

# NYCO® Wollastonite: A Natural Reinforcement for Friction

TYPICAL PRODUCT VALUES	ULTRAFIBE® 4W	ULTRAFIBE® II	ULTRAFIBE® 30	HARRP™ 20X40		
Length (microns)	50	136	600	2106		
Diameter (microns)	4.5	8	40	540		
Aspect Ratio	11:1	17:1	15.1	39:1		
Tapped Bulk Density (g/cc)	0.35	0.48	0.80	1.55		
Tapped Bulk Density (lbs./cu.ft)	22	30	50	97		

## BENEFITS:

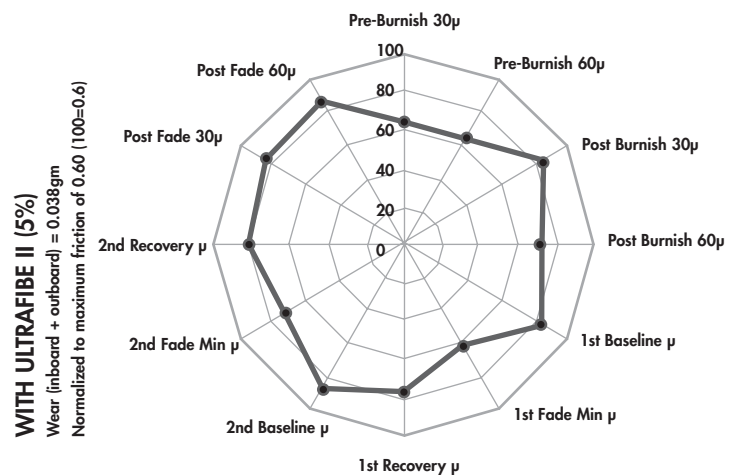
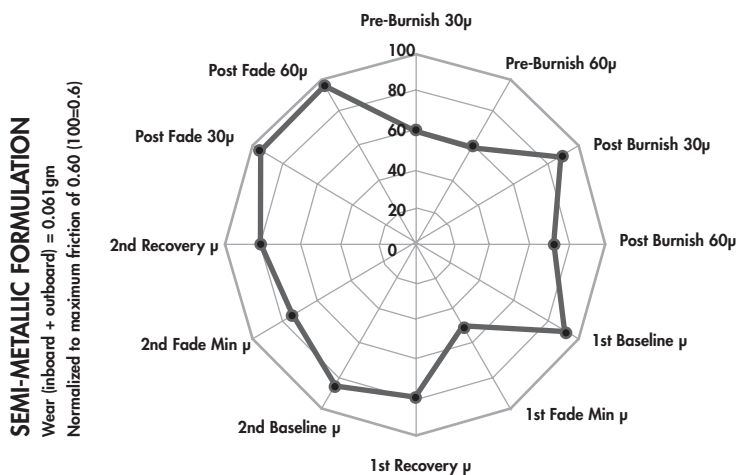
1. Improved physical and mechanical properties
2. Improved fade and recovery
3. Improved friction stability
4. Reduction or elimination of cracking
5. Primary ingredient in the replacement of asbestos
6. Partial replacement for chopped glass and man-made fibers
7. Full replacement for milled glass fiber
8. Improved preforming
9. Reduction in density/unit cost

- Available Untreated or Surface Modified

- Replacement of Synthetic and Man-Made Fibers  
ULTRAFIBE 4W

- Replacement of Milled and Chopped Glass Fiber  
ULTRAFIBE II

- Replacement of Commodity Fillers and Extenders  
HARRP 20x40



- The left hand spider chart does not employ ULTRAFIBE II.
- The right hand spider chart is based on replacing 5% steel fiber with 5% Ultrafibe II.
- A perfect circle would represent a perfect friction material.
- By employing ULTRAFIBE II at the expense of steel fiber there is an improvement in 1st fade, and pre-burnish @ 30µ and 60µ.

