)	ASTM D696
Thermal conductivity at 23 °C/73 °F	W/m·K (BTU·in/h·ft²·°F)	0.2 (1.4)	–	0.2 (1.4)	ASTM C177
Specific heat					
at 23 °C/73 °F	J/g·K (BTU/lb·°F)	1.2 (0.28)	–	1.2 (0.28)	
at 100 °C/212 °F	J/g·K (BTU/lb·°F)	1.6 (0.38)	–	1.6 (0.38)	
Electrical properties					
Surface resistivity (voltage < 1 V, after 2 min, 500 V at 23 °C/73 °F)	Ω	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	ASTM D257
Volume resistivity (intensity = 10 mA, after 2 min at 23 °C/73 °F)	Ω·cm	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	ASTM D257
Dielectric strength at 23 °C/73 °F, 1 mm thick	kV/mm	20–25	–	20–25	ASTM D149
Fire resistance					
UL-94 flammability test	Class	–	–	–	UL-94
Limiting oxygen index (sheet 3 mm thick)	%	44	–	44	ASTM D2863

Mechanical properties are significantly affected by the sample preparation method.
Typical property values are reported in this document. They should not be interpreted as sales specifications.

	Unit	Solef® 9009	Solef® 460	Solef® 41308	Test Method
Physical properties					
Density at 23 °C/73 °F	g/cm³ (lb/ft³)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	ASTM D792
Water absorption (24 h at 23 °C/73 °F)	%	< 0.04	< 0.04	< 0.04	ASTM D570
Melt flow index (230 °C/446 °F)	g/10 min				ASTM D1238
21.6 kg		–	10	–	
10 kg		–	–	–	
5 kg		10–20	–	18–24	
3.8 kg		7–13	–	–	
2.16 kg		–	–	6–8	
Mechanical properties					
Tensile at 23 °C/73 °F (Type IV specimen, 2 mm thick)					ASTM D638
Stress at yield (50 mm/min)	MPa (psi)	45–60 (6,500–8,700)	35–55 (5,000–8,000)	45–50 (6,500–7,200)	
Stress at break (50 mm/min)	MPa (psi)	30–50 (4,400–7,300)	30–50 (4,400–7,300)	20–40 (2,900–5,800)	
Elongation at yield (50 mm/min)	%	5–10	10–15	5–10	
Elongation at break (50 mm/min)	%	20–300	20–300	20–300	
Modulus (1 mm/min)	MPa (kpsi)	1,400–2,200 (200–320)	1,000–1,500 (145–218)	1,600–2,200 (230–320)	
Notched charpy strength (4 mm thick, 2 m/s, 23 °C/73 °F)	J/m (ft·lbf/in)	40–120 (0.7–2.0)	–	40–120 (0.7–2.0)	ASTM D6110
IZOD impact (notched V 10 mm, 23 °C/73 °F, 4 mm thick)	J/m (ft·lbf/in)	–	107 (2)	–	ASTM D256
Shore D hardness (2 mm thick)		73–80	73–80	–	ASTM D2240
Abrasion resistance	mg/1,000 rev	5–10	5–10	5–10	TABER CS 17, 1 kg
Friction coefficient	static dynamic	0.2–0.4 0.15–0.35	0.2–0.4 0.15–0.35	0.25–0.35 0.25–0.35	ASTM D1894

	Unit	Solef® 9009	Solef® 460	Solef® 41308	Test Method
Thermal properties					
Crystallinity by DSC					ASTM D3418
Melting point	°C (°F)	162–168 (324–334)	155–160 (311–320)	167–171 (333–339)	
Heat of fusion (80 °C/176 °F to end of melting)	J/g (BTU/lb)	53–60 (22–26)	42–50 (17–21)	50–55 (21–23)	
Crystallization point	°C (°F)	133–140 (271–284)	128–135 (262–275)	130–140 (266–284)	
Crystallization heat	J/g (BTU/lb)	53–60 (22–26)	42–50 (17–21)	48–54 (20–23)	
VICAT point	°C (°F)	–	–	–	ASTM D1525 2A
Glass transition (Tg)	°C (°F)	−40 (−40)	−39 (−38)	−40 (−40)	ASTM D4065
Molding shrinkage (linear)	%	2–3	–	–	
Thermal stability	°C (°F)	375–400 (707–752)	375–400 (707–752)	>375 (>707)	TGA. T° for 1 % w loss in air
Linear thermal expansion coefficient	10^{-6}/K (10^{-6}/°F)	140 (78)	126 (70)	140 (78)	ASTM D696
Thermal conductivity at 23 °C/73 °F	W/m·K (BTU·in/h·ft²·°F)	0.2 (1.4)	0.2 (1.4)	0.2 (1.4)	ASTM C177
Specific heat					
at 23 °C/73 °F	J/g·K (BTU/lb·°F)	1.2 (0.28)	1.2 (0.28)	–	
at 100 °C/212 °F	J/g·K (BTU/lb·°F)	1.6 (0.38)	1.6 (0.38)	–	
Electrical properties					
Surface resistivity (voltage < 1 V, after 2 min, 500 V at 23 °C/73 °F)	Ω	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	ASTM D257
Volume resistivity (intensity = 10 mA, after 2 min at 23 °C/73 °F)	Ω·cm	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	ASTM D257
Dielectric strength at 23 °C/73 °F, 1 mm thick	kV/mm	20–25	10	–	ASTM D149
Fire resistance					
UL-94 flammability test	Class	V–0	V–0	–	UL-94
Limiting oxygen index (sheet 3 mm thick)	%	44	44	–	ASTM D2863

Mechanical properties are significantly affected by the sample preparation method.
Typical property values are reported in this document. They should not be interpreted as sales specifications.

