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(54) LAMINATED TAPE FOR SHEATHING CABLES

(71) We, SUMITOMO ELECTRIC INDUSTRIES LTD., a Japanese Company, of No. 15, Kitahama 5-Chome, Higashi-Ku, Osaka, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to laminated sheathing tape for forming the shielding layer of a laminate sheathed cable and comprising a metal tape and a resin laminated to one or both surfaces of the metal tape; and to a laminate sheathed cable comprising a cable core, such laminated tape positioned longitudinally or wound helically around the cable core, and a jacket of a plastics material coated on said laminated tape.

A resin to be laminated on the tape during the production of the laminate sheathed cable is required to have adhesive properties whereby it adheres both to the metal tape and to a plastics jacketing material such as polyethylene. The resin is also required to exhibit good processing properties during production of the cable, for example, good abrasion-resistance in a tape-forming apparatus.

Aluminium is usually used for the metallic component of such a metallic tape, and the reasons why the laminate resin is required to have good adhesion for the metallic tape and the polyethylene which is usually used for the jacketing layer are to improve the moisture-resistance of the cable, that is the laminate resin must serve to prevent moisture permeation, to improve the mechanical strength such as the bending property of the unitized sheath (jacketing layer) by strongly laminating the metallic tape to the polyethylene jacketing layer, and to assist the function of the metallic tape to control the shrinkage of the sheath. It should be explained that a plastics sheath has stresses formed therein during extrusion

and thus shrinks due to the heat cycle upon exposure to the open air.

As may be seen from British Patent Specification No. 886,417, polyethylene has long been used as the laminating resin, but it suffers from the defect of weak adhesive strength to aluminium tape.

United States Patent Specification No. 3,233,036 discloses a technique which remedies this defect by using a carboxyl-containing resin so as to improve its adhesion with the aluminium tape. It suffers, however, from the defect that sufficient bond strength in the sheath cannot be obtained because of the greatly different polarity of such a resin from polyethylene used in the outer protective layer.

United States Patent Specification No. 3,586,756 (corresponding to Japanese Patent Publication No. 23257/70) discloses an attempt to eliminate both the above-mentioned defects. A laminated tape is there disclosed comprising an aluminium tape having a polyethylene layer on each face thereof, the inner surface of each polyethylene layer being modified with carboxyl groups capable of chemically bonding with the aluminium of the tape. The outer surface of each layer is accordingly formed of ethylene homopolymer which, although it does not have the ability to adhere to the tape as effectively as carboxyl-containing ethylene copolymer, does adhere more strongly to the jacketing layer.

U.S. Patent Specification No. 3,586,756 also discloses a method whereby the properties of the two-layered laminate tape are imparted to a mono-layered laminate tape. According to this method, reactive groups are concentrated in the vicinity of the metal tape in a resin layer laminated to the metal tape, and the concentration of the reactive groups is decreased progressively with distance from the metal surface so that at the other surface of

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the laminate layer it adheres to the jacketing polyethylene but would not be capable of adhering to the metal. This laminate tape is produced, for example, by first preparing a
5 polyethylene tape, chemically treating one surface only of the polyethylene tape to form a layer containing reactive groups on said surface, bonding the chemically-treated surface to the surface of a metal tape, and then heat-sealing. This method suffers however from
10 manufacturing difficulties, and is not economical.

We have now found that a suitable laminate tape can be simply produced using a laminating resin composed of a terpolymer of
15 ethylene, vinyl acetate and glycidyl methacrylate or glycidyl acrylate which adheres sufficiently to the jacketing polyethylene as well as to the metal layer, and that laminate sheathed cables of superior mechanical properties can be produced with economical advantage using this laminated tape.

According to the present invention, there is provided a laminated tape for forming the
25 shielding layer of a laminate sheathed cable comprising a metal tape and a material having as its major component an ethylene copolymer composition comprising a terpolymer of ethylene, vinyl acetate and glycidyl methacrylate or glycidyl acrylate and optionally
30 containing from 100 ppm to 10,000 ppm of an

anti-oxidant and/or a copolymer of ethylene and an alkyl methacrylate or alkyl acrylate, said material being laminated to one or each surface of the metal tape.

