TSE Industries, Inc.
Millathane® Millable Polyurethanes
4370 112th Terrace North
Clearwater, FL 33762 (USA)
727-573-7676 or 800-237-7634 www.tse-industries.com

Millathane® Millable Polyurethanes for Footwear

Millathane millable (solid) polyurethanes have been used in footwear applications for over 25 years because of the properties that they provide: high strength, high resistance to abrasion, good oil resistance, high coefficient of friction, excellent aging and weathering properties and transparency (Millathane 97 only). Millathane rubber is processed on standard rubber processing equipment and is formulated similarly to other types of rubber.

Typical Grades used in Footwear

Millathane Grade	Urethane Type	Properties
Millathane E34	Polyether	Excellent strength, high abrasion resistance, good processing
Millathane E40	Polyether	Excellent strength, high abrasion resistance, good processing, best low temperature performance
Millathane 55	Polyether	Lower viscosity but gives higher hardness than Millathane E34 in sulfur cures. Excellent strength, abrasion resistance, processing
Millathane CM	Polyether	Excellent strength and abrasion resistance, good low temperature performance
Millathane 97	Polyether	Excellent transparency and colorability, good weatherability, high coefficient of friction. Peroxide curable only.

Processing

Millathane millable polyurethanes are processed by techniques which are common to the rubber industry. Compounds can be mixed on open mills or in internal mixers; molded articles can be produced via compression, transfer or injection molding. Calendered sheets can be press-cured or rotocured, or vulcanized in steam or hot air autoclaves (with protection from contact with steam and oxygen).

Glow In The Dark Compound

Transparent Millathane 97 compounds can be made to glow in the dark (after exposure to light, natural or artificial) by the addition of the additive “Greenglow”. Soles or decorative areas of shoes that glow in the dark can be a benefit to the safety of runners who run at night.

	XP-5758-K
Millathane 97	100
Stearic acid	0.2
Wacker HDK N20P (fumed silica)	20
Silquest A-172 (silane)	0.4
Irganox 1010	0.25
Tinuvin 765	0.25
SR 231 (DEGDMA)	3
GREENGLOW	10
Luperox 231	0.5

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Millathane® Sole Compounds

	Natural	Faster Curing	Better Low Temperature	*Good Adhesion to NR, SBR*
Millathane® E34	100.0	100.0		
Millathane E40			100.0	80.0
Safipol TPU7840				20.0
Zinc Stearate	0.5	0.5	0.5	0.5
Ultrasil VN3	20.0	25.0	25.0	19.0
Silquest A-189	1.0	5.0	0.5	0.4
DBEEA (TP-95)	1.0	5.0		
DBEEF (TP-90B)			5.0	
Cumar P10				4.0
Struktol WB222	0.5		1.0	0.4
Stearic Acid		0.5		
Carbowax 3350		3.0		
MBTS	4.0	4.0	4.0	4.0
MBT	2.0	4.0	2.0	2.0
Thanecure® ZM	1.0	2.0	1.0	1.0
Methazate (ZDMC)		1.0		
Sulfur, 80%	2.5	2.5	2.5	2.8

Physical Properties

Cure Conditions, min./temp.	20'/150ºC	4'/160ºC	11'/160°C	12'/160°C
Hardness, Shore A	65	64	66	67
100% Modulus, kg/cm² (psi)	24 (340)	21 (305)	26 (365)	19 (265)
300% Modulus, kg/cm² (psi)	105 (1500)	82 (1170)	93 (1330)	62 (880)
Tensile Strength, kg/cm² (psi)	288 (4090)	241 (3430)	289 (4110)	278 (3960)
Elongation, %	510	535	555	585
Tear Die C, kg/cm (lb/in)	33 (182)	38 (212)	41 (230)	—
DIN Abrasion loss (rotating), mm³	49	60	52	69

Observations

Millathane E34 and Millathane E40 compounds have *excellent* physical properties and abrasion resistance.

Natural (amber color) compounds can be colored to make white, gray or non-marking black soles.

Millathane E40 will give better low temperature properties, better resistance to low temperature stiffening, than Millathane E34.

Millathane compounds can get excellent adhesion to SBR (or NR) compounding during cure by incorporating Safipol TPU7840 (a Safic-Alcan product) into the Millathane compound and/or into the SBR or NR compound.

