SIPOLPRENE®

Thermoplastic polyether-ester elastomers

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SOCIETÀ ITALIANA POLIMERI

Specialists in **Copolymers**

SIPOLPRENE®
Contents

The **Company**

SIPOL® SPA is a chemical company founded in 1998, today part of the **TECNOGI GROUP**, focused on the development and the production of:

- co-polyesters and co-polyamides hot melt adhesives
- thermoplastic ether-ester elastomers TPC-ET
- biodegradable co-polyesters

Customized **Co-Polymers**

Our researchers' know-how in the macromolecular field allows the company to act as tailor-made co-polymers manufacturer for the end user as well as custom synthesis player.

Markets

- FOOTWEAR
- AUTOMOTIVE
- PACKAGING
- INDUSTRIAL
- SPORT & LEISURE
- COSMETIC & PERSONAL CARE
- CONSUMER GOODS
- E/E

Where **We Are**

Mortara (PV) - Italy
40.000 m² site area
6 polymerization lines

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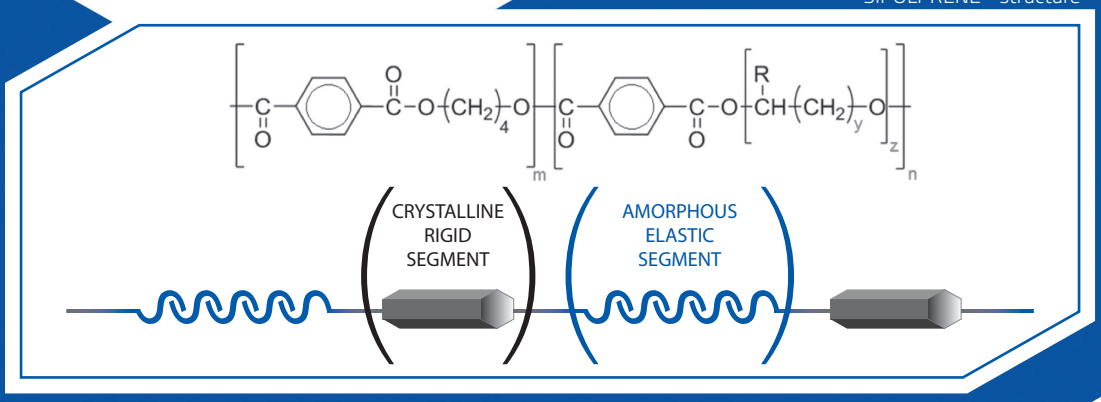
SIPOLPRENE®
General Information

SIPOLPRENE® is the registered trade mark of SIPOL® SPA for its family of thermoplastic ether-ester elastomers.
These engineering polymers are made through the combination of rigid polyester blocks (crystalline segment) and flexible long-chain polyether blocks (amorphous segment).
By varying the structure of these blocks it is possible to determine the final properties of the polymers.

SIPOLPRENE® structure



The rigid part is basically a PBT chain, while the flexible part is a polyether. The higher the number ***n***, the softer is the resulting polymer. In the opposite sense, by bringing ideally ***n*** to *0* the polymer becomes a simple PBT. It is evident that the ratio between rigid and flexible segments is the first and simplest way to drive the polymer hardness.
A second level of modification can be achieved by tuning parameter ***z***, the molecular weight of the polyether chain. This, of course modifies the polymer characteristics as concerns mechanical properties vs temperature, gas permeability, and chemical resistance. Additional modifications can be achieved by changing ***R*** and ***y*** (the ether unit), thus modifying the polymer polarity. The double soul of the SIPOLPRENE® macromolecular chain, (polyester-rigid and polyether-soft) allows the polymer to match the qualities of flexible plastics with the performance of thermoset elastomers.
As thermoplastic elastomer, it can easily be processed by using many different techniques, such as injection molding, extrusion, blow molding, etc.
At microscopic levels, the resulting structure, which is a block copolymer made of short hard segments alternating with long flexible segments, is biphasic in morphology.
The presence of hard polyester blocks assures heat resistance, chemical resistance and easy processing; amorphous polyether regions improve softness and elasticity, directly connected to the material hardness.

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Product **range**

SIPOL® SPA core business is polymerization and it is based on its superior competence in polymer chain modification, producing both standard grades and tailor-made materials designed to match application needs and requirements. SIPOLPRENE® range consists of High Performance and Specialty Grades of various melting points and hardness levels.

