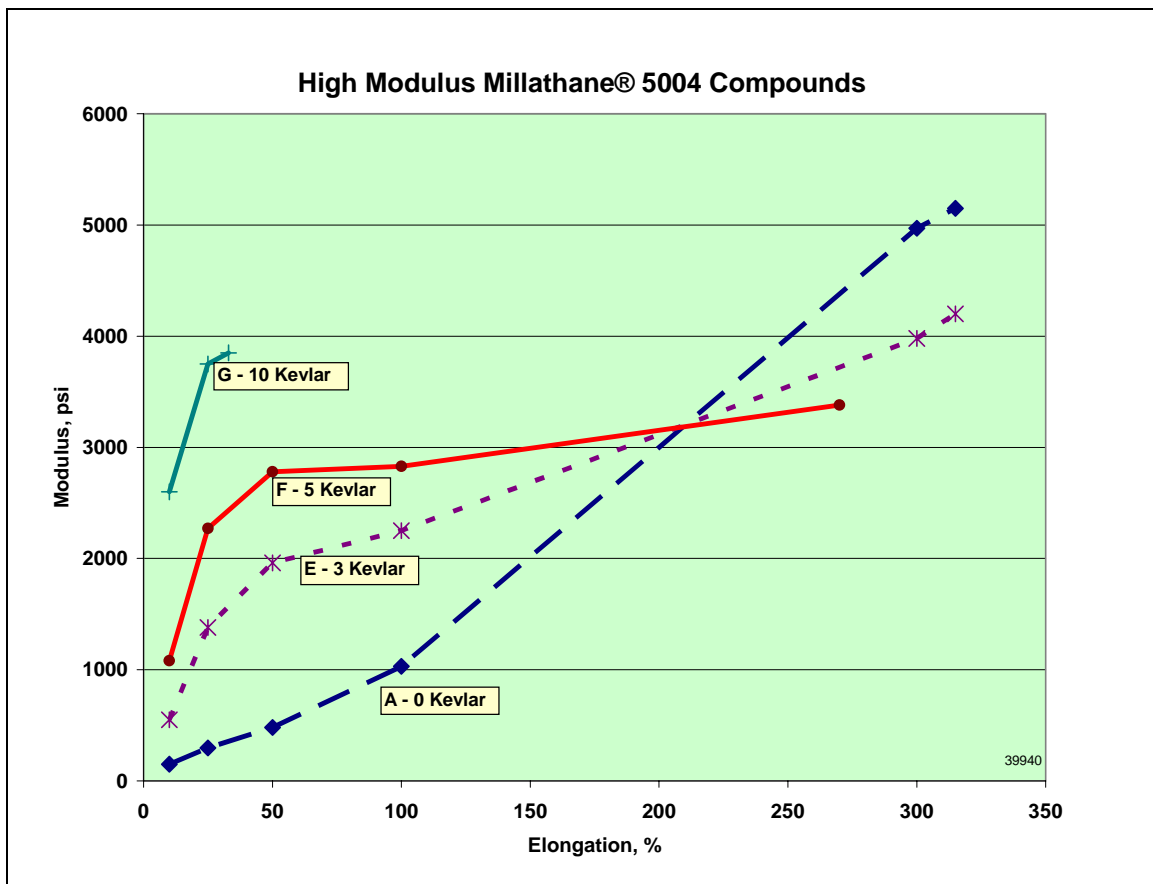




## High Modulus Millathane® 5004 Compounds

Several levels (3-5-10 parts) of Kevlar (DuPont's tradename for their polyaramid fiber) pulp were added to a Millathane 5004 millable urethane compound and the physical properties measured at room temperature and at elevated temperatures. The Kevlar was added as a masterbatch with 50% Kevlar and 50% NBR (nitrile rubber) which was obtained from Rhein Chemie.

The results showed a dramatic increase in modulus, even with as little as 3 parts of Kevlar. Aramid-reinforced compounds such as these find use in applications such as belting.



