

Millathane® 97

Millathane 97 is a polyether polyurethane rubber having excellent transparency, good wear properties, a high coefficient of friction and very good UV stability. This polyurethane rubber is designed for applications in shoe soles, roll coverings and all other applications where transparent, brightly colored or decorative products are desired.



Product Description

Chemical Composition:	Synthetic rubber based on ether/aliphatic diisocyanate
Specific Gravity:	Approximately 1.02
Storage stability:	3 years from date of manufacture (stored under dry and cool conditions)

Part Number	Mooney Viscosity ML(1+4)/100° C	Appearance	Package size/carton
M-0097-45 (Virgin)	45 ± 15	Pale amber to clear solid bales	38 pounds (17.2 kg)
M-0097-60 (Virgin)	60 ± 10		
M-0097M-45 (Premilled)	45 ± 5	Clear to opaque solid sheets	50 pounds (22.7 kg)
M-0097M-60 (Premilled)	60 ± 10		

Processing

Millathane 97 is processed by techniques which are common to the rubber industry. Compounds can be mixed on an open mill or in an internal mixer; 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).

Cleanliness

If transparent, clear compounds are being made, it is extremely important to avoid all possible sources of contamination. Compounds are best mixed in areas away from black-compound mixing, mixing equipment cleaned before mixing and ingredients protected against ambient dust contamination.

Properties

Vulcanizates based on Millathane 97 can be produced in hardnesses of 40 to 95 Shore A, with tensiles up to 4300 psi (30 MPa). Properly formulated compounds offer excellent clarity and abrasion resistance, with good chemical resistance and hydrolysis resistance.

Compounding

Fillers

Millathane 97 requires reinforcing fillers to achieve hardness and high mechanical strength. Fumed silica (e.g., Wacker HDK N20 and Aerosil 200) is the filler of choice for transparent applications. Precipitated silicas can also be used for translucent or non-black compounds. Other conventional fillers like carbon blacks can also be used with Millathane 97. A small amount (0.25 – 0.5 parts) of a silane coupling agent such as Silquest Y-15866, Silquest RC-1 or Silquest A-172 will improve abrasion resistance, tear, and compression set properties of mineral filled compounds. Sulfur-containing coupling agents (e.g., Si69) should NOT be used.



The effect of varying the level of fumed silica is show in the table below. As expected, hardness, tensile strength, and tear strength increase as the level of fumed silica increases.

Millathane® 97	100.0	100.0	100.0	100.0	100.0
Stearic Acid	0.3	0.3	0.3	0.3	0.3
Wacker HDK N20 (fumed silica)	5.0	10.0	15.0	20.0	30.0
Luperox 231	0.4	0.4	0.4	0.4	0.4
SR-231 (DEGDMA)	3.0	3.0	3.0	3.0	3.0
Songnox 1010PW	0.2	0.2	0.2	0.2	0.2



Physical Properties

Cure time at 300°F (149°C), min.	7	7	7	8	8
Hardness, Shore A	55	58	60	62	66
100% Modulus, psi	175	200	210	230	235
MPa	1.2	1.4	1.4	1.6	1.6
300% Modulus	320	405	395	490	480
MPa	2.2	2.8	2.7	3.4	3.3
Tensile Strength. Psi	950	2090	2410	3280	3650
MPa	6.6	14.4	16.6	22.6	25.2
Elongation, %	453	506	535	555	633
Tear Die C, lb/in	135	150	145	175	190
kN/m	23.9	25.9	25.7	30.4	32.9

Plasticizers

Moderate amounts of plasticizer can be incorporated into Millathane 97 to aid in processing and/or to reduce hardness. For the best compound transparency, the plasticizer should also be clear, or very close to clear. Medioplast NB-4 has been shown to have good compatibility, color and properties with Millathane 97. Other plasticizers such as TP-90B (DBEEF) and TP-95 (DBEEA) can also be used. The antistatic plasticizer Struktol AW-1 can be used to a limited extent, but may tend to bleed at levels over 10 parts.

Antidegradants/UV Stabilizers

A small amount, ~0.25 phr, of antioxidant¹ should be used in **all** compounds. For good weather and UV resistance, especially for clear compounds, a UV absorber² and a Hindered Amine Light Stabilizer³ (HALS) should be used at ~0.25 phr each. For higher heat resistance, 2 phr of antioxidant¹, along with the two UV stabilizers noted, should be used, although some yellowing may be a result.

¹ Songnox 2450 or 1010; ² Sabostab UV312; ³ Sabostab UV62

Curing Agents: Peroxides and Coagents

Millathane 97 must be cured with peroxides and, optionally, coagents. The choice of peroxide depends on the cure conditions desired for curing the part. For the best transparency, a neat (not on a filler) peroxide should be used. Luperox (or Varox) 231 is typically used for cures at 145°C – 155°C, while Di-Cup R (dicumyl peroxide) is used for cures at 155°C – 170°C. Varox DBPH can be used for cures at 160°C – 180°C.