The invention also provides a laminate sheathed cable incorporating any one of the above-described laminated tapes.

The present invention will now be more fully described, firstly by comparison with the prior art, with reference to the accompanying drawings in which:

Figure 1 is a transverse section of a known laminate sheathed cable; and,

Figure 2 is a series of three schematic views illustrating methods to be described hereinafter, of testing the adhesive bond strength of laminated tapes.

Laminate sheathed cables of the construction shown in Fig. 1 were produced using the three above-described types of known laminated tapes. The cable of Fig. 1, is composed of a cable core 1, a laminated tape layer 2 consisting of a metal tape 3 and a resin layer 4, and a jacketing layer 5 composed of a synthetic resin. The properties of these three laminate sheathed cables are compared with one another in Table 1 below. The laminated tape used in producing the laminate sheathed cables tested above consisted of a soft aluminium tape having a thickness of 0.2 mm and a resin layer having a thickness of 0.05 mm.

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TABLE 1

Resin No. *	Adhesive strength between the aluminium tape and the polyethylene jacket**	Number of bends required for cracks to appear in the aluminium tape ***	Remarks
P	0.95 Kg/cm (a)	10 - 15 times	(a) Peel-off occurred between the aluminium and the laminated resin
S	1.55 (b)	20 - 25	(b) Peel-off occurred between the polyethylene jacket and the laminated resin
E-S	3.05 (c)	30 - 35	(c) Cohesive destruction between the aluminium and the polyethylene jacket occurred

* P: Polyethylene (Sumikathene F-701)

S: Metal salt of a copolymer of ethylene and acrylic acid (Surlyn A)

E-S: A laminate in which S was laminated to the aluminium surface and a copolymer of ethylene and vinyl acetate (Evatate D-2011) was laminated to the S-layer.

** As shown in Fig. 2 (a), a rectangular sample 10 with a width of 10 mm was taken from the cable sheath, and a peeling test was conducted by peeling the aluminium sheet 11 from the resin layer 12 at an angle of 180° as shown by the arrows and at a separating speed of 100 mm/min.

* registered Trade Mark.

*** Bending test: The sample was bent reciprocally at an angle of 180° over a mandrel having a diameter twelve times that of the cable. One reciprocal bending motion was counted as one bend.

As may be seen from Table 1, the laminate sheathed cable incorporating the E-S laminated tape exhibited very superior properties. On the other hand, however, because of its multi-layered structure, the production of this kind of laminated tape involves complicated manufacturing steps and a high production cost, which in turn results in an increase in the cost of the cable.

The properties of laminate sheathed cables can be improved according to the invention by using a mixture of a terpolymer and copolymer as described above. This is because the adhesion in the laminated tape between the resin layer and the metal is increased not only by the reaction of the metal with the epoxy groups contained in the component (1) but also by ensuring good contact between them by the use of the component (2), and also the adhesion between the jacketing polyethylene and the resin layer of the laminate is increased by the component (2) which has good compatibility with polyethylene. We

attempted to use a copolymer of ethylene and vinyl acetate as the component (2), but since these constituents were already contained in component (1), no effect was observed. The terpolymer used as component (1) may be obtained by various methods. For example, it may be obtained by polymerizing a mixture of ethylene with the other monomers at a temperature of 40 to 300°C and at a pressure of 40 to 5,000 Kg/cm² in the presence of a free radical forming initiator. During polymerization, a chain transfer agent such as ethane, propane or propylene may be added.

The reason for the addition of the antioxidant to the resin is to facilitate the high-speed processing of the resin by elevating the extrusion temperature of the resin to more than about 265°C, which in turn brings about an increase in adhesive strength between the metal and the resin layer and renders uniform the thickness of the resin layer.

The following Examples further illustrate the present invention.