Ref: 39940  
12/02/2004tj

## High Modulus Compounds Based upon Millathane® 5004

	39940A-0	39940E-3	39940F-5	39940G-10
Millathane® 5004	100.0	97	95	90
Kevlar/NBR Masterbatch 50/50*		6	10	20
<b>(Parts of Kevlar --&gt;)</b>	<b>(0)</b>	<b>(3)</b>	<b>(5)</b>	<b>(10)</b>
Stearic Acid	0.3	0.3	0.3	0.3
N330 Black	27	27	27	27
Struktol WB-212	0.5	0.5	0.5	0.5
Dicup 40C	6.0	6.0	6.0	6.0

\*Rheogran P95-50/NBR (Rhein Chemie

<b>Mooney Viscosity, ML4/100°C</b>	73	76	80	89
------------------------------------	----	----	----	----

### MDR, 30'/160°C

ML, lb-in	1.3	1.3	1.4	2.0
dN-m	1.5	1.4	1.6	2.3
MH, lb-in	66.6	56.4	49.4	38.6
dN-m	75.3	63.7	55.8	43.6
ts1, min.	0.7	0.7	0.7	0.8
t50, min.	4.8	5.1	5.2	5.6
t90, min	12.2	12.4	12.0	12.5

### Press Cure 20/160°C -- RT(23°C) Test

Hardness, Shore A	78	83	83	86
10% Modulus, psi	150	550	1080	2600
MPa	1.0	3.8	7.4	17.9
25% Modulus, psi	295	1380	2270	3750
MPa	2.0	9.5	15.7	25.9
50% Modulus, psi	480	1960	2780	
MPa	3.3	13.5	19.2	
Tensile Strength, psi	5150	4200	3380	3850
MPa	35.5	29.0	23.3	26.6
Elongation, %	315	315	270	33

### Press Cure 20/160°C -- 125°C Test

10% Modulus, psi	120	690	270	430
MPa	0.8	4.8	1.9	3.0
% Change from RT	-20	25	-75	-83
25% Modulus, psi	260	940	1080	1510
MPa	1.8	6.5	7.4	10.4
% Change from RT	-12	-32	-52	-60
50% Modulus, psi	500	1210	1540	
MPa	3.4	8.3	10.6	
% Change from RT	4	-38	-45	
Tensile Strength, psi	1600	1490	1650	1900
MPa	11.0	10.3	11.4	13.1
% Change from RT	-69	-65	-51	-51
Elongation, %	160	120	60	30
% Change from RT	-49	-62	-78	-9

## High Modulus Compounds Based upon Millathane® 5004

	39940A-0	39940E-3	39940F-5	39940G-10
Millathane® 5004	100.0	97	95	90
Kevlar/NBR Masterbatch 50/50*		6	10	20
<b>(Parts of Kevlar --&gt;)</b>	<b>(0)</b>	<b>(3)</b>	<b>(5)</b>	<b>(10)</b>

### Press Cure 20/160°C -- 150°C Test

10% Modulus, psi	80	550	820	900
MPa	0.6	3.8	5.7	6.2
% Change from RT test	-47	0	-24	-65
25% Modulus, psi	310	960	1410	1770
MPa	2.1	6.6	9.7	12.2
% Change from RT test	5	-30	-38	-53
50% Modulus, psi	500	1180	1560	
MPa	3	8	11	
% Change from RT test	4	-40	-44	
Tensile Strength, psi	1070	1240	1560	1810
MPa	7	9	11	12
% Change from RT test	-79	-70	-54	-53
Elongation, %	120	70	50	30
% Change from RT test	-62	-78	-81	-9

### Observations:

1. Increasing the amount of Kevlar in the compound increases the viscosity and the modulus of the compound. Tensile strength is lowered somewhat and elongation is reduced, especially at the highest level (10 parts) of Kevlar.
2. Kevlar-containing compounds showed greater loss in modulus when tested at elevated temperatures (125°C and 150°C) compared to room temperature values, although the absolute values were still much higher than the control compound without Kevlar. The Kevlar-containing compounds showed somewhat less loss in tensile strength than the control.

### Conclusion

Kevlar masterbatch can be used effectively to increase the modulus of Millathane® 5004 (and other millable urethane) compounds.