3M

Industrial Adhesives and Tapes Division

BSI ISO9001:2000 FM541346

3M 4412N Peel Strengths on Many Surfaces

TSR # IATD-4871; RGK 08-39; prepared by R.G. Koza on January 6, 2009

Application Description:

The 4412N tape (aka Smart Seal Tape, EST, Extreme Sealing Tape, or single coated Beta tape) is a very thick, very tacky, single coated tape that has many potential uses for a wide variety of sealing applications. As a single coated tape, the sealing is done by "oversealing" an existing joint or penetration, as opposed to "between surface sealing" applications done with a double coated tape, gasket, or liquid sealant/adhesive. One specific, intended use for this tape is "roof-to-trim" sealing on commercial vehicles to eliminate large quantities of liquid sealants.

Purpose of Test:

To determine the ninety degree peel adhesion strength of this 3M 4412N tape to a wide variety of surfaces using up to four surface preparations. Some of this data will likely be used in technical data sheets for 4412N tape.

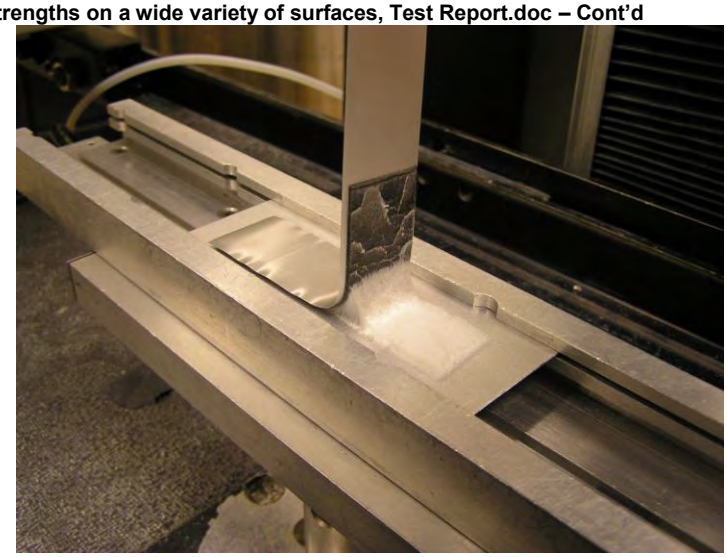
Test sample preparation:

The only tape tested was 3M 4412N; lot #NR26T02B; stock #JT-2700-6005-9. This tape was 1" wide x 4" long x 2mm (.080") thick. This tape is translucent white. It has a clear, matte finish, 2 mil thick, relatively non-stretchy, polyester release liner "attached" to the non-adhesive, top side of the ionomer film. Samples were prepared as described in TSR #IATD-4870 test report with anodized aluminum peel strips attached to the non-adhesive side of the ionomer film of the 4412N with 3M VHB™ tape 5925 (25 mils thick). The 4412N tape roll down to the test substrate was accomplished with a total of two passes under a 15 pound roller traveling at 12 inches per minute. Approximately 300 ninety degree peel adhesion tests were run at room temperature.

The four surface preparations used on the various test substrates, prior to 4412N tape application, were:

1) "Clean only" with a 50:50 mixture of isopropyl alcohol and water.
2) "Fine abrade" was done with a 3M Scotchbrite™ 7447 pad in an electric, palm held, finishing sander. After the fine abrading, cleaning was done with a 50:50 mixture of isopropyl alcohol and water.
3) "AP111"; Test surfaces were first cleaned with a 50:50 mixture of isopropyl alcohol and water and then primed with 3M Adhesion Promoter 111 using a disposable facial tissue. Solvent in this adhesion promoter is isopropyl alcohol.
4) "P94"; Test surfaces were first cleaned with a 50:50 mixture of isopropyl alcohol and water and then primed with 3M Primer 94 using a disposable facial tissue. The primary solvent in 3M Primer 94 is cyclohexane. The 3M Primer 94 was allowed to dry approximately 2 minutes prior to tape application.
5) "AP115"; only surface tested with 3M Silane Glass Treatment AP115 was glass. AP115 was sprayed on the glass surface and wiped dry with a disposable facial tissue. The primary solvent in 3M AP115 is isopropyl alcohol with some water and a very small amount of silane.

