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(54) EMOSSABLE SHEET MATERIAL

(71) We, DYMO INDUSTRIES INC., a corporation organized and existing under the laws of the State of California, United States of America, of One Embarcadero Center, San Francisco, California 94111, United States of America, 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:—

The invention relates to embossable sheet material.

Such material is usually provided in tape form and usually includes a stress whitening film with a darkened background. By stress whitening is meant a characteristic of a material that changes colour and/or opacity, when subjected to cold flow. In stress whitening material, the yield point occurs at a low degree of elongation.

In embossing tape it is desirable that alpha-numeric symbols embossed thereon become entirely opaque and white, so as clearly to stand out and be legible. The embossed symbols should not fracture, since this destroys legibility and creates an unacceptable appearance, should be free of ghosting, which is unsightly and effects legibility, and should be able to retain the sharp characteristics for long periods of time under varying conditions.

To some degree, the stress whitening and fracturing of the symbols is associated. The stressing of the polymeric film by cold flow elongation, results in changes in the physical characteristics of the polymer, which makes the film susceptible to fracture. It is desirable to find an embossing tape which provides a high degree of stress whitening or opacity, while being substantially free of fracturing on embossing. Also, any film used for an embossing tape should desirably be easily processed and fabricated, should readily adhere to a base film, and be stable or stabilizable to heat and light, so as to retain its characteristics for long periods of time.

According to the invention there is pro-

vided an embossable sheet material comprising a rigid non-stress whitening plastics backing film and a base sheet of at least 2 mils in thickness of a stress-whitening elastomer modified poly(methyl methacrylate) having a tensile elongation of from 25 to 80 per cent of elongation at break, the elastomeric modifier being bonded or mixed with the poly(methyl methacrylate).

Thus, the thin sheet of a stress whitening, preferably substantially transparent and haze free, elastomer-modified poly(methyl methacrylate) is provided preferably adhered to the non-stress whitening, opaque polymeric backing film. Advantageously, either the backing film is coloured, or a pigmented film is introduced behind the backing film away from the stress whitening sheet. Normally, an adhesive coating is then applied to the backing film and protected by a releasable liner.

The resulting sheet material can be embossed with sharply defined alpha-numeric symbols, substantially free or free of ghosting, without rupture upon embossing. Furthermore, the sheet material can be stable for long periods of time without substantial loss of the stress whitening, despite normal variations in temperature.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:—

Figure 1 is an enlarged side elevational view, in section, through an embossed section of embossable sheet material according to the invention;

Figure 2 is a plan view of a letter embossed into embossable sheet material according to the invention;

Figures 3 and 4 are similar to Figures 1 and 2, but illustrate the construction of prior art embossable tape and the appearance of a letter, together with a ghost image embossed onto a prior art tape; and

Figure 5 is an enlarged side elevational view, in section, through embossable sheet material according to the invention in the form of a composite multilayered tape.

An embossable sheet material can com-

prise an assembly of a stress whitening film, optionally a pigmented layer, if the backing is clear or white, a backing layer, preferably pigmented, an adhesive coating and a protective strip. The assembly can be in large sheets, tapes of from about $\frac{1}{4}$ " to $\frac{3}{4}$ " in width, or other form. The assembly can vary widely in thickness generally being at least 8 mils in thickness and usually not exceeding 50 mils in thickness, more usually being in the range of 8 to 20 mils in thickness. The particular thickness is a function of the embossing die with which the tape or film is to be used.

The base or stress whitening sheet will normally be of from 2 to 6 mils in thickness, more usually in the range of 3 to 4 mils in thickness. The tensile elongation of the film material when tested in accordance with ASTM D-638 (0.25 in. specimen, 0.2 inches per minute) will have an elongation at break of at least 25%, more usually at least 40% and not exceeding 80%, more usually not exceeding 70%. The Izod Impact Strength (ASTM D-256) notched for a $\frac{1}{4}$ " specimen at 25°C will usually be in excess of 1.0 ft. lb./inch of notch, usually in excess of 1.5 and usually not exceeding 2.1. Haze (ASTM D-1003) will generally be less than 10% for a 0.125" thick specimen.

The polymer has a major amount of a methyl methacrylate polymer and a minor but sufficient amount of an elastomeric interpolymers, usually at least 10 weight percent, and generally not exceeding 40 weight percent of the total composition, usually from 15 to 35 weight percent of the total composition.