**CONCLUSION:** ULTRAFIBE II makes a better friction material (more towards a perfect circle).

**NON ASBESTOS ORGANIC (NAO) Formulation with ULTRAFIBE II**

RAW MATERIALS	WEIGHT PERCENT	WEIGHT PERCENT
Phenolic Resin	8.00%	8.00%
Barium Sulfate	17.00%	14.00%
Rubber	4.00%	4.00%
Kevlar®	2.00%	2.00%
<b>ULTRAFIBE® II</b>	<b>18.00%</b>	<b>18.00%</b>
Fibrox	20.00%	20.00%
Zircon	2.00%	2.00%
Zinc Sulfide	2.00%	2.00%
Calcium Fluoride	2.00%	2.00%
Copper	6.00%	6.00%
Vermiculite	8.00%	8.00%
Graphite	6.00%	5.00%
Extendsphere SG	1.00%	1.00%
Cashew Particles	4.00%	8.00%
<b>TOTAL</b>	<b>100.00%</b>	<b>100.00%</b>

**SEMI-METALLIC 2% AND 6% CASHEW Formulation with ULTRAFIBE II**

RAW MATERIALS	WEIGHT PERCENT	WEIGHT PERCENT
Phenolic Resin	8.00%	8.00%
Barium Sulfate	8.00%	6.00%
Rubber	4.00%	4.00%
<b>ULTRAFIBE® II</b>	<b>3.00%</b>	<b>3.00%</b>
Zircon	4.00%	4.00%
Zinc Sulfide	2.00%	2.00%
Calcium Fluoride	2.00%	2.00%
Vermiculite	6.00%	6.00%
Graphite	6.00%	6.00%
Cashew Particles	2.00%	6.00%
Steel Fiber	35.00%	33.00%
Sponge Iron	20.00%	20.00%
<b>TOTAL</b>	<b>100%</b>	<b>100%</b>

**HARRP™ 20x40 WOLLASTONITE****BRAKE DRUM LINING FORMULATION (Substitution of Barium Sulfate and Calcium Carbonate)**

FORMULATION BY PRODUCT	DENSITY	COST/LB. (USD)	COST/CC (USD)	COST/CU.FT. (USD)
<b>HARRP 20X40</b>	<b>2.09</b>	<b>0.39</b>	<b>0.002</b>	<b>51.42</b>
Barium Sulfate/Calcium Carbonate	2.18	0.39	0.002	53.51

RAW MATERIALS	COSTS (USD)	SPECIFIC GRAVITY	WEIGHT PERCENT	VOLUME	VOLUME PERCENT*	FORMULATION COSTS (USD)
Phenolic Resin	0.61	1.27	15	11.81	$\frac{24.73}{25.73}$	0.09
Cashew Particles	0.52	1.15	6	5.22	$\frac{10.93}{11.37}$	0.03
Rubber	0.27	1.15	5	4.35	$\frac{9.10}{9.47}$	0.01
Vermiculite	0.18	2.25	4	1.78	$\frac{3.72}{3.87}$	0.01
ULTRAFIBE® 30	0.24	2.90	10	3.45	$\frac{7.22}{7.51}$	0.02
Graphite	0.45	2.26	8	3.54	$\frac{7.41}{7.71}$	0.04
Molybdenum Disulfide	2.20	4.80	2	0.42	$\frac{0.87}{0.91}$	0.04
Zinc Sulfide	1.20	4.00	2	0.50	$\frac{1.05}{1.09}$	0.02
Magnesium Oxide	0.53	3.60	2	0.56	$\frac{1.16}{1.21}$	0.01
Aluminum Oxide	1.20	3.95	2	0.51	$\frac{1.06}{1.10}$	0.02
<b>HARRP 20x40</b>	<b>0.08</b>	<b>2.90</b>	<b>18</b>	<b>6.21</b>	<b><math>\frac{13.00}{9.06}</math></b>	<b>0.01</b>
Barium Sulfate	0.08	4.33	18	4.16		0.02
<b>Calcium Carbonate</b>	<b>0.05</b>	<b>2.71</b>	<b>8</b>	<b>2.95</b>	<b><math>\frac{6.43}{6.43}</math></b>	<b>0.004</b>
Fibrox	0.38	2.70	18	6.67	$\frac{13.96}{14.53}$	0.07
<b>TOTAL</b>						
<b>HARRP 20x40</b>			<b>100</b>	<b>48</b>	<b>100</b>	<b>0.4</b>
Barium Sulfate/ Calcium Carbonate			100	46	100	0.4

\* The numbers on top reflect the volume percent with HARRP 20x40

**PERFORMANCE BENEFITS**

- Improved Friction Stability at High Temperatures
- Improved Green Strength
- Reduced Density
- Reduced Composite Cracking
- Non-Glass Forming

**ULTRAFIBE® 4W WOLLASTONITE**  
**DISC PAD FORMULATION** (Substitution of Potassium Titanate)

FORMULATION BY PRODUCT	DENSITY	COST/LB. (USD)	COST/CC (USD)	COST/CU.FT. (USD)
<b>ULTRAFIBE® 4W</b>	<b>2.45</b>	<b>0.94</b>	<b>0.005</b>	<b>143.60</b>
Potassium Titanate	2.45	1.67	0.009	254.58