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EXAMPLE 1.
Samples were prepared by sheet formation and lamination, and the adhesive strength between aluminium and the terpolymer described above (containing no anti-oxidant), the mixture of the components (1) and (2) described above or the conventionally user resin, and the adhesive strength between the above resin and polyethylene used as a jacketing plastics were determined. The results are shown in Table 2. Table 3 shows the composition of each resin and its melt index.

TABLE 2
Adhesive and other properties of the resin (without an antioxidant)

Abbreviation of resin *	Adhesive bond strength between the aluminium tape and the resin	Adhesive bond strength between the resin and polyethylene	Process-stability of cable * (4)	Blocking of the laminate tape * (5)	Adhesive bond strength between the aluminium tape and the laminating resin * (6)
	method * (1)	method * (2)	method * (3)		
E ₁	394 g/cm	320 g/cm	more than 4 kg/cm	yes	—
E ₂	341	341	"	no	—
B ₁	1613	433	"	yes	—
B ₂	1068	421	"	"	—
B ₃	769	390	"	no	—
S	1559	1055	0	"	—
P	159	50	5.5	"	—
H ₁	2940	more than 900 g/cm	more than 4 kg/cm	"	404
G ₁ /B ₁ = 90/10	3440	"	"	"	440
70/30	3310	"	"	"	451
50/50	3215	"	"	"	437
90/70	2860	"	"	"	442
G ₁ /B ₂ = 50/50	2510	"	"	"	+30
G ₁ /B ₃ = 80/20	2940	"	"	"	438

TABLE 2 (continued)
Adhesive and other properties of the resin (without an antioxidant)

Abbreviation of resin *	Adhesive bond strength between the aluminium tape and the resin	Adhesive bond strength between the resin and polyethylene	Process- stability of cable * (4)	Blocking of the laminate tape * (5)	Adhesive bond strength between the aluminium tape and the laminating resin * (6)
	method * (1)	method * (2)	method * (3)		
$G_2/B_1 = 95/5$	3380 g/cm	more than 900 g/cm	more than 4 kg/cm	no	431
60/40	3230	"	"	"	418
30/70	2940	"	"	"	405
10/90	2830	"	"	"	425
$G_1/B_2 = 80/20$	3450	more than 700 g/cm	"	"	400
20/80	2850	"	"	"	419
$G_3/B_1 = 50/50$	2900	"	"	"	448
$G_3/B_2 = 80/20$	3920	"	"	"	452
$G_3/B_2 = 70/30$	3240	"	"	"	455
$G_4/B_3 = 90/10$	more than 4000	"	"	"	460
$G_5/B_1 = 95/5$	3860	"	"	"	449
60/40	2710	"	"	"	432
10/90	2460	"	"	"	418

TABLE 2 (continued)

Adhesive and other properties of the resin (without an antioxidant)

Abbreviation of resin*	Adhesive bond strength between the aluminium tape and the resin		Adhesive bond strength between the resin and polyethylene		Process- stability of cable * (4)	Blocking of the laminate tape * (5)	Adhesive bond strength between the aluminium tape and the laminating resin * (6)
	method * (1)	method * (2)	method * (3)				
G ₅ /B ₂ = 70/30	3355	more than 700 g/cm	more than 4 kg/cm	good	no	450 g/cm	
50/50	2840	"	"	"	"	427	
G ₅ /B ₃ = 60/40	2800	"	"	"	"	431	
G ₆ /B ₁ = 95/5	more than 4000	"	"	"	"	458	
G ₆ /B ₂ = 70/30	"	"	"	"	"	452	
10/90	3890	"	"	"	"	494	
5/95	3870	"	"	"	"	429	
G ₆ /B ₃ = 50/50	more than 4000	"	"	"	"	419	
H ₁ /B ₁ = 90/10	3660	"	"	"	"	415	
50/50	3640	"	"	"	"	421	
H ₁ /B ₂ = 90/10	3480	"	"	"	"	426	
70/30	2220	"	"	"	"	399	
50/50	3340	"	"	"	"	407	

TABLE 2 (continued)

Adhesive and other properties of the resin (without an antioxidant)