Tape was applied at room temperature (~70 degF), allowed to dwell at room temp for 24 hours, and tested at room temp with crosshead speed at 12 inches per minute in mid-December, 2008.



Ninety degree peel adhesion testing showing "adhesive split" of 4412N tape.
(Black area is 5925 tape bonding the aluminum foil peel strip to non-adhesive, ionomer film side of 4412N.)

The thirty-one test substrates were:

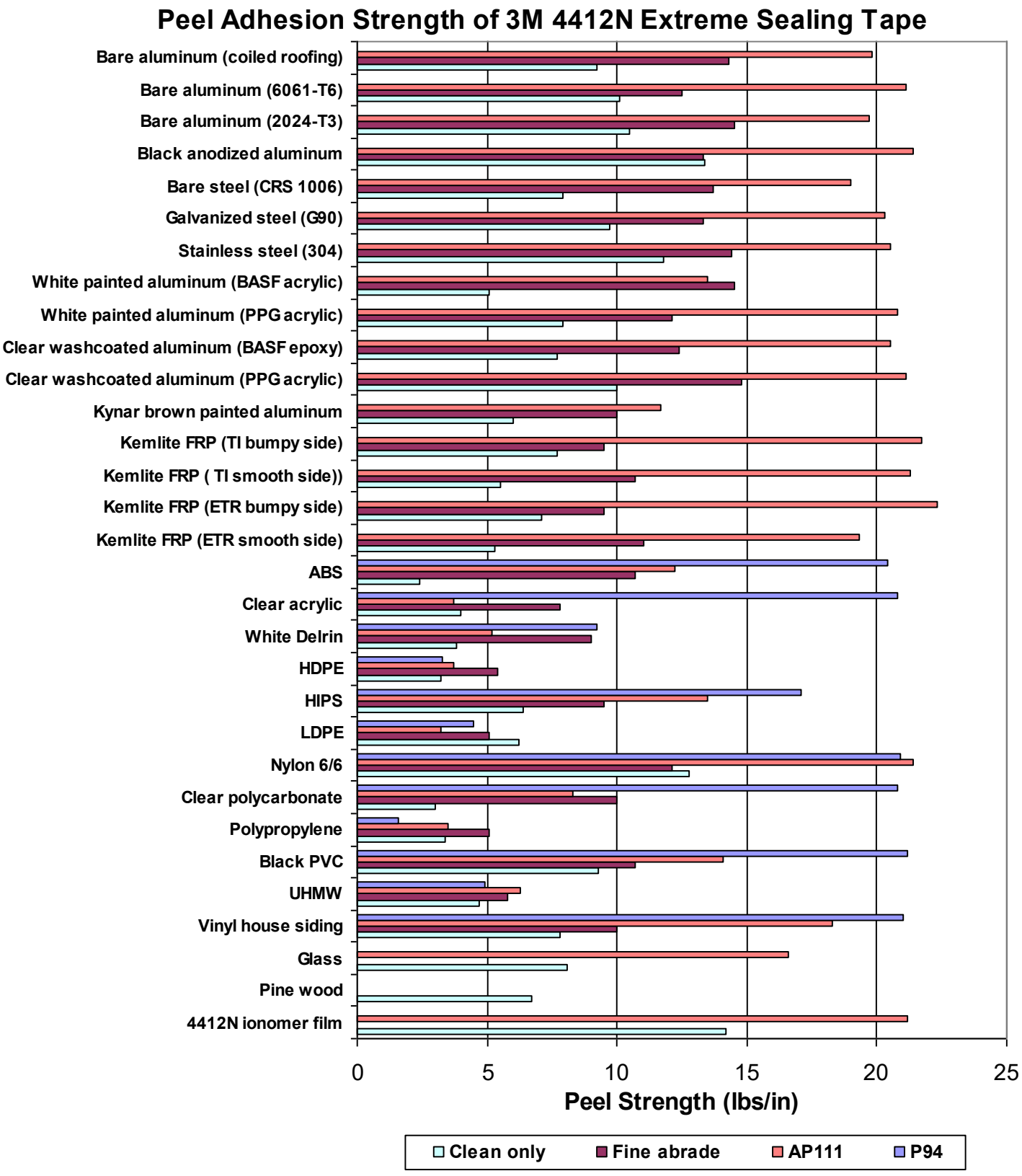
1) Bare aluminum (coiled roofing); .035" thick
2) Bare aluminum (6061-T6); .060" thick
3) Bare aluminum (2024-T3); .040" thick
4) Black anodized aluminum; .058" thick; AA-M12C22A42 Class 1 from Hiawatha Metalcraft, Inc Minneapolis, MN
5) Bare steel (CRS 1006); .048" thick
6) Galvanized steel (G90); .052" thick
7) Stainless steel (Type 304); .048" thick
8) White painted aluminum (BASF acrylic #42W454); .048" thick; from ALPCO in Westlake, OH.
9) White painted aluminum (PPG acrylic #1HW69795); .040" thick; from ALPCO in Westlake, OH.
10) Clear washcoat painted aluminum (BASF epoxy #22C159) .048" thick; from ALPCO in Westlake, OH.
11) Clear washcoat painted aluminum (PPG acrylic #1BHC4409) .040" thick; from ALPCO in Westlake, OH.
12) Kynar brown painted aluminum; 1/8" thick
13) Kemlite® FRP (bumpy topside of TI-08 translucent); .075" thick; fiberglass reinforced polyester resin
14) Kemlite® FRP (smooth bottom of TI-08 translucent); .075" thick; fiberglass reinforced polyester resin
15) Kemlite® FRP (bumpy topside of ETR 10% - 85 white); .075" thick; fiberglass reinforced polyester resin
16) Kemlite® FRP (smooth bottom of ETR 10% - 85 white); .075" thick; fiberglass reinforced polyester resin
