THERMOPLASTIC COPOLYESTER ELASTOMER

pibiflex®

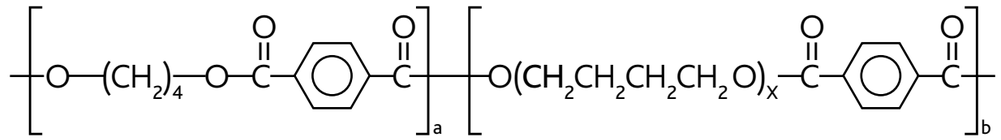
So.F.TeR.

SO.F.TER. SPA
Headquarters
Via Mastro Giorgio 1
Zona industriale Villa Selva
47122 Forlì FC Italy
tel +39 0543 790411
fax +39 0543 473119

SO.F.TER.
TECNOPOLIMERI SRL
Operations
Via Marconi 73
44122 Ferrara Italy
tel +39 0532 774911
fax +39 0532 774941

Chemical structure

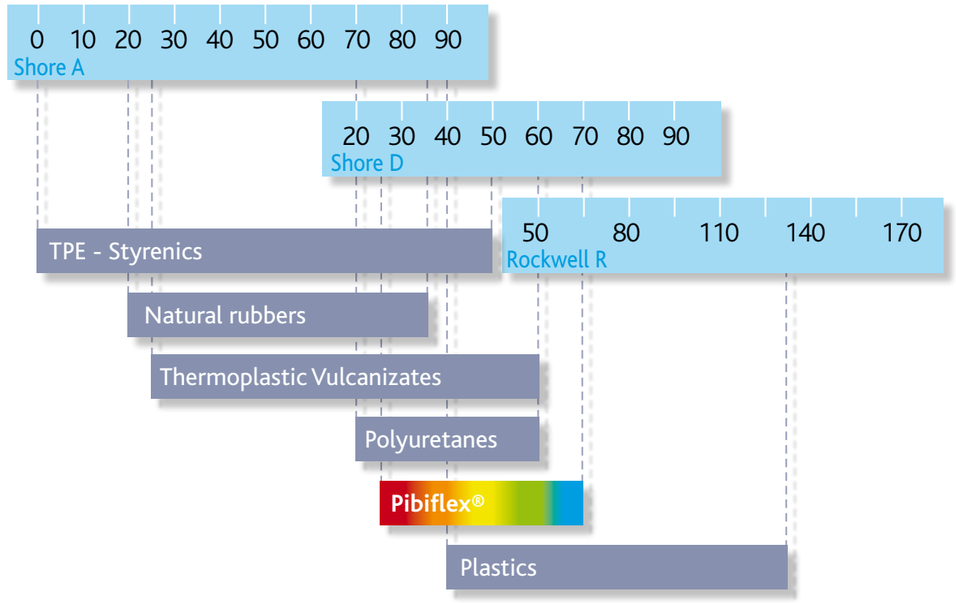
Pibiflex® is a thermoplastic copolyester based elastomer with a partially crystalline sequential structure formed by rigid crystalline PBT segments and soft amorphous polyether/polyester long-chain segments. The soft segments provide elasticity and rubber-like properties, while the hard segments provide the processing ease and the strength typical of engineering plastics. The ratio between hard and soft segments determines the properties of the various grades.



Hard Segment
(Polybuthylene Terephtalate)

Soft Segment
(Polytetramethylene Ether Glycol Terephtalate)

Pibiflex® hardness range



Cover image: courtesy ENNEREV MATERASSI SPA

Range
SO.F.TER. offers a complete portfolio ranging from soft to hard solutions.