Abbreviation of resin *	Adhesive bond strength between the aluminium tape and the resin		Adhesive bond strength between the resin and polyethylene		Process- stability of cable * (4)	Blocking of the laminate tape * (5)	Adhesive bond strength between the aluminium tape and laminating resin * (6)
	method * (1)	method * (2)	method * (3)	method * (3)			
H ₁ /B ₂ = 30/70	3210 g/cm	more than 700 g/cm	more than 4 kg/cm	more than 4 kg/cm	good	no	428 g/cm
10/90	2950	"	"	"	"	"	428
H ₁ /B ₃ = 60/40	3400	"	"	"	"	"	413
20/80	3010	"	"	"	"	"	416
two-layered tape * (7)	—	520	—	—	"	"	—

(Note: Symbol "—" shows that the property was not measured)

* (1) As illustrated in Fig. 2 (a), method wherein soft aluminium 11 (thickness 0.2 mm) was heat bonded at 180°C to a resin layer 12 (thickness 1.0 mm), followed by cooling to room temperature. Peeling was conducted by peeling the sheet 11 from the layer 12 at an angle of 180° as shown by the arrows and at a separating speed of 100 mm/min.

* (2) As illustrated in Fig. 2 (b), method wherein a layer of resin 13, (0.05 mm) was laminated to soft aluminium 14 (thickness 0.2 mm) using an extruder. Peeling was conducted by peeling resin layer 13 from the aluminium 14 at an angle of 180° as shown by the arrows at a separating speed of 100 mm/min. The extrusion temperature was 230°C, and the speed of lamination was 10 metres/min.

Table 2 footnotes continued.

- * (3) As illustrated in Fig. 2 (c), method wherein jacketing polyethylene 15 (low density polyethylene, thickness 1.0 mm) was heat bonded at 160°C to a resin sheet 16 (thickness 1.00 mm), followed by cooling to room temperature. Peeling was conducted by peeling resin sheet 16 from the polyethylene 15 at an angle of 180° as shown by the arrows at a separating speed of 100 mm/min.
- * (4) In the manufacture of cables, the surface of a resin film undergoes wear or splitting in, for example, a laminated tape-forming apparatus. This wear or splitting depends upon the mechanical properties of the resin, and also on the type of the comonomers and their contents.
- * (5) The laminated tape wound in coil form underwent blocking during storage. The blocking depends upon the types of the comonomers, their contents and the melt index of the copolymer.
- * (6) Method wherein a resin layer (thickness 0.05 mm) was laminated on soft aluminium (thickness 0.2 mm) using an extruder. (For the measurement of the adhesive strength, see Fig 2 (c)). The extrusion temperature was higher than 265°C, and the speed of lamination was 10 metres/min.
- * (7) The same tape as E-S in Table 1.
The composition and melt index of each resin were as shown in Table 3.

TABLE 3

Laminate component	Abbreviation of resin	Melt index * (8) g/10 (min)	Composition (wt. %)			
			GMA	GA	VA	Ethylene
Used alone	P	7.2	0	0	0	100
	E ₁	12.4	0	0	14	Remainder
	E ₂	2.8	0	0	5	„
	S	3.5	Composition unknown			
Used either alone (H ₁ only) or as first component of the mixture	G ₁	2.0	0.6	0	8	Remainder
	G ₂	2.0	2.4	0	8	„
	G ₃	2.0	6.0	0	6	„
	G ₄	6.0	12.0	0	6	„
	G ₅	2.0	2.4	0	4	„
	G ₆	12.0	15.0	0	2	„
	H ₁	3.5	0	3.2	8	„
Use either alone or as the second component of the mixture	B ₁	6				
	B ₂	2				
	B ₃	1				

* (8) According to ASTM D-1236, temperature 190°C, load 2160 g.

P : polyethylene

E₁, E₂ : copolymer of ethylene and vinyl acetate

S : copolymer of ethylene and a metal salt of acrylic acid.