SIPOLPRENE® Product Code

SIPOLPRENE®

55	200	W
HARDNESS	MELTING POINT	SECONDARY CODE

High Performance Grades

SIPOLPRENE®	HARDNESS SHORE D (instantaneous)	MELTING TEMPERATURE (°C)
25170	28	173
25185	29	184
35180	35	177
35195	36	195
46185	45	186
48200	48	198
54205	54	205
55200	53	198
58210	58	211
63210	62	211
68217	68	217
72220	72	218

SIPOLPRENE®	HARDNESS SHORE D (instantaneous)	MELTING TEMPERATURE (°C)
35150	37	150
40171	38	170
45211	45	209
55211	54	213

Specialty Grades

- **SIPOLPRENE® 35150**, where melting temperature is lowered to 150°C so as to make it suitable for PVC modification.
- **SIPOLPRENE® reporting "1" as last digit** are modified as to increase crystallization rate, offering faster cycles in injection moulding.

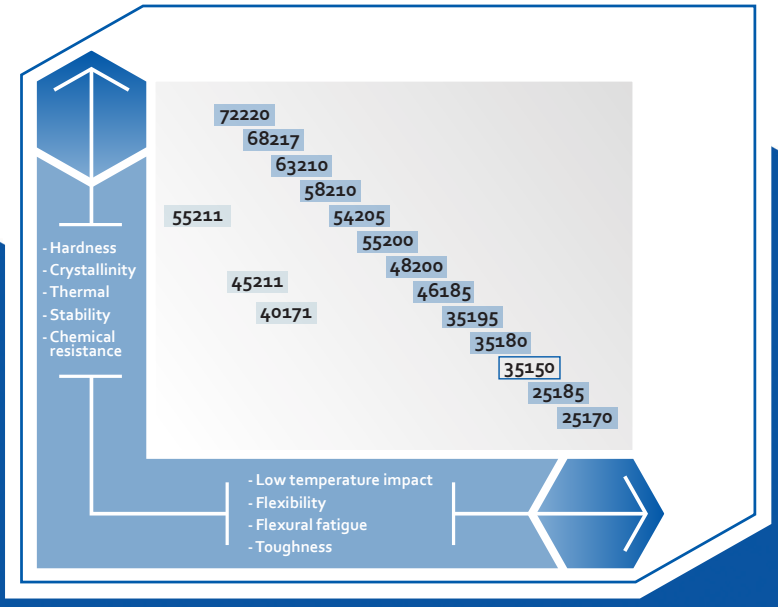
Secondary Code

Can be added for non-standard viscosity, specific stabilization package and black versions.
The following modifications should be evaluated case by case based on both the product grade and the specific requirements of process and final application.

SECONDARY CODE	DESCRIPTION
LV	Low viscosity
HV	High viscosity directly achieved in polymerization
K	Heat stabilized
W	UV stabilized
E	Specific quality dedicated to extrusion process
L	Enhanced lubrication
B	Black coloring through masterbatch dry blending

