Millathane® 97 High Hardness Compounds

High hardness (over 85 Shore A) compounds can be made using Millathane® 97 and high levels of fillers and/or coagents. Typically, compounds with high levels of fillers are stiff in the uncured state, with high viscosity, and hence difficult to process. Combining a moderate level of filler with relatively high levels of coagents can give compounds with improved processing characteristics while retaining the good properties of urethanes. With Millathane® 97, compounds prepared with fumed silica as the filler can be transparent or translucent and thus resemble cast urethanes. The table below shows the effect of increasing the fumed silica by 5 parts and the liquid coagent SR-350 (TMPTMA) by 8 parts. The hardness increased from 83 to 91 Shore A. Compound 2 is being used commercially to mold small diaphragms and it molds well in spite of its high viscosity (146 Mooney units).

Ingredients	Comp. 1	Comp. 2
Millathane® 97	100	100
Wacker HDK N20 (fumed silica)	40	45
TP-95	2	2
AC 617A	2	2
Stearic Acid	0.5	0.5
Carbowax 3350	2.5	2.5
Silquest A-172	2	2
SR 350	12	20
DiCup R	1	1
Irganox 1010	0.25	0.25
TOTAL	**162.25**	**175.25**
Cured Hardness, Shore A	**83**	**91**

To improve processing of the high hardness compound, lower silica and higher methacrylate levels were investigated. To prevent the compound from getting too highly crosslinked with the trifunctional SR350, which typically yields low elongation and low tear strength, the additional methacrylate used was the difunctional SR-231 (DEGDMA). The data below shows the benefit of these changes to viscosity while keeping the high hardness and good properties.

Ingredients	Comp. 2	Comp. 3	Comp. 4
Millathane® 97	100	100	100
Fumed Silica (Wacker HDK N20)	45	35	30
TP-95 (DBEEA)	2	2	2
AC617A Polyethylene	2	2	2
Stearic Acid	0.5	0.5	0.5
Carbowax 3350	2.5	2	2
Silquest A-172	2	1.5	1.5
Irganox 1010	0.25	0.25	0.25
SR-350 (TMPTMA)	20	20	20
SR-231 (DEGDMA)	—	10	20
Dicumyl peroxide	1	1	1
Total	**175.25**	**174.25**	**179.25**
Specific Gravity	1.19	1.15	1.13
Mooney Viscosity, ML(1+4)/100ºC	146	52	36

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Millathane® 97 High Hardness Compounds (cont.)

Rheometer (MDR) at 160ºC (320ºF)	Comp. 2	Comp. 3	Comp. 4
ML, lb-in (dNm)	9.1 (10.3)	1.8 (2.1)	1.3 (1.4)
MH, lb-in (dNm)	65.4 (73.9)	91.5 (103)	92.9 (105)
ts1, min	0.2	0.3	0.3
tc50, min.	0.7	0.6	0.6
tc90, min.	2.5	2.2	1.8

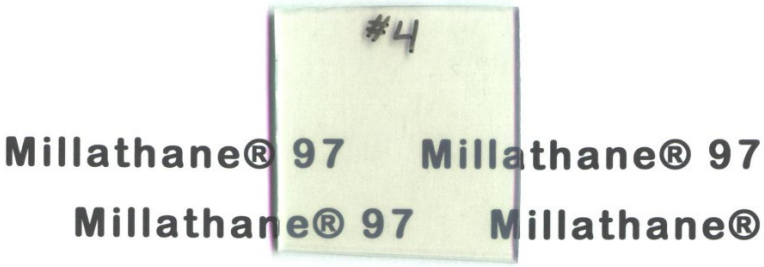
As seen above, the reduction in the fumed silica level plus the addition of the SR-231 coagent has a dramatic effect on the viscosity of the mixed compound. The rheometer data show that these changes increase the cured torque and shorten the cure times (tc90) somewhat.

Physical Properties	Comp. 2	Comp. 3	Comp. 4
Press Cure conditions	5'/160ºC	4'/149ºC	4'/149ºC
Hardness, Shore A	91	94	95
100% Modulus, psi (MPa)	940 (6.5)	1750 (12.0)	1990 (13.7)
200% Modulus, psi (MPa)	1740 (12.0)	—	3060 (21.1)
Tensile Strength, psi (MPa)	3070 (21.1)	2450 (16.9)	3300 (22.7)
Elongation, %	315	180	220
Tear, Die C, lb/in (kN/m)	201 (35.2)	164 (28.8)	174 (30.4)
Compression Set, 22 hr/70ºC	32	26	21
Resilience, Bashore, %	50	43	43

The cured data above show excellent physical properties with all compounds. Compression set was improved with the higher coagent/lower silica compound while resilience was reduced slightly.

COLOR

The compounds above will be a clear, with very slight yellowish tint (see picture below). For a "cleaner" transparent color, a small amount (0.005 phr) of ultramarine blue can be added. To make the compound more yellowish, to mimic the look of cast urethanes, a small amount of yellow and/or brown pigment may be used.



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