GA : glycidyl acrylate

VA : vinyl acetate

B₁ : ethylene/alkylacrylate copolymer (DPDB-6169, acrylate concentration 20% by weight)

B₂ : ethylene/alkylacrylate copolymer (DPBA-6181, acrylate concentration 20 - 30% by weight)

B₃ : ethylene/alkylacrylate copolymer (DPBA-6182, acrylate concentration 14% by weight)

It may be seen from the results shown in Table 2 that when the terpolymer derived from ethylene/vinyl acetate glycidyl acrylate is used as the resin, the various properties are superior to those of the conventional laminated tapes. Furthermore, it may be seen that the properties of the laminated tape using the mixture of the components (1) and (2) are better than those of the laminated tape using only either of components (1) or (2). Only the results of some

of the combinations of the components (1) and (2) are shown in Table 2, but the same tendency was observed with regard to the other combinations.

With the samples obtained by the methods (*1), and (*2), the adhesion between the terpolymer and aluminium was superior, but the laminated tape obtained by using the laminate method (*6) at an extrusion temperature of more than 265°C was little different from the conventional laminate material

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25 and had inferior adhesive bond strength as compared with the case of extruding at 230°C. When the thickness of the laminated resin layer was examined, there was a maximum variation in thickness of 10% in the case of extrusion at 230°C, whereas in the case of
30 extrusion at 265°C, the thickness fluctuated by $\pm 34\%$.

EXAMPLE 2.

35 To the above-described terpolymer and the mixture of the first and second components was added an anti-oxidant in an amount of 100 to 10,000 ppm. This made it possible to laminate the resin to metal at a higher temperature whereby the adhesion between the aluminium tape and the resin layer was further
40 increased, the speed of lamination was increased, and the thickness of the resin layer became uniform. The results of adding various anti-oxidants are shown in Table 4. It may also be seen from Table 4 that these effects
45 cannot be obtained by the use of conventional laminating materials.

Details of the particular anti-oxidants tested are shown in Table 5, but the same effects were obtained with the other anti-oxidants. Furthermore, using the tape including a blend
50 or mixture of the terpolymer with the anti-oxidant, the producibility of cables and the blocking of the laminated tape were examined: the results were as good as when using no anti-oxidant.
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Thermal stability was improved with at least 100 ppm of the anti-oxidant, but the effect of the anti-oxidant was conspicuous with amounts of more than 300 ppm. Similar effects were observed with the amounts up to 10,000
60 ppm. However, when the amount of the anti-oxidant was greatly increased, the anti-oxidant tended to migrate to the surface of the tape. Accordingly, the preferred amount of the anti-oxidant is 300 to 5,000 ppm. By the addition
65 of the anti-oxidant, lamination could be performed at a speed up to 86 metres/min, and the fluctuation in thickness of the resin layer was within $\pm 8\%$.

TABLE 4

Abbreviation of resin	Anti-oxidant	Amount of anti-oxidant	Adhesive bond strength between the aluminium tape and the resin
			Laminating method * (9)
E ₁	Antigene WX	1000 ppm	355 Kg/cm
E ₂	"	"	334
B ₁	"	"	460
B ₂	"	"	430
B ₃	"	"	408
S	"	"	1026
P	"	"	55
G ₁	"	100	510
"	"	300	580
"	"	1000	more than 700
"	"	5000	"
"	"	10000	"
"	Irganox 1010	100	498
"	"	300	563
"	"	1000	more than 700
"	"	5000	"
"	"	10000	"

TABLE 4 (continued)

Abbreviation of resin'	Anti-oxidant	Amount of anti-oxidant	Adhesive bond strength between the aluminium tape and the resin
			Laminating method* (9)
G ₂	Antigene WX	100	515
"	"	300	588
"	"	1000	more than 700
"	"	5000	"
"	"	10000	"
"	Irganox 1010	100	495
"	"	300	549
"	"	1000	more than 700
G ₃	Irganox 1010	5000	"
"	"	10000	"
G ₄	Antigene WX	100	537
"	"	300	610
"	"	1000	more than 700
G ₅	Antigene WX	5000 ppm	more than 700 Kg/cm
"	"	10000	"
"	Irganox 1010	100	502
"	"	300	540
"	"	1000	more than 700
"	"	5000	"
"	"	10000	"
G ₂ /B ₁ = 60/40	Antigene WX	100	491
"	"	300	516
"	"	1000	680
"	"	5000	more than 700
"	"	10000	"
"	Irganox 1010	100	487
"	"	300	532
"	"	1000	more than 700
"	"	5000	"
"	"	10000	"