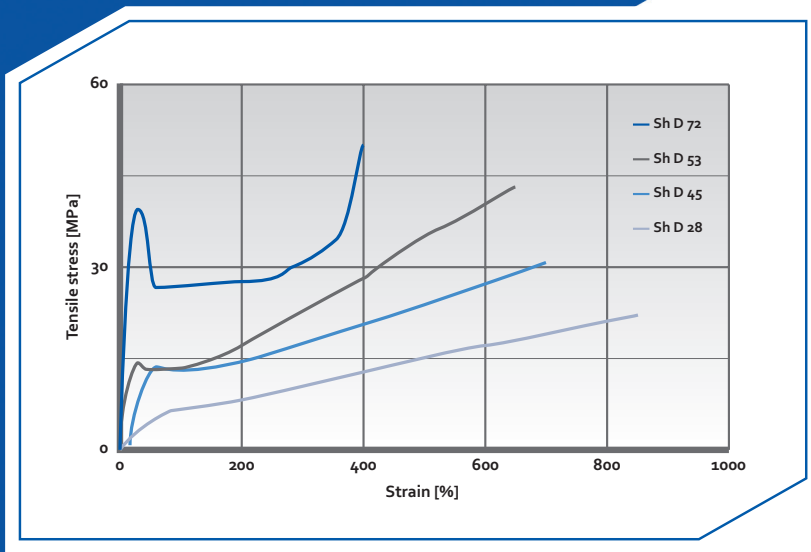
Physical **mechanical properties**

SIPOLPRENE® materials combine flexibility, temperature and chemical resistance with dimensional stability, flexural fatigue resistance and high impact strength.
SIPOLPRENE® products have a good abrasion and tear resistance, good electrical properties and an excellent overmoulding adhesion to various plastic materials due to their polar structure.
Mechanical properties of various SIPOLPRENE® products are strictly related to both their chemical composition and hardness. The more the hard-block content (rigid polyester), the more the hardness and they pass from essentially elastomeric polymers (28 – 45 Shore D) to plastomeric ones (53 – 72 Shore D). The result is an increasing load, stiffness, tear, creep, chemical and temperature resistance. Equally there is a decrease in fatigue and impact resistance.



The best way to understand the elastic behavior of SIPOLPRENE® is to refer to their stress/strain curves.
Tensile strength values are obtained from stress/strain curves determining the point of maximum stress on the curve. Maximum tensile values can be used in rating the relative material strain strength: generally, the softer the polymer the lower the yield point and the higher the elongation at yield. This defines the strain range where the material has elastic properties.

Stress-strain curves of representative SIPOLPRENE® grades are shown in the table at right.



SIPOLPRENE® stress-strain curves by hardness

SIPOLPRENE®'s outstanding creep resistance is explained by its excellent retention of mechanical properties under constant load, for long periods of time. This important feature makes it the ideal candidate for automotive, sealing and snap fit applications. SIPOLPRENE®'s high resistance to creep ensures that parts will be long lasting. Finally, SIPOLPRENE® has excellent compression set resistance compared to other thermoplastic elastomers.

= Good resistance. No effect regarding material or its properties.
= Moderate effect regarding material or its properties.
= Not recommended.

Chemical **resistance**

Having a polyester skeleton SIPOLPRENE® generally shows good resistance to grease and to hydrocarbons. However, polymers become less stable when in contact with polar solvent, ie. hot water, concentrated acids and/or bases, and alcohol above temperatures of 60°C. Having an enhanced PBT behaviour, harder SIPOLPRENE® grades, show a higher chemical resistance.

CHEMICAL AGENT	CHEMICAL RESISTANCE	
	Soft grades 28-45 Sh D	Hard grades 53-72 Sh D
Acetic acid, glacial		
Acetone		
Acetylene		
Antifreeze solution		
Benzene		
Butane		
Carbon dioxide		
Carbon monoxide		
Carbon tetrachloride		
Chloroform		
Cyclohexane		
Ethyl acetate		
Ethanol		
Ethanol/isopropanol 90:10		
Ethylene glycol		
Formaldehyde, 40%		
Formic acid		
Freon		
Gasoline		
n-hexane		
Hydrochloric acid		
Hydrogen		
Hydraulic Oil		
Isooctane		
Isododecane		
Isopropyl alcohol		
Methanol		
Methyl ethyl ketone		
Mineral oil		
Naphtha		
Nitric acid		
Olive oil		
Phenol		
Soap solution		
Silicone grease		
Sodium chloride solution		
Sodium hydroxide 15%		
Sodium hydroxide 35%		
Sulfuric acid > 50%		
Tetrahydrofuran		
Toluene		
Xylene		
Water (70°C)		
Water (100°C)		

SIPOLPRENE® chemical resistance
(if not indicated results are refer to tests at room temperature)

Electrical **properties**

A high dielectric constant together with a good dissipation factor makes SIPOLPRENE® suitable for low voltage applications where high mechanical properties and resistance to high temperatures are appreciated over traditional thermoplastics.