17) ABS plastic; acrylonitrile butadiene styrene; .118" thick; natural (tan) color from Plastics International #ABSN-.125-S
18) Acrylic plastic; .118" thick; clear; from Plastics International #ACRXP-.118-S; PMMA extruded
19) Delrin® plastic; acetyl resin; .125" thick; white; from Plastics International; Eden Prairie, MN
20) HDPE plastic; high density polyethylene; .125" thick; black; from Plastics International
21) HIPS plastic; high impact polystyrene; .118" thick; solid white; from Plastics International
22) LDPE plastic; low density polyethylene; .125" thick; milky white translucent from Plastics International
23) Nylon 6/6 plastic; 1/8" thick; off white; translucent; from Plastics International
24) Polycarbonate plastic; .118" thick; clear; Makrolon® from Plastics International #LEX-.118-S
25) Polypropylene plastic; .125" thick; white; from Plastics International
26) PVC plastic; polyvinylchloride; .118" thick; dark gray from Plastics International
27) UHMW plastic; ultra high molecular weight polyethylene; .250" thick; virgin natural from Plastics International
28) Vinyl house siding; .050" thick; tan with wood grain texture; from Menards
29) Glass; clear float glass; 3/16" thick
30) Pine wood; ¾" thick from Home Depot
31) 3M 4412N tape (ionomer film); non-adhesive side; white; 2" wide tape -- lot #NG11T01B

Definitions of failure modes used in above and below data tables:
X= no testing done
cp = clean peel; over 95% clean peel of tape from substrate; failure mode used in peel adhesion tests
mcp = mostly clean peel; 75-95% clean peel of tape from substrate
pas = partial adhesive split; 25-75% adhesive split of the tape
mas = mostly adhesive split; 75-95% adhesive split of the tape
as = adhesive split; over 95% adhesive split of the tape