Typical Properties of Solef® PVDF Copolymer Grades

	Unit	Solef® 11010	Solef® 21510	Solef® 31508	Solef® 60512	Test Method
Physical properties						
Density at 23 °C/73 °F	g/cm³ (lb/ft³)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	ASTM D792
Water absorption (24 h at 23 °C/73 °F)	%	< 0.04	< 0.04	< 0.04	< 0.04	ASTM D570
Melt flow index (230 °C/446 °F)	g/10 min					ASTM D1238
21.6 kg		–	–	–	–	
10 kg		–	–	–	2.5–4	
5 kg		4–8	3–9	–	–	
3.8 kg		–	–	–	–	
2.16 kg		–	–	3–8	–	
Mechanical properties						
Tensile at 23 °C/73 °F (Type IV specimen, 2 mm thick)						ASTM D638
Stress at yield (50 mm/min)	MPa (psi)	20–35 (2,900–5,000)	15–18 (2,175–2,610)	14–35 (2,030–5,075)	34–40 (4,930–5,800)	
Stress at break (50 mm/min)	MPa (psi)	20–40 (2,900–5,800)	20–40 (2,900–5,800)	14–30 (2,030–4,350)	34–40 (4,930–5,800)	
Elongation at yield (50 mm/min)	%	10–12	12–15	10–12	9–12	
Elongation at break (50 mm/min)	%	200–600	600–750	350–600	100–300	
Modulus (1 mm/min)	MPa (kpsi)	800–1,200 (120–180)	360–480 (52–70)	400–600 (58–87)	1,250–1,400 (181.3–203)	
Notched charpy strength (4 mm thick, 2 m/s, 23 °C/73 °F)	J/m (ft·lbf/in)	150–200 (3–5)	–	–	400–1,000 (7.5–18.7)[2]	ASTM D6110
IZOD impact (notched V 10 mm, 23 °C/73 °F, 4 mm thick)	J/m (ft·lbf/in)	–	180 (3.37)	1,000 (18.7)[2]	–	ASTM D256
Shore D hardness (2 mm thick)		70–75	58–62	50–55	70	ASTM D2240
Abrasion resistance	mg/1,000 rev	5–15	5–15	5–10	5–10	TABER CS 17, 1 kg
Friction coefficient	static dynamic	0.2–0.4 0.15–0.35	0.2–0.4 0.15–0.35	0.2–0.4 0.15–0.35	0.2–0.4 0.2–0.3	ASTM D1894

[2] *Partial break*

	Unit	Solef® 11010	Solef® 21510	Solef® 31508	Solef® 60512	Test Method
Thermal properties						
Crystallinity by DSC						ASTM D3418
Melting point	°C (°F)	158–162 (316–324)	130–136 (266–277)	167–171 (333–339)	170–174 (338–345)	
Heat of fusion (80 °C/176 °F to end of melting)	J/g (BTU/lb)	35–40 (15–18)	20–24 (9–10)	23–29 (8.2–14.2)	41–50 (18–21.5)	
Crystallization point	°C (°F)	115–130 (239–266)	89–93 (192–199)	125–131 (259–265)	142–146 (288–295)	
Crystallization heat	J/g (BTU/lb)	30–40 (13–18)	20–24 (9–10)	22–28 (7–13)	42–50 (18–21.5)	
VICAT point	°C (°F)	90–105 (194–220)	155 (239)	110 (230)	167 (333)	ASTM D1525 2A
Glass transition (Tg)	°C (°F)	–35 (–31)	–40 (–40)	–28 (–18)	–40 (–40)	ASTM D4065
Molding shrinkage (linear)	%	2–3	2–3	2–3	2–3	
Thermal stability	°C (°F)	330–350 (626–662)	340–375 (644–707)	320–340 (608–644)	320–340 (608–644)	TGA. T° for 1 % w loss in air
Linear thermal expansion coefficient	10^{-6}/K (10^{-6}/°F)	180 (100)	180 (100)	130–150 (72–83)	130–180 (72–100)	ASTM D696
Thermal conductivity at 23 °C/73 °F	W/m·K (BTU·in/h·ft²·°F)	0.19 (1.3)	0.18 (1.2)	0.2 (1.4)	0.2 (1.4)	ASTM C177
Specific heat						
at 23 °C/73 °F	J/g·K (BTU/lb·°F)	1.2 (0.28)	1.2 (0.28)	1.2 (0.28)	1.2 (0.28)	
at 100 °C/212 °F	J/g·K (BTU/lb·°F)	1.6 (0.38)	1.6 (0.38)	1.6 (0.38)	1.6 (0.38)	
Electrical properties						
Surface resistivity (voltage < 1 V, after 2 min, 500 V at 23 °C/73 °F)	Ω	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	ASTM D257
Volume resistivity (intensity = 10 mA, after 2 min at 23 °C/73 °F)	Ω·cm	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	≥ 10^{14}	ASTM D257
Dielectric strength at 23 °C/73 °F, 1 mm thick	kV/mm	15–25	15–20	20–25	–	ASTM D149
Fire resistance						
UL-94 flammability test	Class	V–0	–	V–0	–	UL-94
Limiting oxygen index (sheet 3 mm thick)	%	44[3]	44[3]	48	–	ASTM D2863

[3] *Formulations with higher values available: the Limiting Oxygen Index of the /0003 formulation is 65 %; the Limiting Oxygen Index of the /0009 formulation is > 90 %.*

Mechanical properties are significantly affected by the sample preparation method.
Typical property values are reported in this document. They should not be interpreted as sales specifications.

SOLVAY

asking more from chemistry®

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Material Safety Data Sheets (MSDS) are available by emailing us or contacting your sales representative. Always consult the appropriate MSDS before using any of our products.

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