SIPOLPRENE®	ELECTRICAL STRENGTH	VOLUME RESISTIVITY	
	kV/mm	23 °C Ω·cm	1h @ 90 °C Ω·cm
	IEC 60243-1	IEC 62631-3-1	
25170	16	1E+12	1E+10
25185	16	1E+12	1E+10
35150	16	1E+12	1E+11
35180	16	1E+12	1E+11
35195	18	1E+12	1E+11
46185	17	1E+12	1E+11
48200	17	1E+12	1E+11
54205	18	1E+12	1E+11
55200	18	1E+12	1E+11
58210	18	1E+13	1E+11
63210	18	1E+13	1E+11
68217	19	1E+15	1E+12
72220	20	1E+16	1E+13

SIPOLPRENE® HIGH PERFORMANCE GRADES electrical strength and volume resistivity values

SIPOLPRENE®	RELATIVE PERMITTIVITY		DISSIPATION FACTOR	
	frequency 50Hz	frequency 1kHz	frequency 50Hz	frequency 1kHz
	IEC 60250			
25170	5,0	4,5	7,10E-02	4,60E-03
25185	4,9	4,4	6,50E-02	5,50E-03
35150	5,3	5,0	4,90E-02	8,20E-03
35180	5,1	4,9	7,20E-02	7,00E-03
35195	4,9	4,7	5,90E-02	5,40E-03
46185	5,0	4,8	5,30E-02	6,70E-03
48200	4,8	4,7	5,50E-02	6,40E-03
54205	4,8	4,6	5,60E-02	7,70E-03
55200	4,7	4,5	4,70E-02	8,20E-03
58210	4,5	4,2	5,90E-02	8,70E-03
63210	4,4	4,1	5,70E-02	8,50E-03
68217	3,9	3,7	6,20E-02	8,80E-03
72220	3,7	3,5	6,40E-02	9,00E-03

SIPOLPRENE® HIGH PERFORMANCE GRADES dielectric properties

Applications

AUTOMOTIVE & TRANSPORTATION
- Seals and gaskets
- Air bag deployment doors
- Gears
- Various moulded components: rotary encoders, protective caps, ...

INDUSTRIAL
- Seals and gaskets
- Hydraulic hoses
- Hoses for high pressure
- Shock and noise absorbers
- Grips

COSMETICS & PERSONAL CARE
- Mascara brushes
- Flocked applicators
- Dispensers
- Soft grips
- Cosmetic packaging components

CONSUMER GOODS
- Kitchen tools
- Garden tools
- Appliances parts
- Furniture textile and accessories
- Packaging components

SPORTS & LEISURE
- Winter sports accessories
- Sport shoes components
- Breathable membranes for outdoor clothing
- DIY tools

ELECTRICAL & ELECTRONIC
- Cables jacketing
- Cable compounds
- PVC modification

BUILDING & CONSTRUCTION
- Building insulation membranes

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Material **processing**

Drying

SIPOLPRENE® are hygroscopic materials and absorb moisture when exposed to air.
Therefore, it is highly recommended to dry the granules before use. An excess of moisture may trigger a degradation process in the molten material. This may affect the processability - melt strength – and the quality of finished parts – especially mechanical properties and appearance. The best option is to use a vacuum drying oven, because it reduces drying time and avoid contact with oxygen. Most commonly used dry air ovens (dehumidifiers) are also suitable for this purpose.

Product	Temperature °C	Duration h	Max Moisture Level %
HIGH PERFORMANCE GRADES and SIPOLPRENE 35150	90	2 - 3	0,15
SPECIALTY GRADES SIPOLPRENE 40171 | 45211 | 55211	90	3 - 4	0,15

SIPOLPRENE® drying conditions

Injection molding

SIPOLPRENE® can be processed in conventional injection molding machines. A typical single flight screw, about 20 L/D, compression ratio 2,3 ÷ 3, can be used as well as a barrier (double flight) screw, possibly with a shallow design. Injection molding parameters are strictly depending on mold geometry, size, wall thickness, etc; however, compatibly with the specific configuration, it is recommended to set gradual process conditions, limiting as much as possible residence time, back pressure and screw speed. A non-return valve is required to avoid backflow of molten material. Temperature settings: barrel profile should not exceed 30°C above melting temperature of the material; the mold should not exceed 50°C with a tight temperature control over the entire surface (heating and cooling), as shown in the table below. The filling phase must be rapid: the rheology of the material has to be evaluated to adapt the parameters to material behavior.
The shrinkage is of primary importance to obtain the right size of molded parts. MD and TD typical shrinkage values of SIPOLPRENE® are listed in table Typical Proporties. By the way, the global shrinkage depends on many factors: it is recommended to measure the actual shrinkage when an accurate value is required.