3M 4412N Extreme Sealing Tape; Peel adhesion strengths on metal substrates; 24 hour dwell

Substrate	Surface Preparation	Peel Test #1		Peel Test #2		Peel Test #3		Avg Peel
		(lbs/in)	Failure mode	(lbs/in)	Failure mode	(lbs/in)	Failure mode	(lbs/in)
Bare aluminum (coiled roofing)	Clean only	9.5	cp	9.3	cp	8.9	cp	9.2
	Fine abrade	14.5	cp	14.2	cp	14.2	cp	14.3
	AP111	20.0	as	18.4	pas	20.9	as	19.8
Bare aluminum (6061-T6)	Clean only	10.0	cp	10.2	cp	10.2	cp	10.1
	Fine abrade	12.6	cp	12.7	cp	12.2	cp	12.5
	AP111	20.7	as	19.7	mas	23.0	as	21.1
Bare aluminum (2024-T3)	Clean only	10.6	cp	10.5	cp	10.4	cp	10.5
	Fine abrade	15.0	cp	14.0	cp	14.6	cp	14.5
	AP111	18.8	mas	19.5	mas	20.8	as	19.7
Black anodized aluminum	Clean only	13.5	cp	13.3	cp	13.3	cp	13.4
	Fine abrade	14.7	cp	13.6	cp	11.5	cp	13.3
	AP111	22.7	as	20.9	as	20.6	as	21.4
Bare steel (CRS 1006)	Clean only	8.2	cp	7.6	cp	8.0	cp	7.9
	Fine abrade	14.8	cp	13.0	cp	13.1	cp	13.7
	AP111	21.2	as	17.4	pas	18.3	as	19.0
Galvanized steel (G90)	Clean only	10.1	cp	9.2	cp	9.7	cp	9.7
	Fine abrade	13.2	cp	13.3	cp	13.2	cp	13.3
	AP111	21.8	as	19.2	as	20.0	as	20.3
Stainless steel (Type 304)	Clean only	11.2	cp	11.6	cp	12.6	cp	11.8
	Fine abrade	15.7	cp	14.6	cp	13.0	cp	14.4
	AP111	18.6	as	19.9	mas	22.9	mas	20.5
White painted aluminum (BASF acrylic #42W454)	Clean only	5.2	cp	5.1	cp	5.1	cp	5.1
	Fine abrade	14.3	cp	15.0	cp	14.1	cp	14.5
	AP111	11.2	cp	14.6	cp	14.7	cp	13.5
White painted aluminum (PPG acrylic #1HW69795)	Clean only	8.0	cp	7.8	cp	8.0	cp	7.9
	Fine abrade	11.9	cp	12.1	cp	12.2	cp	12.1
	AP111	21.6	as	20.4	as	20.4	as	20.8
Clear washcoated aluminum (BASF epoxy #22C159)	Clean only	7.6	cp	7.7	cp	7.7	cp	7.7
	Fine abrade	12.5	cp	12.1	cp	12.6	cp	12.4
	AP111	20.5	as	20.7	as	20.4	as	20.5
Clear washcoated aluminum (PPG acrylic #1BHC4409)	Clean only	9.9	cp	10.3	cp	10.0	cp	10.0
	Fine abrade	14.8	cp	14.7	cp	15.0	cp	14.8
	AP111	21.1	as	21.6	as	20.6	as	21.1
Kynar brown painted aluminum	Clean only	6.4	cp	5.9	cp	5.8	cp	6.0
	Fine abrade	9.7	cp	10.4	cp	9.9	cp	10.0
	AP111	12.5	cp	10.2	cp	12.5	cp	11.7