- **Injection moulding** grades offering easy processability also for the rigid grades
- **Extrusion** and **blow moulding** grades providing excellent melt strength
- **Dolphin** grades for the production of soft-touch interior trims in a single phase (see Dolphin technology page 8)

Summary of properties
- Hardness from 25 up to 70 Shore D
- Flexural Modulus from 30 up to 600 MPa
- Tensile Strength from 15 up to 40 MPa
- Elongation at break from 300 up to 850 %
- Vicat 1Kg/120 °C from 80 up to over 200 °C
- HDT (0,45 MPa) from 46 up to over 120 °C

Applications
- **Automotive:** CVJ boots, airbags, air ducts, belt drives, conveyor belts, hoses and steering wheel covers, soft skins for dashboard, door panels and interior trims
- **Electrical appliance**: wire and cable jackets, buttons and grips of electric power tools equipment
- **Industrial**: railroad tie pads, high-pressure gaskets, silent gears, spring of dispensing machines, cable ties
- **Sport**: flipper blades

CVJ boots
Pibiflex® B5050 MWR (Blow moulding grade)
Pibiflex® 4054 IM (Injection moulding grade)

Adhesion-2K moulding
Pibiflex® features very good adhesion properties to many polymeric materials including ABS, PBT, PC, PC/PBT, PC/ABS, EVA, TPU, SEBS (special grades) and to many paints, glues and metals.

Approvals
Various Pibiflex® grades have been approved for automotive applications by the most important automotive manufacturers and Tier 1.

Food contact grades
Pibiflex® grades **2560** and **3560** comply with the requirements of the FDA-CFR 21-parts 170 to 199 item 177.2600, paragraph a) b) c) d) e) f) for use in contact with dry foods, aqueous foods and fatty foods. Such grades can be used in food packaging and in alcohol, fruit juices and oil bottling.

Medical grades
Pibiflex® grades **2560** and **3560** comply with the requirements of USP XXXII:2009 Class VI and ISO 10993-4/5/10 and can be used in medical applications.
Test performed:
- Intracutaneous reactivity
- Systemic toxicity
- Implantation test in the rabbit
- Physicochemical test <661> Plastics: nonvolatile residue, heavy metals, buffering capacity
- Cytotoxicity, MEM Elution
- Hemolysis test, direct and indirect contact

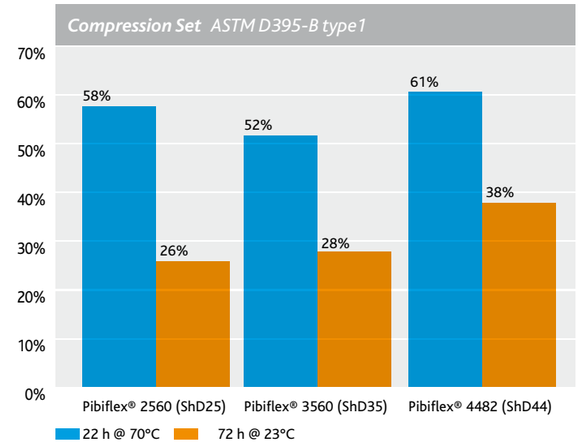
Bi-material air duct
Blow moulded PBT ducts, heat welded to theTPC base
Pibiter® BM521 (PBT, blow moulding)
Pibiflex® 4632 (TPC, injection moulding)

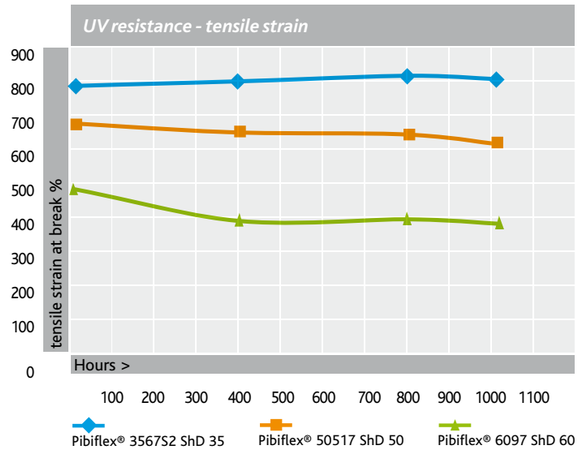
Elastic properties
Pibiflex® features excellent mechanical properties, such as tensile strength and tear strength, exceptional toughness and resilience, high creep and flexural fatigue resistance.