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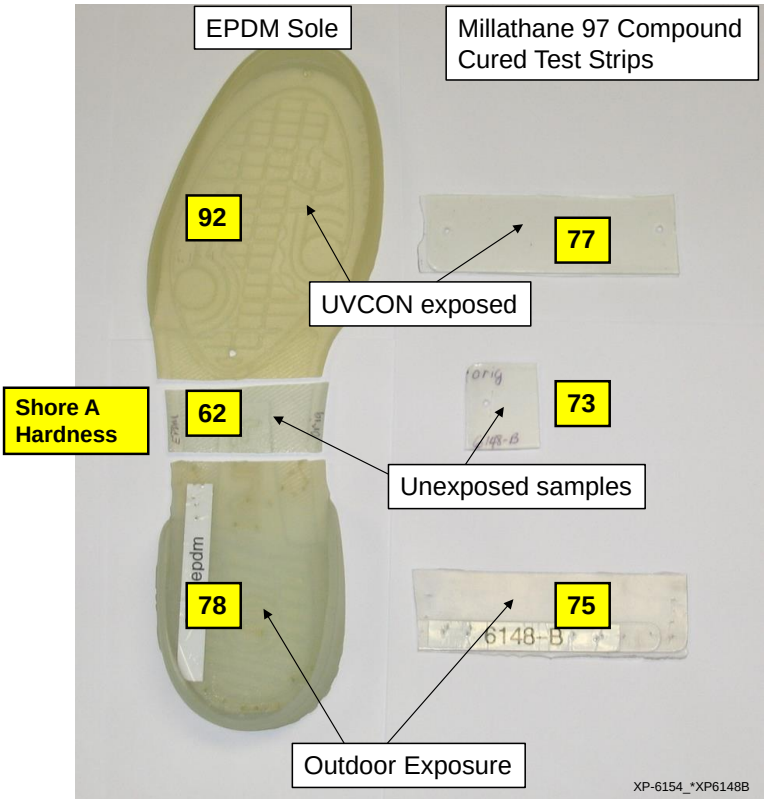
Millathane® 97 Transparent Compounds

Millathane 97 was developed for transparent footwear applications and compounds have been proven to give much improved weathering compared to compounds based upon other types of rubber. The figure below shows that the Millathane 97 compound had very minimal hardness and color change compared to the commercial EPDM sole that was very hard and brittle, and yellowed significantly after the weathering and UV test exposures.

The Millathane 97 transparent formulation on the right has excellent transparency, excellent UV resistance and excellent resistance to yellowing after UV and humidity exposures.

UV Testing of Commercial EPDM shoe sole vs. Millathane® 97 Compound*

Samples below were exposed to 12 weeks of Florida (US) outdoor exposure or 12 weeks UVCON testing (40ºC)



Summary: The EPDM shoe sole sample hardened and yellowed significantly after the UV and outdoor exposures. The Millathane 97 compound hardened and yellowed very slightly.

Transparent Millathane® 97 Sole

Millathane 97	100.0
Stearic acid	0.3
Wacker HDK N20	25.0
Silquest RC-1	0.5
Songnox 2450	0.3
Sabostab UV62	0.3
Sabostab UV312	0.3
SR231 (DEGDMA)	3.0
DiCup R	0.5
Physical Properties, Press Cure 9'/160°C	
Hardness, Shore A	68
TSE-100*, kg/cm² (lb/in²)	190 (275)
TSE-300*, kg/cm² (lb/in²)	48 (690)
Tensile Strength, kg/cm² (lb/in²)	273 (3890)
Elongation, %	615
Tear, Die C, kg/cm	36 (203)
Bashore Resilience, %	55
Compression Set, 22 hr/70°C, %	26
DIN Abrasion loss, mm³	58

Ref: XP8288S

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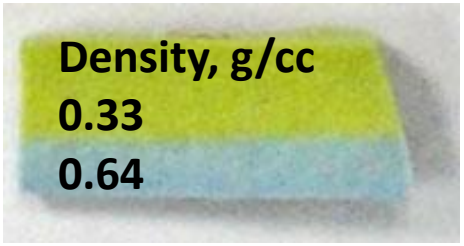
Millathane® Sponge Compounds

Millathane millable polyurethanes can be made into sponge compounds, for lighter weight in footwear applications. Because of the high inherent abrasion resistance of Millathane compounds, lighter weight sponge compounds still have very good abrasion resistance.

Sponge compounds are made by molding compounds that use expandable microspheres as the “blowing agent”, and they can be used in any Millathane grade, whether sulfur or peroxide cured. Densities as low as 0.33 g/cc can be obtained, and dual-density sponge compounds can be made by molding together compounds with different levels of the expandable microspheres.



Typical formulations are shown below:

	6130B	7198B	7198C	6158C	6158D
Millathane® E34	100				
Millathane 26		100	100		
Millathane 97				100	100
Zinc stearate	0.5				
Stearic acid		0.3	0.3	0.2	0.2
Ultrasil VN3	25	10	10		
Nucap 100G		10	10	0	15
Wacker HDK N20				17	
Polyfil HG90					15
Silquest A-172				0.3	
TP-95	5	5	5		
Mediaplast NB-4				4	11
Carbowax 3350	1				
Struktol WB222	1				
AC 617A	2	2	2	0.5	2
Irganox 1010				0.25	0.25
Tinuvin 328				0.25	0.25
Tinuvin 765				0.25	0.25
MBTS	4				
MBT	2				
Thanecure ZM	1				
Sulfur	2				
SR 231		10	10	12	10
SR 350		2	2		
TAC				0.5	0.5
DiCup 40C		4.5	4.5	1.5	1.5
Expancel 009DU80	5			5	5
Expancel 930DU120		5	10		
Density, g/cc	**0.88**	**0.53**	**0.33**	**0.67**	**0.53**
DIN Abrasion, mm³ loss	**136**	**200**	**295**	**179**	**194**

For further information, visit our web site www.tse-industries.com, send us an email at Millathaneinfo@tse-industries.com or call us at 1-727-573-7676 or 800-237-7634.