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[54] **SEWING TAPE**

[75] Inventors: **James J. Pedginski**, West St. Paul; **William A. Peper**, Maplewood Village, both of Minn.

[73] Assignee: **Minnesota Mining and Manufacturing Company**, St. Paul, Minn.

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[58] **Field of Search**..... 117/122 PF, 122 PA, 76 A, 117/68.5

[56] **References Cited**

UNITED STATES PATENTS

2,884,126	4/1959	Ulrich	117/122
3,144,430	8/1964	Schaffhausen	117/122 X
3,396,837	8/1968	Schmelzle et al.	117/122 X
3,406,039	10/1968	Paufler	117/122 X
3,462,284	8/1969	Vertnik	117/122
3,661,618	5/1972	Brookman et al.	117/122 X
3,733,292	5/1973	Sirota et al.	117/122 X

Primary Examiner—William D. Martin
Assistant Examiner—Bernard D. Pianalto
Attorney, Agent, or Firm—Alexander, Sell, Steldt & DeLaHunt

[57] **ABSTRACT**

Sewing tape which can be adhered to fabric, stitched through without gumming the needle and thereafter easily removed from the fabric is made by coating certain polyolefin film backings with a pressure-sensitive adhesive having a loss shear modulus greater than 10^6 dynes/cm^2. At 7% elongation in the crossweb direction, the film shows a tensile stress of 75–250 kg/cm^2 and a tensile force of 200–2,000 grams/cm.

3 Claims, No Drawings

SEWING TAPE

BACKGROUND OF THE INVENTION

This invention relates to normally tacky and pressure-sensitive adhesive tape, and particularly to tapes having utility in sewing, dressmaking, tailoring, and similar procedures.

For at least a decade normally tacky and pressure-sensitive adhesive tape has been employed in sewing operations. For example, transparent tape is used to tape a pattern to fabric, the seamstress or tailor thereafter cutting through both the tape and the pattern. Tape can be adhered to fabric to provide a straight edge along which a seam is to be sewed; it has also been employed to hold pockets, decorative lace, rickrack, braid, applique, and other trimming in place on an underlying fabric to which they are to be sewn, thereby eliminating a time-consuming basting step. There are other situations where transparent tape has sometimes been applied to two plies of fabric, a seam stitched through both tape and fabric, and the tape then removed. Many pressure-sensitive adhesives gum a rapidly moving sewing machine needle, and this procedure has thus not been recommended. Further, previously available tape which had been stitched to an underlying fabric tended to tear and sliver and was removed only with great difficulty. Top stitching operations, where two or more closely spaced stitch lines were applied, aggravated the tape removal problem, and a zig zag or other decorative stitch made tape removal intolerably tedious and annoying. Attempts to remove other tapes sometimes require a force so great that the stitches are actually loosened and lifted, e.g., in sewing muslin with mercerized cotton thread.

SUMMARY OF THE INVENTION

The present invention provides a normally tacky and pressure-sensitive adhesive tape which not only has unique construction but which also possesses unique and valuable characteristics for use in sewing operations. Like previous tape products, the tape of the present invention can be used to assist in the spacing and alignment of button holes, the temporary positioning of zippers, pockets or decorative trim, etc. Unlike previous products, however, the present tape product can be stitched through with a high speed sewing machine without gumming the needle, and even in the case of top stitching or zigzag stitching, the tape can thereafter be removed easily and simply.

The tape of the invention comprises a self-supporting film backing consisting essentially of polyolefin having specific physical properties, with a layer of normally tacky and pressure-sensitive adhesive applied to one face of the film and likewise possessing certain specific physical properties. The film, at an elongation of 7% in the cross direction, displays a tensile stress of about 75–250 kg/cm^2, and a tensile force of about 200–2,000 gms/cm, the thickness to achieve this tensile force being in the range of about 25–250 microns, and preferably 40–80 microns. The adhesive layer is at least about 12 microns (preferably 15–25 microns) thick and has a loss modulus as hereinafter defined of more than 10^6 dynes/cm^2.