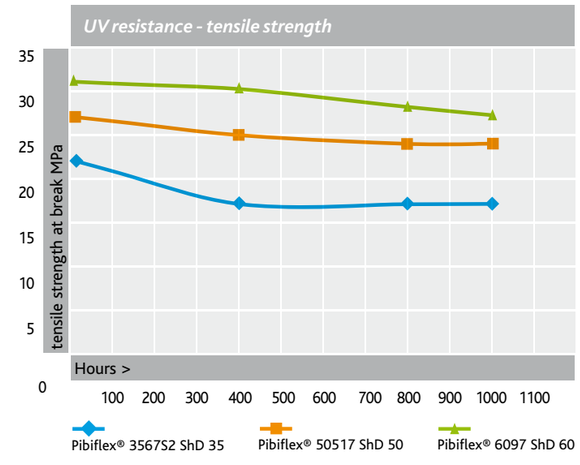
Temperature resistance
Pibiflex® has an excellent temperature behaviour:
- maintains flexibility at low temperatures (low temperature limit - 45 °C)
- retains properties at high temperatures (high temperature limit 150 °C, continuous use)

Weathering resistance
UV stabilized grades
- Pibiflex® 3567 S2 Black 33
- Pibiflex® 50517 Black
- Pibiflex® 6097 Black

show a substantial retain of mechanical properties after 1000 hours exposure to Xenon lamps (Norm PSA Peugeot Citroen D27 1389).





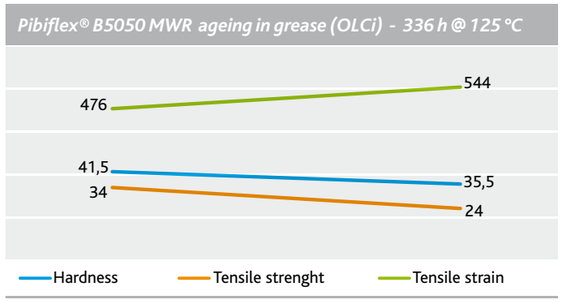


Chemical resistance

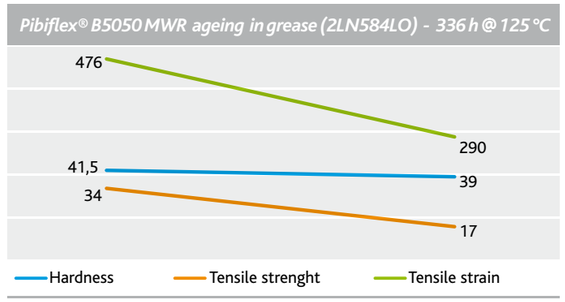
Pibiflex® offers outstanding chemical resistance to fuels, oils, greases and it is particularly suitable for applications in the automotive sector where continuous contact with oils and greases at high temperature is required.

	Hardness (Shore D)		
	35-40	45-55	>60
Oils, greases, hydrocarbons			
Mineral oil, grease, non aromatic hydrocarbons	☺	☺	☺
Benzene, toluene, aromatic hydrocarbons, chemicals, solvents	☹	😐	☺
Water, alchohols, glycols			
At ambient temperature	☺	☺	☺
>50 °C without specific stabilizer	☹	☹	☹
>50 °C with specific stabilizer	😐	😐	😐
Acids and bases			
Diluited	😐	☺	☺
Concentrated	☹	☹	☹

Pibiflex® B5050 MWR ageing in grease (OLCi) - 336 h @ 125 °C



Pibiflex® B5050 MWR ageing in grease (2LN584LO) - 336 h @ 125 °C



Recycling

Pibiflex® is a fully recyclable material.
Production scraps can be re-used after grinding.
Recovered material can be mixed with virgin material, but we recommend not to exceed a percentage of 20%, in order not to alter the compound final quality.