The methyl methacrylate polymer may have from 0 to 20 monomer percent of another monomer, usually an alkyl acrylate wherein the alkyl group is of from 1 to 6 carbon atoms. The polymers will usually have a viscosity average molecular weight in the range of 75,000 to 250,000, more usually of 100,000 to 200,000. The methyl methacrylate polymer is bonded to the elastomer modifier or the elastomer modified is a mixture with the methyl methacrylate polymer.

An elastomer modifier is provided for combination with the methacrylate polymer. The polymers may be cross linked or mechanically mixed. The elastomer modifier is conveniently an acrylate polymer having also units of one or more other monomers. Usually, the acrylate will be present in at least 50 monomer percent and normally not exceeding 70 monomer percent. The acrylate is an alkyl acrylate of from 1 to 6 carbon atoms, more usually of from 1 to 4 carbon atoms. Small amounts, generally from 0.1 to 2 monomer percent are added of cross linking monomers that is, monomers which have two active non-conjugated (with each other) double bonds. Illustrative cross linking monomers include alkylene diacrylates, alkylene

dimethacrylates, and the like. The remainder of the monomers will be derived from aromatic addition monomers, such as styrene, alkyl methacrylates (alkyl of from 1 to 4 carbon atoms) and hydrophilic addition monomers, such as hydroxyalkyl, alkoxyalkyl, or alkylthioalkyl (alkyl of from 2 to 4 carbon atoms) acrylates and methacrylates, vinyl pyrrolidone, acrylonitrile and the like. Of particular interest are the hydroxyalkyl methacrylates and acrylates. The individual monomers will normally be present in amounts from 0.1 to 15 monomer percent with styrene present in an amount from 5 to 15 monomer percent and the other monomers in amounts from 0.1 to 5 monomer percent.

The polymers mentioned above are illustrated in French Patent Specification No. 71/07305, filed December 27, 1971. Elastomer modified methacrylates the commercially available from Rohm and Hass Co., West Philadelphia, Pennsylvania, under the trade designation DR-42 and from American Cyanamid Co., New York, under the trade designation XT-375.

The base sheet is normally and preferably adhered to a rigid plastics backing film. Conveniently, the plastics backing film can be any of a wide variety of suitable plastics to which the methacrylate polymer readily adheres, which are reasonably stable to light and heat, have a similar coefficient of expansion to the methacrylate polymer, and provide the desired degree of mechanical strength, while still being embossable, so as to retain the desired structure after being embossed with a die. Among the various polymers which may be used are such addition polymers as polyvinyl chloride, copolymers of vinyl chloride and vinylidene chloride, copolymers of vinyl chloride and vinyl acetate, polypropylene, and the like. The backing film will commonly be of a thickness of from 2 to 6 mils, usually 2 to 4 mils.

If desired, a coloured coating may be introduced behind the backing film where the backing film is transparent. The coating will vary from a fraction of a mil to 1 mil in thickness and can be applied according to conventional means, such as spraying, brushing or the like. The coating provides a coloured background which is aesthetically pleasing, and enhances the legibility and clarity of the embossed symbol. Conveniently, a paint binder such as Union Carbide's VYHH may be employed. Preferably, and alternatively, the backing is coloured with one of a wide variety of dyes and pigments, particularly those providing red, brown, green or blue colouration. The dye may be a soluble or insoluble dye as described in U.S. Patent No. 2,925,625, column 4, the

disclosure of which is incorporated herein by reference.

The base sheet and backing film may be joined together by having the two compositions coextruded as sheets and calendered, by lamination, or other techniques well known in the art.

In a preferred embodiment, the base sheet and backing film are annealed at a temperature at or above 200°F, after they are joined together.

To the exposed surface of the backing film, an adhesive layer is applied by conventional means. Various adhesives may be used, such as those described in U.S. Patent No. 2,953,475 and U.S. Patent No. 3,036,945. See particularly column 3 of the latter.

Finally, a protective layer is placed over the adhesive layer. The protective layer may be any of a wide variety of easily removable films, such as a metal film, e.g. aluminum, a plastic film, e.g. polyethylene, fabric, e.g. cellulosic, or the like. The thickness of the protective layer will be at least 2 mils, generally not exceeding 10 mils, and usually in the range 4 to 8 mils.