At this point it should be noted that pressure-sensitive adhesive tapes having polyolefin film backings and designed for packaging and wrapping purposes are broadly old in the art; see, e.g., U.S. Pats. Nos. 2,631,954, 3,079,278, 3,088,848, 3,241,662, 3,265,769 and 3,372,049. The strength and high modulus characteristics sought in such backings, however, do not provide a product suitable for use as a sewing tape. Similarly, the physical characteristics which have been empirically found essential for a satisfactory sewing tape are not desired for conventional tapes.

DESCRIPTION OF PRESENTLY PREFERRED EMBODIMENTS

In order to improve understanding of the invention, it is believed that it will be helpful to describe certain tests which are used in measuring either components of the sewing tape or the performance of the finished tape itself.

Tensile Force

A strip of film 2.54 cm (1 inch) wide and 20.3 cm (8 inches) long is cut in the cross web direction of a backing which is to be tested. Opposite ends of the film are then clamped in the jaws of a tensile testing machine having a chart which records force vs. % elongation, the jaws initially being 12.7 cm (5 inches) apart. The jaws are then separated at the rate of 12.7 cm/minute until they are at least about 14.0 cm apart; the tensile force at 7% elongation is then read from the chart. This force, in grams, is divided by 2.54 to obtain the tensile force expressed in terms of gms/cm width; the resultant figure should be in the range of about 200–2,000 gms/cm for the film to be useful as a backing for sewing tape. If the tensile force falls below 200 gms/cm, the tape can not be removed cleanly, leaving fragments below the stitches. On the other hand, if this force exceeds 2,000 gms/cm, stitch loosening often results on removal of the tape.

Tensile Stress

The tensile force in gms/cm, determined as described in the preceding paragraph, is divided by the film thickness in centimeters and the value further divided by 1,000 (gms per kilogram) to obtain a value expressed in kg/cm^2. The resultant tensile stress should be in the range of about 75–250 kg/cm^2. If the tensile stress value falls below the range, the tape tends to tear randomly during removal, while if the upper end of the range is exceeded, the tape is excessively brittle, typically "slivering" during removal.

It will be readily apparent that the tensile stress is substantially independent of thickness but that the thickness of a film can be increased or decreased to obtain an appropriate tensile force. The film thickness itself should, however, fall within the range of about 25–250 microns, preferably 40–80 microns. If the thickness falls much below 25 microns, the tape unfortunately conforms and adheres so well to fabric that it is extremely hard to remove after stitching. On the other hand, if the thickness exceeds 250 microns, there is a tendency for stitches to loosen when the tape is removed, even where double-knit polyester fabric is stitched with a stretch thread.

Adhesive loss shear modulus

An adhesive film about 300 microns thick is prepared by spin casting a solution thereof in a polytetrafluoroethylene-lined cup, partially drying the film, removing it, and drying it 30–40 hours in a vacuum oven maintained at 40°C. Pieces of film about 1.0 × 0.35 cm are then die cut from the film and tested in a shear rheometer. The piece of adhesive film to be tested is placed on the piezoelectric sensor plate of the rheometer, where

its dimensions are accurately measured, after which it is clamped firmly between the sensor plate and electromechanical driver plate, static compression of the film sample being about 10–15%. The driver plate is then actuated by a power oscillator at 23°C. and a frequency of 20 Hz*, the piezoelectric sensor generating voltages which are read by a vector voltmeter and converted to shear storage modulus (G′) and shear loss modulus (G″) values. It has been empirically determined that an adhesive whose shear loss modulus exceeds 10^6 dynes/cm² at 20 Hz and 23° C. will not gum a sewing machine needle, while one whose shear loss modulus falls significantly below that figure tends to do so. The upper limit of loss shear modulus need not be numerically established, since an excessively firm adhesive will not be "pressure-sensitive," i.e., possess the long-recognized 4-fold balance of adhesion, cohesion, stretchiness, and elasticity; see U.S. Pat. No. 2,750,315, Col. 6, lines 40 et seq.