3M 4412N Extreme Sealing Tape; Peel adhesion strengths on plastic substrates; 24 hour dwell								
Substrate	Surface Preparation	Peel Test #1		Peel Test #2		Peel Test #3		Avg Peel
		(lbs/in)	Failure mode	(lbs/in)	Failure mode	(lbs/in)	Failure mode	(lbs/in)
Kemlite FRP (bumpy topside of TI .075W" 08 translucent)	Clean only	7.6	cp	7.7	cp	7.7	cp	7.7
	Fine abrade	9.2	cp	9.8	cp	9.5	cp	9.5
	AP111	21.0	as	22.2	as	21.8	as	21.7
Kemlite FRP (smooth bottom of TI .075W" 08 translucent)	Clean only	5.5	cp	5.7	cp	5.2	cp	5.5
	Fine abrade	11.6	cp	10.5	cp	10.1	cp	10.7
	AP111	21.9	as	21.3	as	20.7	as	21.3
Kemlite FRP (bumpy topside of ETR .075W" 10%; 85 white)	Clean only	7.1	cp	7.0	cp	7.0	cp	7.1
	Fine abrade	9.5	cp	9.5	cp	9.4	cp	9.5
	AP111	22.3	as	21.9	as	22.8	as	22.3
Kemlite FRP (smooth bottom of ETR .075W" 10%; 85 white)	Clean only	5.5	cp	4.7	cp	5.6	cp	5.3
	Fine abrade	10.9	cp	10.8	cp	11.4	cp	11.0
	AP111	20.8	pas	17.0	pas	20.2	pas	19.3
ABS	Clean only	2.2	cp	2.2	cp	2.7	cp	2.4
	Fine abrade	11.1	cp	11.4	cp	9.7	cp	10.7
	AP111	12.4	cp	12.6	cp	11.6	cp	12.2
	P94	21.3	as	20.2	as	19.7	as	20.4
Acrylic	Clean only	3.6	cp	4.8	cp	3.5	cp	4.0
	Fine abrade	8.3	cp	7.5	cp	7.5	cp	7.8
	AP111	3.8	cp	3.7	cp	3.6	cp	3.7
	P94	21.6	as	20.8	as	20.1	pas	20.8
Delrin	Clean only	3.6	cp	3.7	cp	4.2	cp	3.8
	Fine abrade	9.0	cp	8.4	cp	9.8	cp	9.0
	AP111	4.8	cp	2.9	cp	7.9	cp	5.2
	P94	9.2	cp	8.4	cp	9.9	cp	9.2
HDPE	Clean only	3.3	cp	3.1	cp	3.4	cp	3.2
	Fine abrade	5.4	cp	5.3	cp	5.5	cp	5.4
	AP111	4.0	cp	3.6	cp	3.5	cp	3.7
	P94	3.1	cp	3.8	cp	3.1	cp	3.3
HIPS	Clean only	6.2	cp	6.7	cp	6.4	cp	6.4
	Fine abrade	9.5	cp	9.5	cp	9.7	cp	9.5
	AP111	13.7	mcp	12.3	cp	14.5	cp	13.5
	P94	15.6	mcp	20.0	as	15.9	mcp	17.1
LDPE	Clean only	6.4	cp	6.1	cp	6.2	cp	6.2
	Fine abrade	5.2	cp	5.0	cp	5.1	cp	5.1
	AP111	3.1	cp	3.2	cp	3.2	cp	3.2
	P94	3.4	cp	4.4	cp	5.7	cp	4.5
Nylon 6/6	Clean only	12.5	cp	12.7	cp	13.3	cp	12.8
	Fine abrade	11.8	cp	11.5	cp	12.9	cp	12.1
	AP111	21.9	pas	20.7	as	21.5	as	21.4
	P94	21.1	as	21.6	as	20.0	as	20.9
Polycarbonate	Clean only	3.2	cp	3.0	cp	2.9	cp	3.0
	Fine abrade	10.5	cp	9.3	cp	10.3	cp	10.0
	AP111	10.3	cp	4.5	cp	10.1	cp	8.3
	P94	20.9	as	21.3	mas	20.1	as	20.8
Polypropylene	Clean only	3.5	cp	3.2	cp	3.6	cp	3.4
	Fine abrade	5.1	cp	5.0	cp	5.3	cp	5.1
	AP111	3.5	cp	3.6	cp	3.5	cp	3.5
	P94	2.1	cp	1.1	cp	1.7	cp	1.6
Polyvinylchoride	Clean only	9.4	cp	8.9	cp	9.7	cp	9.3
	Fine abrade	10.4	cp	10.7	cp	11.0	cp	10.7
	AP111	14.1	cp	14.6	cp	13.6	cp	14.1
	P94	21.8	as	21.3	as	20.6	as	21.2
UHMW	Clean only	4.4	cp	5.6	cp	4.2	cp	4.7
	Fine abrade	5.6	cp	5.5	cp	6.3	cp	5.8
	AP111	7.3	cp	5.0	cp	6.6	cp	6.3
	P94	4.7	cp	5.6	cp	4.4	cp	4.9
Vinyl house siding	Clean only	7.5	cp	8.1	cp	X	X	7.8
	Fine abrade	10.2	cp	10.5	cp	9.3	cp	10.0
	AP111	24.0	mas	10.4	mcp	20.5	pas	18.3
	P94	21.2	as	20.9	as	X	X	21.0
Glass	Clean only	8.1	cp	8.0	cp	8.1	cp	8.1
	AP111	21.7	mas	14.7	cp	13.4	cp	16.6
	AP115	9.4	cp	9.6	cp	10.0	cp	9.7
Pine wood	As received	6.4	cp	6.6	cp	7.2	cp	6.7
4412N (Ionomer film)	As received	13.9	cp	13.9	cp	14.8	cp	14.2
	AP111	20.8	as	20.3	as	22.3	as	21.2


