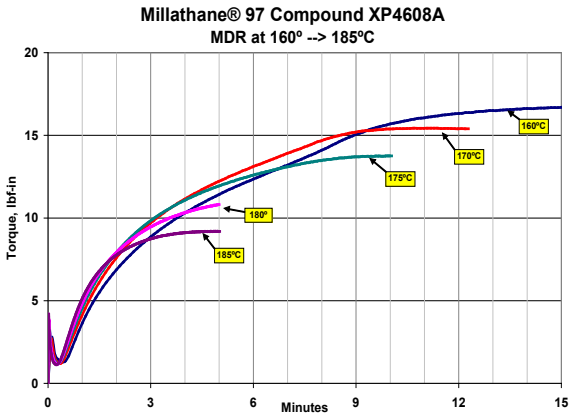
Injection Molding of Millathane® 97

Millathane® 97 is a polyether millable urethane that is used to make transparent articles. For transparency, fumed silica must be used as the reinforcing filler and other ingredients must be carefully selected so as to not make the compound cloudy or opaque. Millathane® 97 compounds can be compression, transfer, or injection molded. Details of injection molding a transparent 63 Shore A hardness compound are show below.

FORMULATION

Below is a typical Millathane® 97 compound for transparent applications. The fumed silica level can be adjusted for the desired hardness. A silane coupling agent, such as the Silquest A-172 used, is added at 2% of the filler loading to give good tear and physical properties. An antioxidant like Irganox 1010 is necessary for good aging and compound stability, and the UV absorber Tinuvin 770DF gives resistance to outdoor weather exposure. SR-231 is a difunctional coagent that, along with the peroxide DiCup R, gives a good state of cure and good tear and abrasion resistance.

Formulation	XP-4608-A
Millathane® 97	100.0
Stearic acid	0.3
Wacker HDK N20	15.0
Silquest A-172	0.3
Irganox 1010	0.3
Tinuvin 770DF	0.3
SR-231 (DEGDMA)	3.0
DiCup R	0.5
Total	**119.7**



PROCESSING AND PHYSICAL PROPERTIES	
Physical Properties, Press Cure 9'/160° C (320°F)	
Mooney Viscosity, ML (1+4)/100°C	73
Hardness, Shore A	63
100% Modulus, psi / MPa	245 / 1.7
200% Modulus, psi / MPa	400 / 2.8
300% Modulus, psi / MPa	730 / 5.0
Tensile Strength, psi / MPa	2680 / 18.5
Elongation, %	525
Tear, Die C, lb/in	167
kN/m	29.2
Bashore Resilience, %	60
Compression Set, 22 hr/70°C, %	22
DIN (ASTM D5963) Abrasion loss, mm³	71

MDR Data at Various Temperatures (using a TechPro MDpt)					
Temperature	**160°C**	**170 °C**	**175 °C**	**180 °C**	**185 °C**
ML, lb-in (dNm)	1.3 (1.4)	1.2 (1.4)	1.2 (1.4)	1.2 (1.3)	1.1 (1.3)
MH, lb-in (dNm)	16.8 (19.0)	15.4 (17.4)	13.8 (15.5)	10.8 (12.2)	9.2 (10.4)
ts1, min.	0.7	0.6	0.6	0.5	0.5
tc50, min	3.1	2.3	1.8	1.3	1.0
tc90, min	9.3	7.1	5.9	3.4	2.5

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Injection Molding of Millathane® 97 (cont.)

INJECTION MOLDING

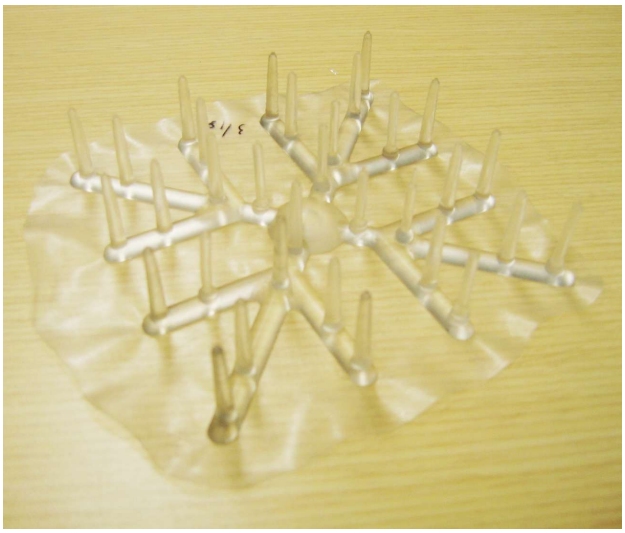
This compound was cured on a REP injection press, Model V37/100, making parts having excellent transparency. Small rollers with OD/ID/Width of 0.68/0.34/0.30 in (18/9/7 mm)) were molded with the curing conditions tabulated below.

Extruder Temperature	75ºC
Injection Chamber Temperature	80ºC
Mold Temperature	170 – 185ºC

Molding Times	1 -5 minutes
Injection Pressure	250 bar
Screw Speed	80 RPM

Cure conditions evaluated were 5'/170ºC, 3'/180ºC, 2'/180ºC, and 1'/185ºC. All conditions gave parts with good look and feel. The runner was well-cured and showed good flow of the compound.

REP Injection Molding Machine



Injection Molding Runner

Molded Rolls

Molded Rolls Pressed on Hubs

SUMMARY

This Millathane® 97 compound was easily mixed on a two-roll mill. Internal mixing with this compound could be done as well. This Millathane® 97 formulation had excellent physical properties and clarity. The peroxide type in the compound could be changed to give lower or higher temperature curing. Parts were easily injection molded over a wide time/temperature range making very nice, transparent rollers.

Ingredient	Description	Supplier/Tradename owner
Wacker HDK N20	Fumed silica, surface area 200 m²/g	Wacker Silicones Corp.
Silquest A-172	Vinyl silane	GE Silicones
Irganox 1010	Antioxidant	Ciba Specialty Chemicals
Tinuvin 770 DF	HALS-Hindered Amine Light Stabilizer	Ciba Specialty Chemicals
SR-231	Diethylene glycol dimethacrylate	Sartomer Corporation
DiCup R	Dicumyl peroxide	Geo Specialty Chemicals

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