Referring to Figures 1, 2 and 5, an embossing tape 2 comprises a clear transparent or translucent methacrylate base sheet 4, a backing film 6 adhered or affixed to the base sheet 4, an adhesive coating 8 and a protective strip 10, that can be peeled off the adhesive coating 8 to expose the latter for adhering the tape to a support surface. (For the purpose of this Specification and the Claims, the terms "clear", "transparent" and "translucent" are used interchangeably, and the term "transparent" is intended to include the others). The base sheet 4 is constructed of an elastomer modified methacrylate. The backing film 6 is a non-stress whitening rigid plastic, which is pigmented unless a coloured coating is provided at the back of the backing film. The base sheet 4 and backing film 6 are affixed to each other by a bonding agent, heat sealing, coextrusion, or the like.

The adhesive layer 8 is coated onto the exposed surface of the backing film and protected by the protective strip 10.

The tape is provided of a thickness and a width suitable for an embossing machine in which the tape is intended for use. It passes longitudinally through the embossing machine and letters, symbols and the like are sequentially embossed on the tape at spaced intervals. By deforming the tape, by raising tape portions or sections 12 above the flat remainder of the tape, as illustrated in Figure 1, the raised section is stressed beyond the yield point of the stress whitening methyl methacrylate base sheet 4. A stress whitened area 16 extends a relatively short distance to either side of an imaginary central line of each raised section 12, that terminates well short of the flat tape remainder 14.

Maximum stresses in the base sheet 4 appear in the vicinity of a convex exterior curvature 18. Substantially no stress whitening is experienced in the area of concave exterior surfaces 20 of the base sheet 4. This lesser stressed area can result in a stress whitening, creating a ghosting or halo effect, in embossing tapes which do not follow the teaching of this invention. In the subject embossing tape, the stress whitened area is limited to the immediate vicinity of the imaginary centres of the raised sections 12, thus leading to sharply defined, stress whitened symbols, such as the letter "L" illustrated in Figure 2.

As an alternative to pigmenting the backing sheet 6 a coating of an ink or paint 22 (Figure 5) may be provided on the face of the backing film 6 remote from the base sheet 4. A letter embossed on the tape 2 has a background, colour and appearance supplied by the paint 22 and stress whitening solely from the base sheet 4.

Referring briefly to Figures 3 and 4, for purposes of illustration, there is shown an embossing tape constructed in accordance with the prior art. Such prior art tape comprises a layer 24 of a stress whitening material such as polyvinyl chloride, a suitable adhesive and a protective strip (not shown in the drawings). Upon embossing of this prior art tape, a stress whitened area 26 is formed which extends from an imaginary centre line of the raised section to a flat remainder 28 of the tape. As compared to tape according to invention, the stress whitened area extends substantially further away from the imaginary centre line. In transitional areas 30, between concave tape portions 32 and convex tape portions 34, only limited stress whitening takes place, leaving dark areas 30. The stress whitening which occurs at the concave portions 32 creates an unsightly and undesirable ghost or halo 36. Consequently, a letter, such as the letter "L" as shown in Figure 4, embossed on prior art tape, has a peripheral secondary or ghost image 36, which detracts from its appearance.

In a letter embossed on tape according to the invention, such ghost images do not form, because the stress whitened area 16 terminates at about the transition between the convex and concave surfaces of the raised section and because the lower portion of the tape (which is the portion that stress whitens the furthest away from the centre line in the prior art tape) does not stress whiten at all.

Although normally the base sheet 4 is transparent, so that the coloured backing film can be viewed through the base sheet and provide the desired background colour of the tape, in some situations it may be desirable to colour the base sheet 4. Any colouring should be consistent with the

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colouring of the backing film, and should not be detrimental to the stress whitening characteristic of the base sheet.

5 In material according to the invention, larger letters can be achieved with greater stroke width, without letter fracture, and clarity and legibility can be enhanced by the absence of ghosting. The white resulting can be a sharper, clearer white than previously
10 attained with earlier tapes.

The following examples are offered by way of illustration and not by way of limitation.

15 **EXAMPLE I**

An 0.004 inch thick base sheet was constructed from Rohm and Haas DR-42 elastomer-modified poly(methyl methacrylate). An
20 0.002 inch layer of a pigmented, non-stress whitening rigid vinyl (PVC) backing film was affixed to the base sheet. The backing film was adhesive coated and the adhesive was protected by an 0.006 inch polyethylene release liner.

25 A tape so constructed, when embossed, showed sharp embossing outlines free of ghost images.

EXAMPLE II

30 A backing film constructed of an 0.004 inch non-stress whitening rigid vinyl was affixed to the same base sheet as the one used in Example I. The resulting tape showed clear, sharply defined embossings free of
35 ghost images.