Tape removal

*If the electronic accessories used with the shear rheometer are incapable of providing accurate modulus data at frequencies as low as 20 Hz, one plot of G″ vs frequency may be made at 23°C. and another at 41°C., the two plots then being superimposed to obtain an extrapolated value at a lower frequency; see, e.g., the procedure described in Ferry, "Viscoelastic Properties of Polymers," John Wiley & Sons, Inc., 1970, pp. 292–351 and Tobolsky, "Properties and Structure of Polymers", John Wiley & Sons, Inc., 1960, pp. 144–152.

In evaluating the performance of sewing tapes, the following procedure is used: A double-knit creped polyester material (3 square yards/lb.) is folded so that a double layer about 6 inches square results. Three pieces of test tape ¾ inch wide × 4 inches long are then laid across the material parallel to the machine direction of the fabric. A 4½ pound rubber roller is then passed over the tape and the material, which is supported on a flat table, four times to insure close contact and adhesion between the tape and cloth. Using an electric sewing machine capable of zigzag sewing (e.g., a Singer "Touch & Sew" Model No. 758) with normal presser foot pressure, thread tension set at 9, No. 14 ball point needle, spun polyester extra strong thread, a stitch setting of 12/inch, a width setting of zero, and a slow speed setting (11 cycles/second), a single straight line is sewed through the center of one of the tape samples from end to end, using the maximum rate available at a slow speed setting.

Using the equipment just described, the stitch setting is changed to 8/inch and 3 parallel lines of stitches one-fourth inch apart are sewed down the length of the second strip of tape, thereby simulating a common method of top stitching.

Using the procedure described in connection with straight stitch sewing, the width is changed to the No. 3 position (1/16-inch width) and a zigzag stitch sewed down the entire length of the third strip of tape.

Test samples are allowed to remain at room temperature for 18 hours, after which each of the three tapes is removed, using a jerky tearing motion, about one inch of tape at a time. The person performing the test removes the tape from only one side of a line of stitching at a time, pulling the tape up at a 45° angle to the fabric and across the stitches at a 45° angle to the edge of the tape. Each test is scored separately and a composite total computed. One point is scored for each stitch under which a residue of tape remains, and one point for each time the tape tears so that the removal strip has to be restarted. The maximum points for an acceptable product are as follows: straight stitch, 2; top stitch, 15; zigzag stitch, 15; total, 29.

Needle gumming

A solution of pressure-sensitive adhesive is coated on a silicone-treated release liner and the solvent evaporated to leave a dry thickness of about 18–20 microns (0.7–0.8 mil). A 4-inch × 10-inch piece of mercerized cotton rib woven flannel having a soft brushed finish, about 5 square yards/lb. is adhered to the exposed face of the adhesive. A No. 14 needle is washed in methylethyl ketone, air dried, placed in a sewing machine and threaded with No. 50 white mercerized cotton thread. The machine speed is set at slow, the stitch width at zero, and the stitch setting at 12/inch. An 8-inch length is then stitched through the cloth:adhesive:liner laminate (cloth side up) at the maximum slow speed setting (11 cycles/second). The needle is then removed from the machine and a 7X magnifying glass used to determine whether any residue remains. The test is repeated at fast speed (18 cycles/second). The stitch setting is then increased to 20/inch and the test again run at both slow and fast speeds. There should be no adhesive visible on the needle.

The invention will now be described with respect to specific illustrative but nonlimiting examples, in which all parts are by weight unless otherwise noted.