TABLE 4 (continued)

Abbreviation of resin	Anti-oxidant	Amount of anti-oxidant	Adhesive bond strength between the aluminium tape and the resin
			Laminating method * (9)
$G_s/B_s = 60/40$	Antigene WX	100	502
"	"	300	594
"	"	1000	more than 700
"	"	5000	"
$G_s/B_s = 60/40$	Antigene WX	10000	"
"	Irganox 1010	100	506
"	"	300	631
"	"	1000	more than 700
"	"	5000	"
"	"	10000	"
$H_i/B_i = 50/50$	Antigene WX	100	482
"	"	300	499
"	"	1000	545
$H_i/B_i = 50/50$	Antigene WX	5000 ppm	more than 700 Kg/cm
"	"	10000	"
"	Irganox 1010	100	471
"	"	300	532
"	"	1000	682
"	"	5000	more than 700
"	"	10000	"

* (9) Extrusion temperature, 265°C; speed of lamination, 30 metres/min.

TABLE 5

Anti-oxidants		
No.	Chemical nomenclature	Trade name
1	4,4'-thiobis-(6- <i>tert.</i> butyl-3-methyl phenol)	Antigene WX
2	4,4'-butylidene-bis-(6- <i>tert.</i> butyl-3-cresol)	Sumilizer BBM
3	High molecular weight phenol type compound	Topanol CA
4	Mercaptobenzimidazole	Antigene MB
5	Zinc salt of 2-mercaptobenzothiazole	Soxinol MZ
6	Selenium diethyl-dithiocarbamate	Soxinol SE
7	Polymer of 2,2,4-trimethyl-1,2-dihydroquinoline	Antigene RD
8	Reaction product of 1,1-bis-(4-hydroxyphenyl) cyclohexane and an organic amine	Antigene WA
9	N,N-di- β -naphthyl- <i>p</i> -phenylene diamine	Antigene F
10	Phenyl- α -naphthylamine	Antigene PA
11	Phenyl- β -naphthylamine	Antigene D
12	Triazine derivative	Irganox 565
13	Triazine derivative	Irganox 858
14	High molecular weight sterically hindered phenol	Irganox 1010
15	High molecular weight sterically hindered phenol	Irganox 1076

A laminated tape was produced using each of the resins alone or a mixture of the first and second components, and a laminate sheathed cable was produced using each of the laminated tapes. The properties of the laminate sheathed cables obtained are shown in Tables 6, 7 and 8.

The laminated tape was produced using an extruder having a cylindrical diameter of 50 mm at an extrusion temperature of about 230°C (for resins not containing the anti-

oxidant) or at 265°C (for those containing the anti-oxidant) in accordance with the T-die method. Each of the laminated tapes consisted of a 0.2 mm thick soft aluminium tape and the resin layer having a thickness of 0.05 mm. The cable tested was of the structure shown in Fig. 1, and was an aerial cable with a conductor diameter of 0.4 mm (26 AWG, 100 pairs). The jacketing resin was polyethylene, and the processing temperature was 220 to 230°C.

TABLE 6

Component	Abbreviation of resin	(without anti-oxidant)	
		Adhesive bond strength between the aluminium tape and the polyethylene jacket (Note -1)	Number of bends required for cracks to appear in the aluminium tape (Note -2)
First component	H ₁	3.12	30 - 35
	B ₁	1.54	20 - 25
Second component	B ₂	0.94	12 - 16
	B ₃	0.68	8 - 13

Note - 1: Same as in Table 1

Note - 2:

TABLE 7

Component	Ratio of first/ second compo- nents (wt. %)	Adhesive bond strength between the aluminium tape and the polyethylene jacket (Kg/cm) (Note - 1)	Number of bends required for cracks to appear in the aluminium tape (Note - 2)
Mixture of the first and second components	$G_1/B_1 = 90/10$	3.54	33 - 38
	„ = 70/30	3.52	„
	„ = 30/70	3.49	„
	$G_1/B_2 = 50/50$	3.40	„
	$G_1/B_3 = 80/20$	3.50	„
	$G_2/B_1 = 95/5$	3.82	more than 40
	„ = 60/40	3.80	„
	„ = 10/90	3.51	„
	$G_2/B_2 = 80/20$	3.74	„
	„ = 20/80	3.61	„
	$G_3/B_1 = 50/50$	3.68	„
	$G_3/B_2 = 80/20$	3.94	„
	$G_4/B_3 = 90/10$	more than 4.00	„
	$G_5/B_1 = 95/5$	„	„
	„ = 60/40	3.85	„
	$G_5/B_2 = 70/30$	3.85	„
	„ = 50/50	3.71	„
	$G_5/B_3 = 60/40$	3.72	„
	$G_6/B_2 = 70/30$	3.92	„
	„ = 5/95	3.45	„
	$G_6/B_3 = 50/50$	3.67	„
	$H_1/B_1 = 90/10$	3.44	„
	„ = 50/50	3.42	„
	$H_1/B_2 = 90/10$	3.78	„
	„ = 50/50	3.61	„
	„ = 10/90	3.16	„
	$H_1/B_3 = 60/40$	3.55	„
	„ = 20/80	3.20	„

Note - 1:

Same as in Table 1

Note - 2:

TABLE 8

Abbreviation of resin (bracketed figures represent anti-oxidant concentration)		Adhesive bond strength between the aluminium tape and the polyethylene jacket (Note - 1)	Number of bends required for cracks to appear in the aluminium tape (Note - 2)
G ₁	(300 ppm)	3.23	30 - 35
G ₁	(1000 ppm)	3.45	30 - 40
G ₁	(5000 ppm)	3.51	35 - 40
G ₃	(300 ppm)	3.32	35 - 40
G ₃	(1000 ppm)	3.50	35 - 40
G ₃	(5000 ppm)	3.65	more than 40
H ₁	(1000 ppm)	3.37	35 - 40
G ₂ /B ₁ = 60/40 (1000 ppm)		3.88	more than 40
G ₂ /B ₁ = 60/40 (500 ppm)		3.82	"
G ₅ /B ₁ = 60/40 (1000 ppm)		3.90	"
G ₅ /B ₁ = 60/40 (5000 ppm)		3.94	"
H ₁ /B ₁ = 50/50 (1000 ppm)		3.62	"

Note - 1:

Same as in Table 1

Note - 2:

5 It will be seen from the results shown in Tables 6, 7 and 8 that the laminate sheathed cables produced by using the laminated tapes of this invention have outstandingly superior characteristics compared with the conventional cables. Table 8 shows the results of only some of the experiments performed, but extensive investigations have shown that the characteristics of the laminate sheathed cable of this invention are best when a mixture of the first component and 5 to 95% by weight, preferably 5 to 70% by weight of the total weight of resin, of the second component is used to produce the laminated tape of this invention.

10 Patent Specification No. 1,394,110 describes and claims a laminated sheathing tape for forming the shielding layer of a laminate sheathed cable and comprising a metallic tape and a resin laminated thereon, the resin being an ethylene / glycidyl methacrylate / vinyl acetate terpolymer. Accordingly we make no claim to a laminated tape as claimed in any of the claims to Specification No. 1,394,110.

25 Subject to the foregoing disclaimer,

WHAT WE CLAIM IS:—

1. A laminated tape for forming the shielding layer of a laminate sheathed cable comprising a metal tape and a material having as its major component an ethylene copolymer composition comprising a terpolymer of ethylene, vinyl acetate and glycidyl methacrylate or glycidyl acrylate and optionally containing from 100 ppm to 10,000 ppm of an anti-oxidant and/or a copolymer of ethylene and an alkyl methacrylate or alkyl acrylate, said material being laminated to one or each surface of the metal tape.