Coagents typically used in Millathane 97 are the liquid methacrylate types, such as SR-231 (DEGDMA) and SR-350 (TMPTMA) from Sartomer. Difunctional methacrylates, such as SR-231 and SR-297 (BGDMA), give improvements in abrasion and tear resistance, while the trifunctional



methacrylates such as SR-350 give a greater increase in hardness than the difunctional types. The liquid methacrylate coagents also give the benefit of reducing compound viscosity, which improves processing and mold flow. High hardness Millathane 97 compounds can be made with blends of di- and tri-functional methacrylates, resulting in good processing compounds with excellent cured properties. Most scorch-retarded liquid coagents should not be used for clear compounds as their scorch-retarding ingredients will tend to yellow the cured parts. Liquid polybutadiene, such as Ricon 153, can be used as a coagent but it can tend to make compounds cloudy and less transparent. TAC and TAIC can also be used as coagents, although only at low levels (< 2 phr) as high levels tend to give high crosslink densities which can result in low elongation and tensile and tear strengths.



Colorants

For transparent compounds, a very small amount of ultramarine blue (0.002 – 0.005 parts) will minimize any slight yellowing of the compound and give the compound a brighter appearance. For brightly colored transparent compounds, 0.005 – 0.1 part of various organic colors can be used. Examples of these are Akrochem 97AA Red, Akrochem 802 Yellow, and Akrochem 414 Green. For opaque compounds, a rutile grade of titanium dioxide should be used.



Vulcanization Conditions

Curing conditions are dependant on the molded part configuration as well as the peroxide used. Compounds based on Millathane 97 using Luperox 231 are typically vulcanized for 5-10 minutes at 145° - 155° C. If dicumyl peroxide is used, cures of 5-20 minutes at 155°C - 170°C are typical for compression or transfer molding, 2-5 minutes at 170° - 180°C for injection molding. Note that higher temperatures can tend to yellow the cured parts slightly, so lower cure temperatures will give the best transparency. The small wheels, below, were injection molded for 2 minutes at 180°C in a REP injection molding machine. *See our TIPS publication Volume 3-1 for more info on injection molding Millathane 97 compounds.*



Formulation Examples

Hardness, Shore A	46	65	70	81	95
Millathane 97	100	100	100	100	100
Stearic Acid	0.25	0.25	0.5	0.5	0.5
Wacker HDK-N20	15	20	30	20	35
Mediaplast NB-4	15	—	—	—	—
Silquest A-172	0.3	0.40	0.3	0.5	0.7
Irganox 1010 (or Songnox 2450)	0.25	0.25	0.25	0.25	0.25
Tinuvin 328 (or Sabostab UV312)	0.25	0.25	0.25	0.25	0.25
Tinuvin 765 (or Sabostab UV62)	0.25	0.25	0.25	0.25	0.25
SR-231 (DEGDMA)	2	3	3	16	15
SR-350 (TMPTMA)	—	—	—	—	15
AC617A Polyethylene	—	—	—	—	1
Luperox 231	0.4	0.5	0.5	—	—
DiCup R	—	—	—	0.5	0.7

Physical Properties	5752CF	6648A	#557	3439E	7588B
Cure Time/Temperature, °C	4'/150°C	4'/152°C	6'/149°C	10'/160°C	2'/160°C
Hardness, Shore A	46	65	70	81	95
100% Modulus, psi	138	265	339	565	1030
MPa	0.9	1.8	2.3	3.9	7.1
300% Modulus, psi	220	465	1427	1930	2540
MPa	1.5	3.2	9.8	13.3	17.5
Tensile Strength psi	2375	3280	3851	2770	3560
MPa	16.4	22.6	26.6	19.1	24.6
Elongation,%	800	550	462	380	390
Tear Die C, lb/in	108	175	197	181	278
kNm	19.7	30.6	34.5	31.7	48.7

Ingredients	Description	Supplier/Manufacturer
AC717A	Low molecular weight polyethylene	Honeywell
Carbowax 3350	Polyethylene glycol	Dow Chemical Co.
Di-Cup R	Dicumyl Peroxide	Arkema Inc.
Irganox 1010	Antioxidant	BASF
Luperox 231	1,1-Di(t-butylperoxy)-3,3,5-trimethylcyclohexane	Arkema Inc.
Mediaplast NB-4	Adipine acid plasticizer	Kettlitz-Chemie
Silquest A172/RC-1	Vinyl silane	Momentive
Sabostab UV62	Hindered Amine Light Stabilizer (HALS)	Sabo S.p.A./RTV
Sabostab UV312	UV Light Absorber	Songwon Industrial Co./RTV
Songnox 1010PW, 2450	Antioxidant	Songwon Industrial Co./RTV
SR-231	Diethyleneglycol Dimethacrylate (DEGDMA)	Sartomer
SR-350	Trimethylol propane Trimethacrylate (TMPTMA)	Sartomer
TAC	Triallyl Cyanurate	Various
TAIC	Triallyl Isocyanurate	Various
Tinuvin 328	UV Light Absorber	BASF
Tinuvin 765	Hindered Amine Light Stabilizer (HALS)	BASF
TP-95	Di (butoxy-ethoxy-ethyl) adipate (DBEEA)	Hallstar
Varox DBPH	2,5-Dimethyl-2,5-di(t-butylperoxy)hexane (peroxide)	Vanderbilt Chemicals
Wacker HDK N20	Fumed silica, surface area 200 m ² /g	Wacker Silicones

Contact:

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