EXAMPLE 1

Forty parts of medium density (0.935) polyethylene (commercially available from Gulf Oil Company under the designation "Gulf 2604–M" was blended with one part of yellow polyethylene resin concentrate (commercially available from Eastman Chemical Products, Inc. under the trade designation 1830E–77225) and extruded as a 3.5-mil (89-micron) film. After extrusion at 450°F. the polyethylene film was quenched slowly on internally water-cooled rolls maintained at 180°F., causing it to have a relatively high degree of crystallinity. The film was then conventionally corona treated on both sides, using two electrodes, 18 amps/electrode, at 50 feet per minute; after which a black nitro-cellulose ink was flexographically printed on one side in the form of dashed lines one-fourth inch apart, extending in the machine direction of the film; at ½-inch intervals along each dashed line a cross was printed, the crosses on adjacent dashed lines being staggered, one-fourth inch. A 14% toluene solution of a 90:10 iso-octyl acrylate:acrylic acid copolymer pressure-sensitive adhesive was then coated on a silicone-coated kraft paper release liner and the solvent evaporated to leave a dry adhesive weight of 3.6–4.0 grams per 24 square inches, corresponding to a thickness of about 18 microns (0.7 mil). This adhesive was then transferred to the unprinted side of the previously prepared yellow polyethylene film, after which the printed side was provided with a polyvinyl carbamate low adhesion backsize as described in Dahlquist et al U.S. Pat. No. 2,532,011. The tape was then slit to ¾-inch width in such a manner that three machine direction lines appeared and wound convolutely about a core in the form of 25-foot rolls.

The tape described in the preceding paragraph of this Example adhered well to a variety of fabrics, could be stitched through without gumming the sewing machine needle, and was thereafter readily removable without undue tearing or slivering.

For convenience in analysis, there are now provided a series of tabulated examples, including certain unsatisfactory tape products, to help in delineating the invention. (In the interest of completeness, Example 1 is repeated in each table.) The following abbreviations are employed:

LDPE	low density (0.917) polyethylene, melt flow index 0.75 gm/10 min., commercially available from Union Carbide as "DFD-5505".
MDPE	medium density (0.934) polyethylene, melt flow index 1.2 gms/10 min., commercially available from Sinclair Koppers as "Super Dylan 6560"
IPP	isotactic polypropylene, 0.903–0.904 density, melt flow index in gms/10 min. shown in parentheses, commercially available from Hercules Chemical Company as "Profax"
IOA	iso-octyl acrylate, i.e., acrylic acid ester of the mixed isomers of octyl alcohol
AA	acrylic acid
IOA:AA	copolymer of monomers, weight ratio shown in parentheses; inherent viscosity (ethyl acetate), 1.5–2.1
iso-TBS	rubber-resin pressure-sensitive adhesive in which 100 parts of polyisoprene is tackified by blending there with 75 parts of poly-tert-butyl styrene, the molecular weight of the tackifier being shown in parentheses
iso-BT	polyisobutylene, commercially available from BASF as "Oppanol B-150"
hex	polyhexene, having an inherent viscosity (toluene) 5.4
oct	polyoctene, inherent viscosity (toluene), 3.2–4.0
PVEE	polyvinyl ethyl ether, commercially available from Union Carbide as EDBM
PViBE	polyvinyl iso-butyl ether, commercially available from BASF as "Oppanol C/KV-125"
AR-1107	homopolymer of n-butyl acrylate, commercially available from Ashland Chemical Company
PVnBE	polyvinyl n-butyl ether, inherent viscosity (benzene), 3.3
NSR	2-ethylhexyl acrylate:ethyl acrylate:vinyl acetate:acrylamide copolymer, commercially available from National Starch Company as "Resyn 78-3240"
AR-1044	2-ethylhexyl acrylate:vinyl acetate:acrylic acid: ethylacrylate copolymer, commercially available from Ashland Chemical Company
G260	2-ethylhexyl acrylate:vinyl acetate copolymer, commercially available from Monsanto Chemical Co. as "Gelva 260"
G263	2-ethylhexyl acrylate:methyl acrylate:acrylic acid:glycidyl methacrylate copolymer, commercially available from Monsanto Chemical Co. as "Gelva 263"

