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## Composites of Nomex<sup>2</sup>

Nomex paper or mat can be combined with nearly any other flexible insulating material to form a composite. Those which possess the most obvious advantages and are of the greatest current interest are:

### Nomex/Polyester Film

The combination of Nomex paper or mat with polyester film represents an improvement in cut-through resistance and superior thermal aging characteristics. Combinations of this type can be made with any number of plies, the most common composites being of two and three plies. In selecting the type of construction to be used, it is well to consider the function of the polyester film. If the film is simply a reinforcing material, and is not required as a long term dielectric, then two ply composites are the most economical. They are also higher in tear resistance than three ply composites of the same thickness. This is especially so in applications where the composites can be inserted in such a manner that the film ply must withstand the greater elongation. For example, in motor slot applications, higher tear resistance is usually obtained when the film is next to the steel laminations.

When the film is to be used as a dielectric throughout the life of the unit, three ply combinations are recommended. This allows the film to be protected on both sides, and as tests and field experience have indicated, this greatly extends its useful life at elevated temperatures.

Nomex 416 is the standard paper used in Nomex/Polyester film composites. Nomex 416 is recognized by UL as a 200°C material.

### Nomex/Kapton<sup>3</sup>

In order to utilize the full thermal stability of Nomex 410 (UL recognizes Nomex 410 paper as a 200°C material). It is desirable to form composites with films of like thermal stability. One such suitable material is duPont's Kapton polyimide film. At room temperature the properties of Kapton are similar to those of polyester films; however, both the electrical and mechanical characteristics are maintained over a much broader

temperature range. Tests indicate that Kapton is suitable for continuous operation at 230°C. In addition, it does not melt and is infusible. Thus Nomex-Kapton composites offer many of the familiar advantages of polyester mat/polyester film combinations plus thermal stability adequate for Class H applications, provided they are bonded with a suitable adhesive.

### Nomex Type 416/Polyester Film/Nomex Type 416

Product	Composite Thickness ASTM D374 (inches)	Yield Sq. Yds./ Lb.	Lbs./ Sq. Yd.	Dielectric Strength ASTM D149 (2 in. Dia. Electrodes) (volts)	Volume Resistivity <sup>1</sup> ASTM D257 (ohm/cm)	Surface Resistivity <sup>1</sup> ASTM D257 (ohms)	Tensile Strength ASTM D828 Lbs./In. Width		Tear Strength Graves (Lbs.)	
							MD	CMD	MD	CMD
3-3-3	0.010	2.01	0.50	11,600	10 <sup>14</sup>	10 <sup>13</sup>	142	116	11	10
3-5-3	0.012	1.54	0.65	12,600	10 <sup>14</sup>	10 <sup>13</sup>	175	150	14	12
3-7 1/2 - 3	0.016	---	0.77	16,000	10 <sup>14</sup>	10 <sup>13</sup>	285	200	16	22
5-3-5	0.0135	1.38	0.72	15,000	10 <sup>14</sup>	10 <sup>13</sup>	235	165	16	13
5-5-5	0.0145	---	0.78	17,000	10 <sup>14</sup>	10 <sup>13</sup>	220	200	16	22

1 - Values obtained were greater than values shown.

### Nomex Type 410/Kapton/Nomex Type 410

Product	Composite Thickness ASTM D374 (inches)	Yield Sq. Yds./ Lb.	Lbs./ Sq. Yd.	Dielectric Strength ASTM D149 (2 in. Dia. Electrodes) (volts)	Volume Resistivity <sup>1</sup> ASTM D257 (ohm/cm)	Surface Resistivity <sup>1</sup> ASTM D257 (ohms)	Tensile Strength ASTM D828 Lbs./In. Width		Tear Strength Graves (Lbs.)	
							MD	CMD	MD	CMD
3-1	0.005	4.55	0.22	5,300	10 <sup>14</sup>	10 <sup>13</sup>	60	40	4	5
3-2	0.005	3.82	0.26	6,000	10 <sup>14</sup>	10 <sup>13</sup>	70	55	6	5
5-2	0.007	2.77	0.36	9,500	10 <sup>14</sup>	10 <sup>13</sup>	115	90	10	10
2-2-2	0.006	2.77	0.36	7,300	10 <sup>14</sup>	10 <sup>13</sup>	67	57	---	---
3-1-3	0.008	2.55	0.39	6,600	10 <sup>14</sup>	10 <sup>13</sup>	104	76	8	6
3-2-3	0.009	2.22	0.45	8,900	10 <sup>14</sup>	10 <sup>13</sup>	112	81	10	6
3-3-3	0.0010	1.92	0.52	16,000	10 <sup>14</sup>	10 <sup>13</sup>	150	105	11	9

1 - Values obtained were greater than values shown.



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## Composites of Nomex<sup>2</sup>

### Pyromid<sup>®</sup> 180

A flexible insulation, high temperature combination material, that looks, feels and handles like DMD, but operates up to 180C. The fact that it is a mat rather than a hard paper product, enables it to absorb varnish and enhance the bonding of the wire and steel to the insulation, thus making a more homogeneous structure.

Miscellaneous Nomex Composites  
 Nomex may also be combined with any number of fibrous materials, cloths of films where certain specific properties are desired; for example:

Nomex-Glass where unidirectional or woven glass can be oriented to provide increased mechanical strength in one or more specific directions. Such a material would also have good thermal stability and flame resistance.

Nomex-Varnished Glass for higher electric strength and excellent physical properties over a wide temperature range.

2 – duPont registered TM for its aramid paper.  
 3 – duPont registered TM for its polyimide film.

### Nomex Type 464/Polyester Film

Product	2-2-2	2-3-2	2-5-2	2-7-2	2-7-2.5	2-10-2	2-14-2
Thickness	0.00636	0.00718	0.00919	0.0116	0.0124	0.0143	0.0179
Yield (LB/SY)	0.32	0.38	0.5	0.70	0.73	0.84	1.09
2" Electrode Dielectric							
ASTM D1-49	9.800	11.600	14.900	18.100	19.800	20.700	25.000
Tensile (LB/IN WD)							
ASTM D828							
MD	89	105	141	187	192	247	290
CMD	76	100	163	201	200	245	320
Graves Tear (LBS)							
ASTM D1004							
MD	10	15	22	31	33	35	49
CMD	8.5	14	20	30	27	36	47
Graves Tear:	Tear is actually 90° to the direction of orientation.						

Bedford Materials has no control over the final application of the product by others, therefore, the information contained herein is intended as a general guide to product use and should not be construed as a warranty.