Packaging and storage

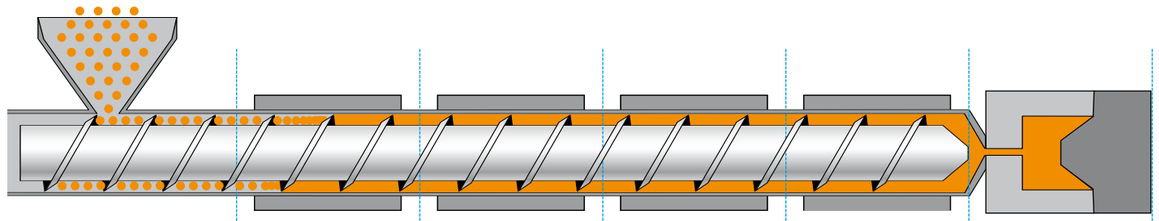
Pibiflex® is supplied in 25 kg moisture proof aluminium bags. The product should be stored in its original packaging in a cool, dry place at temperatures below 40 °C. Exposure to light and to other heat sources must be avoided.

Processing conditions

Injection moulding	
drying	3-4 h @ 90-120 °C in dehumidifying hopper drier
plasticizing screw	polyesther-type screw
screw L/D ratio	≥ 20:1
screw compression ratio	3:1 to 4:1
plasticizing speed	high
injection speed	high
injection pressure	high
runners	having circular section and gradually decreasing flow-through diameter
injection points (*)	Ø ≥ 0.7 mm
mould air vents	Ø 0.03 ÷ 0.05 mm
Extrusion/blow moulding	
drying	3-4 h @ 90-120 °C in dehumidifying hopper drier
plasticizing screw	polyethylene-type screw
screw L/D ratio	≥ 20:1
screw compression ratio	2,5:1 to 3,5:1
die land	<10 mm
breaker plate	60 Mesh

(*) We recommend not to use injection points having a diameter <0.3 mm without prior selection of the appropriate grades, to be agreed with SO.F.TER. Technical Support.

Indicative processing temperatures (°C)



Injection moulding	1st Zone	2nd Zone	3rd Zone	Nozzle	Mould
hardness 25-50 ShD	210-225	220-230	225-240	230-250	40-60
hardness 55-70 ShD	220-230	230-240	240-250	240-250	40-70

Extrusion	1st Zone	2nd Zone	3rd Zone	Head	Die
hardness 45-60 ShD	220-230	230-240	240-250	230-250	230-250

Blow moulding	1st Zone	2nd Zone	3rd Zone	Head	Die
hardness 40-50 ShD	200-220	210-230	220-240	220-250	220-250