TABLE I*

Backing film			At 7% cross-web elongation		Tape removal rating points				Acceptable (A) or unacceptable (U) removability
Example	Composition	Thickness, microns	Tensile stress, kg/cm²	Tensile force, gms/cm	Straight	Top	ZigZag	Total	
Limits	—	25–250	75–250	200–2000	≦2	≦15	≦15	≦29	—
1	MDPE	89	117	1040	0	3	5	8	A
2	do.	63	100	630	0	15	10	25	A
3	LDPE	68	74	500	0	18	10	28	Borderline
4	do.	62	53	329	10	34	31	75	U
5	HDPE	41	172	705	0	9	2	11	A
6	do.	79	191	1510	0	5	5	10	A
7	IPP (4.0)	86	281	2420	0	15	28	43	U
8	IPP (0.8)	81	182	1470	0	0	13	13	A
9	Cellulose acetate	51	496	2530	30	23	8	61	U
10	Biaxially oriented polyethylene terephthalate	28	1010	2830	4	12	43	59	U
11	Cellophane	34	580	1970	4	25	24	53	U

* Pressure-sensitive adhesive same as in Example 1, so gumming is not a problem.

TABLE II**

	Adhesive		Adhesive loss shear modulus (G''), dynes/cm² × 10⁶ at 20 Hz	Acceptable (A) or unacceptable (U) needle gumming
Example	Type	Thickness, microns		
Limits	—	≧ 12	>1	—
1	IOA:AA (90:10)	16	7.93	A
12	IOA:AA (97:3)	18	0.45	U
13	AR-1107	18	0.26	U
14	G-263	16	3.99	A

** Film backing same as in Example 1, so tape removal not a problem.

The following table shows the relationship between an adhesive's loss shear modulus and its tendency to gum a sewing machine needle, using the tests previously described:

TABLE III

Example	Adhesive	Adhesive Loss shear modulus (G'') dynes/cm² ×10⁶ at 20 Hz	Acceptable (A) or unacceptable (U) needle gumming
Limit	—	>1	—
15	iso-TBS (1600)	0.16	U
16	oct	0.17	U
13	AR-1107	0.26	U
17	PVEE	0.32	U
12	IOA:AA (97:3)	0.45	U
18	PVnBE	0.63	U
19	hex	0.81	U
20	IOA:AA (95:5)	1.04	A
21	iso BT	1.24	A
22	IOA:AA (93:7)	2.15	A
23	NSR	2.34	A
24	AR-1044	2.64	A
14	G 263	3.99	A
25	PViBE	5.09	A
1	IOA:AA (90:10)	7.93	A
26	G 260	11.1	A
27	iso-TBS (10,000)	15.1	A

Except for coloring material, each useful backing film described above consists essentially of a homopolymer of polyethylene or polypropylene. Copolymers of more than one olefin monomer, including higher monomers, may also be employed, provided that the ultimate film possesses the previously specified physi-

cal properties. In like manner, blends of separately prepared polyolefins may be incorporated into the film backing. Minor amounts of other monomers may be copolymerized with one or more olefin monomers in the same way, just as minor amounts of other polymers may be blended with polyolefin. Those skilled in the art will also appreciate that minor amounts of pigments, processing aids, fillers and the like may be included in the backing.

What is claimed is as follows:

1. A colored, matte-finished normally tacky and pressure-sensitive adhesive tape provided with repeating printed indicia at predetermined intervals and having particular utility in sewing procedures, comprising in combination:

a. a self-supporting medium to high density polyethylene film backing, having, at 7% elongation in the cross direction,

1. a tensile stress in the range of about 75 to 250 kg/cm^2 and

2. a thickness in the range of about 40 to 80 microns, such that the tensile force is in the range of about 400–2,000 gms/cm width;

b. coated on one surface of said backing a layer of normally tacky and pressure-sensitive adhesive which

1. is in the range of about 12 to 15 microns thick and

2. has a loss shear modulus of more than 10^6 $dynes/cm^2$,

whereby the tape can be adhered firmly to fabric, stitched through rapidly using an electric sewing machine without gumming the needle, and completely and easily removed from a line of stitching which extends therethrough without loosening the stitches.

2. The tape of claim **1** wherein the adhesive is a 90:10 iso-octyl acrylate:acrylic acid copolymer.

3. The tape of claim **2** wherein the film is a medium density polyethylene.

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