SIPOLPRENE®	Melting T	MFI (2,16 kg)	Mold T	Nozzle	Front Zone 3	Center Zone 2	Rear Zone 1
	°C	g/10'	°C	°C	°C	°C	°C
25170	173	12 (200°C)	20-30	200	190	180	155 - 170
25185	184	20 (220°C)	20-30	210	200	190	165 - 180
35180	177	34 (230°C)	20-30	205	195	185	160 - 175
35195	195	28 (230°C)	20-30	220	210	200	175 - 190
46185	186	34 (230°C)	20-30	210	200	190	165 - 180
48200	198	23 (230°C)	30-40	225	215	205	180 - 195
54205	205	20 (230°C)	30-40	230	220	210	185 - 200
55200	198	20 (230°C)	30-40	225	215	205	180 - 195
58210	211	23 (230°C)	30-40	235	225	215	190 - 205
63210	211	23 (230°C)	30-40	235	225	215	190 - 205
68217	217	20 (230°C)	40-50	240	230	220	195 - 210
72220	218	19 (230°C)	40-50	240	230	220	195 - 210
35150	150	9 (190°C)	20-30	175	165	155	130 - 145
40171	170	10 (190°C)	20-30	195	185	175	150 - 165
45211	209	16 (230°C)	30-40	235	225	215	190 - 205
55211	213	12 (230°C)	30-40	235	225	215	190 - 205

SIPOLPRENE® general temperature profiles for injection moulding

Extrusion

Several SIPOLPRENE® grades are suitable for extrusion process in several applications, like tubings, cables and monofilaments. Each extrusion process has its own specificity - i.e. presence of a calibration system, with or without vacuum, of a stretching phase, wide range of thicknesses, etc.- so the selection of the proper grade for each application has to be very accurate.

SIPOLPRENE® can be processed in a regular single screw extruder: 3 zones, L/D about 25, compression ratio between 2,4 and 3,2. Venting is not mandatory as a very low quantity of volatiles is developed during the process. Instead, it is recommended to use a gear pump to achieve a very regular flow of molten material.

Twin screw extruder is not the optimum for SIPOLPRENE® materials, because the shear stress is very high; nevertheless, it can be used setting the parameters as gradual as possible.

SIPOLPRENE®	Melting T	MFI (2,16 kg)	Feeding zone	Compression zone	Metering zone	Head Die
	°C	g/10'	°C	°C	°C	°C
25170	173	12 (200°C)	160-180	175-185	180-195	180-195
25185	184	20 (200°C)	165-180	175-185	180-195	180-195
35180	177	34 (230°C)	165-180	175-185	180-195	180-195
35195	195	28 (230°C)	185-200	195-205	205-220	205-220
46185	186	34 (230°C)	175-190	185-195	190-205	190-205
48200	198	23 (230°C)	190-205	205-215	210-225	210-225
54205	205	20 (230°C)	195-210	205-215	210-225	210-225
55200	198	20 (230°C)	190-205	205-215	210-225	210-225
58210	211	23 (230°C)	195-210	210-220	210-225	210-225
63210	211	23 (230°C)	195-210	210-220	210-225	210-225
68217	217	20 (230°C)	200-215	215-225	215-230	215-230
72220	218	19 (230°C)	200-215	215-225	215-230	215-230
35150	150	9 (190°C)	140-150	150-160	155-170	155-170
40171	170	10 (190°C)	160-170	170-180	170-185	170-185
45211	209	16 (230°C)	195-210	205-215	210-225	210-225
55211	213	12 (230°C)	200-215	210-220	215-230	215-230

SIPOLPRENE® general temperature profiles for extrusion

SIPOLPRENE®

Thermoplastic polyether-ester elastomers

Polymer modifier

Thanks to its high compatibility with PVC, PET, SEBS, ABS and TPU, SIPOLPRENE® is frequently used in compounding as a modifier to improve some specific properties of the final compound.
By compounding SIPOLPRENE® with other polymeric materials, a wide range of possible modifications can be reached.
The most common modification is the use in PVC compounds to improve their low temperature resistance and to reduce the amount of added plasticizer.
Furthermore, in SEBS compounds, SIPOLPRENE® can be blended to gain thermal resistance or to modify the adhesion to polar substrates for 2K moulding applications.

Recycling

SIPOLPRENE® exhibit good thermal stability at the temperatures required for manufacturing.
This feature makes it possible to regrind the scraps and mix them to fresh granules.
A maximum of 25% is recommended to avoid significant changes in melt flow rate and mechanical properties.