2. A tape as claimed in Claim 1, wherein the said material contains from 300 to 5,000 ppm of an anti-oxidant.

3. A tape as claimed in Claim 1 or 2 wherein said anti-oxidant is any one of the anti-oxidants Nos. 1 to 15 listed in Table 5 herein.

4. A tape as claimed in any one of Claims 1 to 3, wherein the material contains a copolymer composition which contains from 5 to 95% by weight of the copolymer of ethylene and an alkyl methacrylate or alkyl acrylate.



* C L M S *

TABLE 8

Abbreviation of resin (bracketed figures represent anti-oxidant concentration)	Adhesive bond strength between the aluminium tape and the polyethylene jacket (Note - 1)	Number of bends required for cracks to appear in the aluminium tape (Note - 2)
G ₁ (300 ppm)	3.23	30 - 35
G ₁ (1000 ppm)	3.45	30 - 40
G ₁ (5000 ppm)	3.51	35 - 40
G ₃ (300 ppm)	3.32	35 - 40
G ₃ (1000 ppm)	3.50	35 - 40
G ₃ (5000 ppm)	3.65	more than 40
H ₁ (1000 ppm)	3.37	35 - 40
G ₂ /B ₁ = 60/40 (1000 ppm)	3.88	more than 40
G ₂ /B ₁ = 60/40 (500 ppm)	3.82	"
G ₅ /B ₁ = 60/40 (1000 ppm)	3.90	"
G ₅ /B ₁ = 60/40 (5000 ppm)	3.94	"
H ₁ /B ₁ = 50/50 (1000 ppm)	3.62	"

Note - 1:

Same as in Table 1

Note - 2:

It will be seen from the results shown in Tables 6, 7 and 8 that the laminate sheathed cables produced by using the laminated tapes of this invention have outstandingly superior characteristics compared with the conventional cables. Table 8 shows the results of only some of the experiments performed, but extensive investigations have shown that the characteristics of the laminate sheathed cable of this invention are best when a mixture of the first component and 5 to 95% by weight, preferably 5 to 70% by weight of the total weight of resin, of the second component is used to produce the laminated tape of this invention.

Patent Specification No. 1,394,110 describes and claims a laminated sheathing tape for forming the shielding layer of a laminate sheathed cable and comprising a metallic tape and a resin laminated thereon, the resin being an ethylene / glycidyl methacrylate / vinyl acetate terpolymer. Accordingly we make no claim to a laminated tape as claimed in any of the claims to Specification No. 1,394,110.

Subject to the foregoing disclaimer,

WHAT WE CLAIM IS:—

1. A laminated tape for forming the shielding layer of a laminate sheathed cable comprising a metal tape and a material having as its major component an ethylene copolymer composition comprising a terpolymer of ethylene, vinyl acetate and glycidyl methacrylate or glycidyl acrylate and optionally containing from 100 ppm to 10,000 ppm of an anti-oxidant and/or a copolymer of ethylene and an alkyl methacrylate or alkyl acrylate, said material being laminated to one or each surface of the metal tape.

2. A tape as claimed in Claim 1, wherein the said material contains from 300 to 5,000 ppm of an anti-oxidant.

3. A tape as claimed in Claim 1 or 2 wherein said anti-oxidant is any one of the anti-oxidants Nos. 1 to 15 listed in Table 5 herein.

4. A tape as claimed in any one of Claims 1 to 3, wherein the material contains a copolymer composition which contains from 5 to 95% by weight of the copolymer of ethylene and an alkyl methacrylate or alkyl acrylate.



5. A tape as claimed in Claim 4, wherein the copolymer composition contains from 5 to 70% by weight of the copolymer of ethylene and an alkyl methacrylate or alkyl acrylate.
- 5 6. A laminated tape as claimed in Claim 1 and substantially as herein described with reference to Example 1 or Example 2 herein.
7. A laminate-sheathed cable comprising a cable core and an air-tight sheath formed by wrapping around the core a tape as claimed in any preceding Claim.
- 10 8. A laminate-sheathed cable incorporating

a tape as claimed in any one of Claims 1, 2 and 5 and substantially as herein described.

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