Technical data

PIBIFLEX® Thermoplastic Copolyester Elastomer (TPC)																								
			INJECTION MOULDING																	BLOW MOULDING			EXTRUSION			
			Pibiflex® 2094 S NAT	Pibiflex® 2560 NAT	Pibiflex® 3560 NAT	Pibiflex® 3567 S2	Pibiflex® 4010 LC NAT	Pibiflex® 4054 IM NERO	Pibiflex® 4482 NAT	Pibiflex® 4612 NAT	Pibiflex® 5312 NAT	Pibiflex® 5612 NAT	Pibiflex® 5880 NAT	Pibiflex® 6097 NERO	Pibiflex® L 6360 NAT	Pibiflex® 7212 NAT	Pibiflex® 8394 NAT	Pibiflex® B 5050 MWR NERO	Pibiflex® RFB 40011 NERO	Pibiflex® B 50518 T2 NERO	Pibiflex® E 4482 NAT	Pibiflex® E 5332 NAT	Pibiflex® E 5888 NAT	Pibiflex® E 6060 NAT
Physical properties	*Method*	*Unit*																						
hardness 15"	ASTM D2240	Shore D	23	27	35	35	33	41	44	46	53	54	56	60	63	68	66	41	45	48	45	53	55	60
density	ASTM D792	g/cm³	1,09	1,09	1,12	1,12	1,15	1,14	1,19	1,17	1,2	1,22	1,24	1,21	1,24	1,27	1,26	1,14	1,16	1,18	1,19	1,23	1,24	1,23
water absorption 24 h/23 °C	ASTM D570	%	-	0,95	0,9	0,9		0,6	3	0,8	0,6	0,52	2,5	0,23	0,22	0,16	0,3	0,6			3	1,25	2,5	0,23
melting point (dsc)	ASTM D3417	°C	185	185	195	195	155	200	210	194	203	208	218	212	219	215	198	200	214	205	210	200	218	218
glass transition	INTERNAL	°C	-	-70	-65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MVR melt volume rate (220 °C - 2,16 kg)	ASTM D1238	cm³/10'	9	20	25	25	16				-	-	-	-	-	-	-	-	-	-	-	-	-	-
MFI melt flow index (230 °C - 2,16 kg)	ASTM D1238	g/10'	-	-	-	-	-	10	13	20	15	15	-	9	80	-	25	1,5	-	-	5	9	7	9
MFI melt flow index (230 °C - 5 kg)	ASTM D1238	g/10'	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	5	1	-	-	-	-
MFI melt flow index (240 °C - 2,16 kg)	ASTM D1238	g/10'	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-
Mechanical properties																								
tensile strength at break	ASTM D638	MPa	12	16	18	18	20	33	28	25	30	35	38	30	34	40	32	30	28	30	28	35	40	35
elongation at break	ASTM D638	%	750	800	850	750	730	600	500	800	650	600	500	400	500	420	350	460	500	350	500	600	500	500
flexural modulus	ASTM D790	MPa	30	35	55	55	56	90	150	125	210	260	300	450	520	640	1100	90	160	150	160	220	300	430
tear strength	ASTM D624	N/mm	-	-	60	-	-	98	-	85	-	155	-	-	-	-	-	110	-	-	-	120	-	-
fatigue resistance	ASTM D1052	mm/Kcicli	-	-	0,1/300	-	-	0,1/300	-	0,1/300	-	6/50	-	-	-	-	-	0,1/300	-	-	-	0,1/300	-	-
IZOD impact strength notched at 23 °C	ASTM D256/A	J/m	N.B.	N.B.	N.B.	N.B.	N.B.	N.B.	N.B.	N.B.	N.B.	800	N.B.	-	-	-	85	N.B.	N.B.	-	N.B.	N.B.	N.B.	-
IZOD impact strength notched at -10 °C	ASTM D256/A	J/m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N.B.	-	-	-	-
IZOD impact strength notched at -30 °C	ASTM D256/A	J/m	N.B.	N.B.	N.B.	N.B.	N.B.	N.B.	N.B.	N.B.	N.B.	130	N.B.	-	-	-	-	N.B.	N.B.	-	N.B.	800	N.B.	-
IZOD impact strength notched at -40 °C	ASTM D256/A	J/m	-	-	-	-	-	-	-	-	-	-	-	-	80	-	-	-	N.B.	500	-	-	-	-
IZOD impact strength notched at -50 °C	ASTM D256/A	J/m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	150	-	-	-	-
abrasion resistance (taber h18 - 1kg)	ASTM D1044	mg/Kcicli	50	-	-	-	-	-	-	85	-	73	-	-	-	-	-	-	-	-	-	62	-	-
Thermal properties																								
VICAT method A (120 °C/h at 10 N)	ASTM D1525	°C	-	-	-	-	-	155	-	148	-	188	198	-	203	-	175	155	-	175	-	180	198	>150
H.D.T. Method B (0,45 MPa)	ASTM D648	°C	-	-	-	-	-	-	-	54	-	88	-	-	-	-	73	-	-	-	-	80	-	95
Flammability properties																								
oxygen index	ASTM D2863	-	20	20	20	20	20	20	20	20	20	20	20	21	21	22		20		20	20	20	20	21
flame rating 1.6 mm	UL 94	-	-	-	-	-	-	-	-	-	-	-	-	-	HB	-	-	-	-	-	-	-	-	-
Electrical properties																								
volume resistivity at 23 °C	ASTM D257	Ohm.cm	-	> 10^{13}	> 10^{13}	-	-	-	-	> 10^{13}	-	> 10^{13}	-	-	> 10^{13}	> 10^{14}	-	-	-	-	-	-	-	-
volume resistivity at 100 °C	ASTM D257	Ohm.cm	-	> 10^{11}	> 10^{11}	-	-	-	-	> 10^{11}	-	> 10^{12}	-	-	> 10^{12}	> 10^{13}	-	-	-	-	-	-	-	-
dielectric strength at 2,0 mm -23 °C	ASTM D149	kV/mm	-	16	17	-	-	-	-	17	-	18	-	-	-	18	-	-	-	-	-	-	-	-
dielectric constant 1KHz	ASTM D150	-	-	4,4	4,3	-	-	-	-	4,25	-	3,8	-	-	-	2,85	-	-	-	-	-	-	-	-
dielectric constant 100KHz	ASTM D150	-	-	4,3	4,25	-	-	-	-	4,21	-	3,7	-	-	-	2,75	-	-	-	-	-	-	-	-
dissipation factor tan ∂ - 1 KHz	ASTM D150	-	-	0,005	0,006	-	-	-	-	0,006	-	0,011	-	-	-	0,0132	-	-	-	-	-	-	-	-
dissipation factor tan ∂ - 100 KHz	ASTM D150	-	-	0,014	0,015	-	-	-	-	0,016	-	0,024	-	-	-	0,0126	-	-	-	-	-	-	-	-