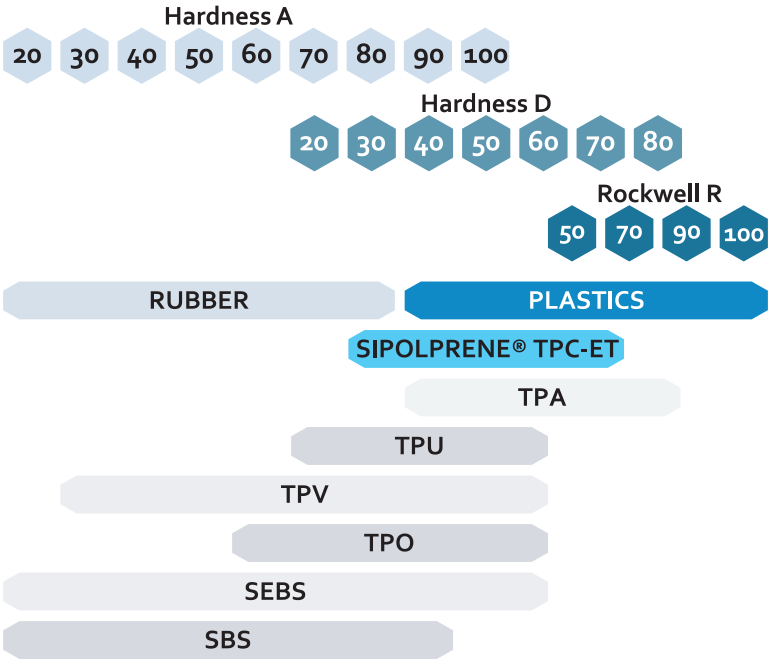
2K – Molding

The soft nature of SIPOLPRENE® and its chemical structure, which allows to achieve a good adhesion to several rigid engineering plastics products, make it a material of choice in 2K-molding application where "soft touch" or functional flexible properties are needed and other thermoplastic elastomers do not provide sufficient adhesion.
The table below shows an overview of the adhesion properties of SIPOLPRENE® and other polymers to several substrates.

Advantages of SIPOLPRENE® in 2K-Molding compared to other Elastomers

= Excellent / good adhesion.
= Adhesion only with modified grades.
= No adhesion.

SIPOLPRENE® vs
other thermoplastic elastomers



	SBS	SEBS	TPO	TPV	TPU	TPA	SIPOLPRENE® TPC-ET
Density (g/cm³)	0,9 – 1,2	0,9 – 1,2	0,9 – 1,2	0,9 – 1,1	1,1 – 1,4	1,05 – 1,20	1,09 – 1,25
Hardness (Shore A/D)	25A – 50D	0A – 60D	60A – 60D	30A – 65D	65A – 70D	25D – 80D	75A – 72D
Temperature range of usage (°C)	-50 / 90	-50 / 110	-60 / 110	-50 / 140	-40 / 110	-50 / 170	-60 / 185
Compression Set (70/100 °C)	●	●●	●●	●	●●	●●	●●
Abrasion Resistance (mm³)	●	●●	●●	●●	●	●	●
Hydrocarbons/ Fat Resistance	●	●	●●	●●	●	●	●
Non polar/ Aqueous Solvent Resistance	●	●	●●	●	●●	●	●
UV Resistance	●●	●	●	●	●	●	●●
Low temperature performance	●●	●●	●	●●	●	●	●