RAW MATERIALS	COSTS (USD)	SPECIFIC GRAVITY	WEIGHT PERCENT	VOLUME	VOLUME PERCENT	FORMULATION COSTS (USD)
Phenolic Resin	0.61	1.27	12	9.45	23.12	0.07
Cashew Particles	0.52	1.15	5	4.35	10.64	0.03
Rubber	0.27	1.15	5	4.35	10.64	0.01
Vermiculite	0.18	2.25	8	3.56	8.70	0.01
Copper	3.50	8.92	10	1.12	2.74	0.35
Graphite	0.45	2.26	8	3.54	8.66	0.04
Calcium Fluoride	1.25	3.18	2	0.63	1.54	0.03
Zinc Sulfide	1.20	4.00	2	0.50	1.22	0.02
Zircon	1.05	4.56	2	0.44	1.07	0.02
Aluminum Oxide	1.20	3.95	2	0.51	1.24	0.02
Barium Sulfate	0.85	4.33	25	5.77	14.13	0.02
Kaowool	3.00	2.70	4	1.48	3.63	0.12
<b>ULTRAFIBE® 4W</b>	<b>1.28</b>	<b>2.90</b>	<b>15</b>	<b>5.17</b>	<b>12.66</b>	<b>0.19</b>
Potassium Titanate	4.85	2.90	15	5.17	12.66	0.73
<b>Total</b> <b>ULTRAFIBE® 4W</b> Potassium Titanate			<b>100</b> 100	<b>41</b> 41	<b>100</b> 100	<b>0.93</b> 1.66

**PERFORMANCE BENEFITS**

- Cost Savings
- Non-Hazardous
- Processing Aid
- Comparable Performance vs. Potassium Titanate
- Acicular Structure

**HARRP™ 20x40 WOLLASTONITE  
LOW-METALLIC DISC PAD FORMULATION**

FORMULATION	DENSITY	COST/LB. (USD)	COST/CC (USD)	COST/CU.FT. (USD)
Low-Metallic Disc Pads	3.08	\$0.869	\$0.005901	\$167.1705

RAW MATERIAL	RAW MATERIAL COSTS	SPECIFIC GRAVITY	BATCH WEIGHT	WEIGHT PERCENT	VOLUME	VOLUME PERCENT	FORMULATION COSTS (USD)
Phenolic Resin	\$0.610	1.27	9	9.0	7.09	21.84	0.055
Cashew Particles	\$0.400	1.15	2	2.0	1.74	5.36	0.008
Rubber	\$0.270	1.15	2	2.0	1.74	5.36	0.005
Graphite	\$0.450	2.26	8	8.0	3.54	10.91	0.036
Steel Wool 205	\$0.640	7.86	20.5	20.5	2.61	8.04	0.131
Kevlar®	\$10.000	1.44	1.5	1.5	1.04	3.21	0.150
HARRP 20x40	\$0.080	2.9	6	6.0	2.07	6.38	0.005
Vermiculite	\$0.180	2.25	6	6.0	2.67	8.22	0.011
Molybdenum Disulfide	\$2.200	4.8	1	1.0	0.21	0.64	0.022
Antimony Trisulfide	\$4.500	4.6	2	2.0	0.43	1.34	0.090
Zircon	\$1.050	4.56	5	5.0	1.10	3.38	0.053
Zinc Oxide	\$0.00	7.14	2	2.0	0.28	0.86	0.000
Copper	\$3.500	8.92	8	8.0	0.90	2.76	0.280
Coke 9	\$0.160	1.9	3	3.0	1.58	4.87	0.005
Barium Sulfate	\$0.085	4.33	22	22.0	5.08	15.66	0.019
Iron Oxide	\$0.000	5.34	2	2.0	0.37	1.15	0.000
<b>Totals</b>			<b>100</b>	<b>100</b>	<b>32.44</b>	<b>100.00</b>	<b>0.869</b>

**HARRP 20x40 WOLLASTONITE****SEMI-METALLIC DISC PAD FORMULATION (Substitution of Barium Sulfate)**

FORMULATION BY PRODUCT	DENSITY	COST/LB. (USD)	COST/CC (USD)	COST/CU.FT. (USD)
HARRP 20x40	3.00	0.70	0.005	131.79
Barium Sulfate	3.16	0.71	0.005	139.11