All the figures reported in this publication are the result of tests and analyses carried out in our laboratories and are believed to be accurate and reliable.
Tests are performed at 23 °C unless otherwise specified. Data may be subject to revision and are provided for general guidance only.
The user is responsible for carrying out all the tests necessary to verify the suitability of the material for the specific application.
SO.F.TER. makes no warranties and assumes no liability in connection with any use of this information.

Dolphin

Aesthetics meets technology

Dolphin is an innovative technology that enables the production of soft-touch dashboard and interior panels in a single phase.

The production of the three-layer structure takes place in a single moulding cell:

1. injection of the rigid structural carrier in Reblend® (PC/ABS alloy)
2. injection and foaming of the intermediate structural layer (MuCell® foamed Pibiflex®)
3. injection of upper soft-touch layer in Pibiflex®

Benefits

- leaner logistics and production cycle
- cost reduction
- full recyclability of the entire item, in compliance with EU Directive 2000/53/EC – ELV (End of Life Vehicles).

Application

Dashboard, door panels, armrest, consoles and soft-touch parts of automotive interiors.

Pibiflex® 3567 S2

The soft-touch skin is made with Pibiflex® 3567 S2 a grade specifically developed for this application which guarantees:

- very high UV and scratch resistance combined with excellent haptic properties
- preservation of properties (haptic and softness) even at very low temperature
- excellent aesthetic properties in various colours
- high chemical affinity with the gas used in the MuCell® foaming process
- high chemical affinity with the structural carrier made in PC/ABS

The high chemical affinity of the materials used ensures a perfect adhesion between rigid and soft part, as confirmed by specific tests.

Pibiflex® 3567 S2 meets the requirements of the following automotive norms:

- material properties DBL 5562.50
- climate resistance test (alternating climates) DBL 5471
- constant climate (dry hot) DBL 5471
- constant climate (wet hot) DBL 5471
- colour change after climate storage DBL 5471
- solar simulation DBL 5471
- abrasion resistance DIN EN ISO 105-X12
- scratch resistance DBL 5471
- emission analysis VOC DBL 8585 – VDA 278
- emission analysis FOG DBL 8585 – VDA 278
- odour test DBL 5471 – VDA 270
- fogging test DBL 5471 – DIN 75 201

Reblend®

The rigid carrier is made with Reblend (PC/ABS alloy). The specific grade developed for this application has good flowability and high dimensional stability.