EXAMPLE III

40 An 0.004 inch thick backing film of pigmented Marbon's Cylolac (Registered Trade Mark) CG-ABS compound was affixed to the same base sheet as was used in Example I. As in Example I, embossings on the tape were clear, sharply defined and free of ghost images.

45 **EXAMPLE IV**

An 0.004 inch thick backing film constructed of pigmented Dow Chemical Styron (Registered Trade Mark) 470 high impact
50 polystyrene resin was affixed to the same base sheet as was used in Example I. Embossings on the tape were again clear, sharply defined and without ghost images.

55 **EXAMPLE V**

60 A base sheet constructed of an 0.044 inch thick UV-Stabilized American Cyanamid XT-375 elastomer modified poly(methyl methacrylate) was affixed to an 0.002 inch thick pigmented layer of rigid vinyl which formed a backing film and, in turn, received an adhesive coat and a polyethylene release liner. Embossings on this tape were again clear, sharply defined, and without ghost
65 images.

EXAMPLE VI

The American Cyanamid XT-375 base sheet was combined with the same backing film as was the Rohm and Haas DR-42 base sheet. In addition, both the Rohm and Haas
70 DR-42 and the American Cyanamid XT-375 base sheets were combined with the various liners listed in Examples I-IV but a coat of paint was applied to the side of the backing film attached to the base and no
75 pigmentation was used in the backing film. In all instances, the embossings on the tape were clear, sharply defined and free of ghost images.

Tapes formed of embossable sheet material according to the invention can have excellent stability for long periods of time to temperatures and light encountered in storage and use. Even when exposed to weathering under
80 severe conditions, the tape can still retain the desirable embossing characteristics for long periods of time. The embossing tapes can provide clear, sharply defined characters undistorted by ghosting and without letter fracture. In addition, the stress whitening
85 obtained can be opaque and bright, so as to provide enhanced clarity and legibility, further enhancing the desired characteristics of the embossing tape.

WHAT WE CLAIM IS:—

1. An embossable sheet material comprising a rigid non-stress whitening plastics backing film and a base sheet of at least 2
100 mils in thickness of a stress-whitening elastomer modified poly(methyl methacrylate) having a tensile elongation of from 25 to 80 per cent of elongation at break, the elastomeric modifier being bonded or mixed with the poly(methyl methacrylate).

2. An embossable sheet material according to Claim 1, in which the backing film is of a thickness of from 2 to 6 mils.

3. An embossable sheet material according to Claim 2, having an adhesive layer
110 adhered to the exposed surface of the backing film and a protective liner for the adhesive layer.

4. An embossable sheet material according to Claim 2, wherein the base sheet is transparent and the backing film is opaque and pigmented.

5. An embossable sheet material according to Claim 2, having a pigmented coating on the backing film.

6. An embossable sheet material according to Claim 2, wherein the backing film is polyvinyl chloride.

7. An embossable sheet material according to claim 1, in the form of an embossing
125 tape, for use in machines of the kind for impressing onto the tape alpha numeric symbols, wherein the base sheet is transparent and from 2 to 6 mils in thickness, the backing film is affixed to the base sheet, an
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colouring of the backing film, and should not be detrimental to the stress whitening characteristic of the base sheet.

- 5 In material according to the invention, larger letters can be achieved with greater stroke width, without letter fracture, and clarity and legibility can be enhanced by the absence of ghosting. The white resulting can be a sharper, clearer white than previously attained with earlier tapes.

10 The following examples are offered by way of illustration and not by way of limitation.

15 EXAMPLE I

An 0.004 inch thick base sheet was constructed from Rohm and Haas DR-42 elastomer-modified poly(methyl methacrylate). An 0.002 inch layer of a pigmented, non-stress whitening rigid vinyl (PVC) backing film was affixed to the base sheet. The backing film was adhesive coated and the adhesive was protected by an 0.006 inch polyethylene release liner.

25 A tape so constructed, when embossed, showed sharp embossing outlines free of ghost images.

30 EXAMPLE II

A backing film constructed of an 0.004 inch non-stress whitening rigid vinyl was affixed to the same base sheet as the one used in Example I. The resulting tape showed clear, sharply defined embossings free of ghost images.

35 EXAMPLE III

40 An 0.004 inch thick backing film of pigmented Marbon's Cyclocac (Registered Trade Mark) CG-ABS compound was affixed to the same base sheet as was used in Example I. As in Example I, embossings on the tape were clear, sharply defined and free of ghost images.