Peel Adhesion Strength of 3M 4412N Extreme Sealing Tape
Bare aluminum (coiled roofing)
Bare aluminum (6061-T6)
Bare aluminum (2024-T3)
Black anodized aluminum
Bare steel (CRS 1006)
Galvanized steel (G90)
Stainless steel (304)
White painted aluminum (BASF acrylic)
White painted aluminum (PPG acrylic)
Clear washcoated aluminum (BASF epoxy)
Clear washcoated aluminum (PPG acrylic)
Kynar brown painted aluminum
Kemlite FRP (TI bumpy side)
Kemlite FRP (TI smooth side))
Kemlite FRP (ETR bumpy side)
Kemlite FRP (ETR smooth side)
ABS
Clear acrylic
White Delrin
HDPE
HIPS
LDPE
Nylon 6/6
Clear polycarbonate
Polypropylene
Black PVC
UHMW
Vinyl house siding
Glass
Pine wood
4412N ionomer film
0
5
10
15
20
25
Peel Strength (lbs/in)
Clean only
Fine abrade
AP111
P94

Summary and Comments:

It appears that the ninety degree "adhesive split" (aka "foam split") value for 4412N tape (at 12 inches per minute peel speed with a non-stretchy anodized aluminum peel strip) is about 20-21 pounds per inch width of tape. This "adhesive split" occurs when the adhesive strength of the tape to the test substrate and peel strip is greater than the cohesive strength of the thick adhesive/foam of the 4412N.

Some reasonable peel adhesion strengths were achieved with the "clean only" surface preparation on many of these 31 different test substrates. However, the use of Adhesion Promoter 111 on most metals and painted surfaces and the use of Primer 94 on many plastics greatly increased the peel adhesion strengths. On many test substrates, fine abrading also showed some significant improvements in peel adhesion strengths. Although not a surprise, adhesion to the polyolefins (LDPE, HDPE, UHMWPE, and PP) was generally poor with little to no improvement with either Adhesion Promoter 111 or Primer 94.

This 4412N tape appears to be soft enough, and therefore conformable enough, to adhere equally well on both the bumpy side and smooth side of the very popular Kemlite® brand FRP roofing materials. Adhesion to all of the tested bare or treated metals seemed to be about the same.

Please call if you have questions or if I can help further.

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