RAW MATERIALS	COSTS (USD)	SPECIFIC GRAVITY	WEIGHT PERCENT	VOLUME	VOLUME PERCENT*	FORMULATION COSTS (USD)
Phenolic Resin	0.61	1.27	10	7.87	$\frac{23.66}{24.85}$	0.06
Cashew Particles	0.52	1.15	4	3.48	$\frac{10.45}{10.98}$	0.02
Rubber	0.27	1.15	4	3.48	$\frac{10.45}{10.98}$	0.01
Zinc Sulfide	1.20	4.00	4	1.00	$\frac{3.00}{3.16}$	0.05
Graphite	0.45	2.26	10	4.42	$\frac{13.29}{13.96}$	0.05
Steel Wool 205	0.64	7.86	30	3.82	$\frac{11.47}{12.04}$	0.19
Iron Sponge	0.48	7.82	20	2.56	$\frac{7.68}{8.07}$	0.10
Zircon	1.05	4.56	2	0.44	$\frac{1.32}{1.38}$	0.02
Aramid	10.00	1.44	2	1.39	$\frac{4.17}{4.38}$	0.20
<b>HARRP 20x40</b>	<b>0.06</b>	<b>2.90</b>	<b>14</b>	<b>4.83</b>	<b>14.50</b>	<b>0.01</b>
Barium Sulfate	0.09	4.33	14	3.23	10.20	0.01
<b>TOTAL</b>						
<b>HARRP 20x40</b>			<b>100</b>	<b>33</b>	<b>100</b>	<b>0.71</b>
Barium Sulfate			100	32	100	0.71

\* The numbers on top reflect the volume percent with HARRP 20x40.

**PERFORMANCE BENEFITS**

- Improved Friction Stability at High Temperatures
- Processing Aid
- Reduced Density
- Improved Green Strength
- Non-Glass Forming

**ULTRAFIBE® II WOLLASTONITE****TRUCK BLOCK FORMULATION (Substitution of 1/8" Fiberglass)**

FORMULATION BY PRODUCT	DENSITY	COST/LB. (USD)	COST/CC (USD)	COST/CU.FT. (USD)
<b>ULTRAFIBE® II</b>	<b>2.30</b>	<b>0.68</b>	<b>0.003</b>	<b>97.62</b>
1/8" Fiberglass	2.26	0.73	0.004	102.02

RAW MATERIALS	COSTS (USD)	SPECIFIC GRAVITY	WEIGHT PERCENT	VOLUME	VOLUME PERCENT*	FORMULATION COSTS (USD)
Phenolic Resin	0.61	1.27	15	11.81	<u>27.18</u> 26.64	0.09
Cashew Particles	0.52	1.15	6	5.22	<u>12.01</u> 11.77	0.03
Rubber	0.27	1.15	6	5.22	<u>12.01</u> 11.77	0.02
Vermiculite	0.18	2.25	4	1.78	<u>4.09</u> 4.01	0.01
Graphite	0.45	2.26	8	3.54	<u>8.15</u> 7.98	0.04
Molybdenum Disulfide	2.20	4.80	2	0.42	<u>0.96</u> 0.94	0.04
Brass Chips	1.45	8.40	8	0.95	<u>2.19</u> 2.15	0.12
Magnesium Oxide	0.53	3.60	2	0.56	<u>1.28</u> 1.25	0.01
Aluminum Oxide	1.20	3.95	2	0.51	<u>1.17</u> 1.14	0.02
Barium Sulfate	0.09	4.33	25	5.77	<u>13.29</u> 13.02	0.02
Kaowool	3.00	2.70	4	1.48	<u>3.41</u> 3.34	0.12
<b>ULTRAFIBE® II</b>	<b>0.90</b>	<b>2.90</b>	<b>18</b>	<b>6.21</b>	<b>14.28</b>	<b>0.16</b>
1/8" Fiberglass	1.15	2.54	18	7.09	15.98	0.21
<b>TOTAL</b>						
<b>ULTRAFIBE® II</b>			<b>100</b>	<b>43.46</b>	<b>100</b>	<b>0.68</b>
1/8" Fiberglass			100	44.34	100	0.73

\* The numbers on top reflect the volume percent with ULTRAFIBE® II

**PERFORMANCE BENEFITS**

- Cost Savings
- Processing Aid
- Reduced Composite Cracking
- Less Moisture Sensitive
- Non-Glass Forming
- Reduced Scoring of Brake Rotors