45 EXAMPLE IV

50 An 0.004 inch thick backing film constructed of pigmented Dow Chemical Styron (Registered Trade Mark) 470 high impact polystyrene resin was affixed to the same base sheet as was used in Example I. Embossings on the tape were again clear, sharply defined and without ghost images.

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60 A base sheet constructed of an 0.044 inch thick UV-Stabilized American Cyanamid XT-375 elastomer modified poly(methyl methacrylate) was affixed to an 0.002 inch thick pigmented layer of rigid vinyl which formed a backing film and, in turn, received an adhesive coat and a polyethylene release liner. Embossings on this tape were again clear, sharply defined, and without ghost images.

EXAMPLE VI

The American Cyanamid XT-375 base sheet was combined with the same backing film as was the Rohm and Haas DR-42 base sheet. In addition, both the Rohm and Haas DR-42 and the American Cyanamid XT-375 base sheets were combined with the various liners listed in Examples I-IV but a coat of paint was applied to the side of the backing film attached to the base and no pigmentation was used in the backing film. In all instances, the embossings on the tape were clear, sharply defined and free of ghost images.

Tapes formed of embossable sheet material according to the invention can have excellent stability for long periods of time to temperatures and light encountered in storage and use. Even when exposed to weathering under severe conditions, the tape can still retain the desirable embossing characteristics for long periods of time. The embossing tapes can provide clear, sharply defined characters undistorted by ghosting and without letter fracture. In addition, the stress whitening obtained can be opaque and bright, so as to provide enhanced clarity and legibility, further enhancing the desired characteristics of the embossing tape.

WHAT WE CLAIM IS:—

1. An embossable sheet material comprising a rigid non-stress whitening plastics backing film and a base sheet of at least 2 mils in thickness of a stress-whitening elastomer modified poly(methyl methacrylate) having a tensile elongation of from 25 to 80 per cent of elongation at break, the elastomeric modifier being bonded or mixed with the poly(methyl methacrylate).
2. An embossable sheet material according to Claim 1, in which the backing film is of a thickness of from 2 to 6 mils.
3. An embossable sheet material according to Claim 2, having an adhesive layer adhered to the exposed surface of the backing film and a protective liner for the adhesive layer.
4. An embossable sheet material according to Claim 2, wherein the base sheet is transparent and the backing film is opaque and pigmented.
5. An embossable sheet material according to Claim 2, having a pigmented coating on the backing film.
6. An embossable sheet material according to Claim 2, wherein the backing film is polyvinyl chloride.
7. An embossable sheet material according to claim 1, in the form of an embossing tape, for use in machines of the kind for impressing onto the tape alpha numeric symbols, wherein the base sheet is transparent and from 2 to 6 mils in thickness, the backing film is affixed to the base sheet, an



adhesive coating is affixed to the exposed side of the backing film and a protective liner is adhered to the adhesive coating.

5 8. An embossable sheet material according to Claim 7, wherein the elastomer modified poly(methyl methacrylate) contains an acrylate polymer as the elastomer.

10 9. An embossable sheet material according to Claim 7 or Claim 8, wherein the backing film is a polyvinyl chloride.

10 10. An embossable sheet material according to any one of Claims 7 to 9, wherein the backing film is pigmented and is opaque.

15 11. An embossable sheet material according to Claim 7, wherein the total thickness of the tape is from 8 to 20 mils.

12. An embossable sheet material according to Claim 7, having a pigmented coating on the backing film.

20 13. An embossable sheet material according to Claim 1, in the form of an embossing tape, for use in machines of the kind for impressing onto the tape alpha-numeric symbols, wherein the base sheet is transparent and has an acrylate polymer as the elastomer

modifier, an adhesive coating is provided on the exposed side of the backing film, and a protective liner is adhered to the adhesive.

14. An embossable sheet material according to Claim 13, having a total thickness of from 8 to 20 mils. 30

15. An embossable sheet material according to Claim 13, wherein the backing film is formed of polyvinyl chloride.

16. An embossable sheet material according to Claim 13, wherein the backing film is formed of polypropylene. 35

17. An embossable sheet material according to Claim 13, wherein the acrylate polymer is cross linked to the poly(methyl methacrylate). 40

18. An embossable sheet material substantially as hereinbefore described and illustrated with reference to Figures 1, 2 and 5 of the accompanying drawing. 45

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