● Bad
● Moderate
● Good
● Excellent

HIGH PERFORMANCE

PROPERTIES	TEST METHODS	U.M.	25170	25185	35180	35195	46185	48200	54205
Shore D Hardness Instantaneous / 15 s	ISO 868	_	28/25	29/26	35/33	36/33	45/42	48/46	54/51
Stress at break	ISO 527	MPa	23	25	28	21	33	34	43
Elongation at break	ISO 527	%	830	700	630	700	660	560	500
Flexural Modulus	ISO 178	MPa	25	35	60	50	85	150	200
Izod impact strength (notched) (23°C)	ISO 180	J/m	NB	NB	NB	NB	NB	NB	NB
Izod impact strength (notched) (-40°C)	ISO 180	J/m	NB	NB	NB	NB	NB	NB	NB
Abrasion Resistance (vertical load 5 N)	ISO 4649	mm^3	45	35	26	27	24	23	18
Compression set (23 °C)	ISO 815:1991	%	26	24	25	22	34	34	22
Compression set (70 °C)	ISO 815:1991	%	67	65	68	63	69	61	60
Molding shrinkage (normal)	ISO 294-4	%	1,0	1,2	1,1	1,2	1,1	1,4	1,7
Molding shrinkage (parallel)	ISO 294-4	%	1,1	1,1	1,0	1,0	1,1	0,8	1,1
Melting Temperature	ISO 11357-3	°C	173	184	177	195	186	198	204
Crystallization Temperature	ISO 11357-3	°C	105	110	116	131	131	152	163
Glass Transition Temperature	ISO 11357-2	°C	-65	-65	-46	-45	-38	-18	-14
Vicat A/50	ISO 306	°C	73	98	111	137	149	174	182
MFI (2,16 Kg)	ISO 1133	g/10 min	200 °C 12	220 °C 20	230 °C 34	230 °C 28	230 °C 34	230 °C 23	230 °C 20
MVR (2,16 Kg)	ISO 1133	cm^3/10 min	11	18	31	25	30	19	17
Density	ISO 1183	g/cm^3	1,09	1,09	1,11	1,11	1,15	1,18	1,21
Water absorption (23°C x 24 h immersion)	MI 08	%	0,8	0,8	0,7	0,7	0,5	0,4	0,3
Idrolysis resistance (Viscosity decrease after 25 days immerison at 80 °C)	MI 20	%	48	28	57	30	75	68	84
Food contact EU Regulation n. 10/2011			V	V	V	V	V	V	V
Food contact US FDA Regulation			V	V	V	V	V	V	V
European Regulation REACh			V	V	V	V	V	V	V
RoHS Directive			V	V	V	V	V	V	V

GRADES

SPECIALITY GRADES

55200	58210	63210	68217	72220	35150	40171	45211	55211
53/50	58/55	62/59	68/65	72/69	37/33	38/35	45/42	54/51
43	44	48	58	53	28	22	23	29
590	530	470	490	460	570	380	380	410
190	280	320	525	660	50	50	75	150
NB	142	155	37	46	NB	NB	NB	NB
NB	80	82	34	36	NB	NB	NB	NB
24	33	32	56	76	33	51	22	36
42	20	39	18	18	24	22	28	33
61	67	62	67	70	76	62	64	46
1,7	1,7	2,1	2,0	2,1	0,4	0,8	1,8	1,9
1,3	0,9	0,6	0,9	0,6	0,5	0,6	1,6	1,8
198	211	211	217	218	150	170	209	213
147	174	167	177	183	74	101	169	172
-20	-8	3	30	28	-55	-35	-7	-18
177	190	195	208	210	105	103	186	183
230 °C	230 °C	230 °C	230 °C	230 °C	190 °C	190 °C	230 °C	230 °C
20	23	23	20	19	9	10	16	12
17	19	19	16	15	8	8	14	10
1,19	1,20	1,22	1,25	1,25	1,15	1,18	1,17	1,21
0,4	0,3	0,2	0,2	0,1	0,7	3,2	3,5	1,7
67	78	76	78	82	56	83	71	75
V	V	V	V	V	V	X	X	X
V	V	V	V	V	X	V	X	X
V	V	V	V	V	V	V	V	V
V	V	V	V	V	V	V	V	V

Information & TDS

The information provided in this documentation corresponds to our current knowledge at the date of publication. This information may be subject to revision as additional knowledge and experience become available. The data provided falls within the normal range of product properties and must be considered as guiding and typical values, relates only to the specific material; this data may not be valid for such material used in combination with any other materials or additives, unless expressly indicated otherwise. The data provided must not be used to define specification limits nor used alone as basis of design; they are not intended to substitute for any testing you may need to determine the suitability of a specific material for your particular application. User is responsible to check the suitability of product for intended processes and applications. Since SIPOL® SPA cannot anticipate all variations in actual end-use conditions, SIPOL® SPA makes warranties and assumes no liability in connection with any use of this information. Nothing in this publication is to consider as a license to operate under or a recommendation to infringe any patent rights.

SIPOL spa

SOCIETÀ ITALIANA POLIMERI

SIPOL spa
Via Leonardo Da Vinci, 5 - 27036 Mortara (PV) Italy
Tel. +39 0384 295237 - Fax +39 0384 295084
sipol@sipol.com - www.sipol.com