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RELEASE FILM FOR LABEL STOCK

The present invention relates to a release film, a major utility of which is to protect and carry label stock until the label is put into use on an appropriate surface.

For many years labels have been prepared with an adhesive applied to one side thereof. In instances where the adhesive is a pressure sensitive adhesive, some means had to be provided to protect the adhesive surface in advance of applying the label to the ultimate surface to be labeled. A technique has evolved over the years by which the pressure sensitive adhesive is protected by bringing the adhesive surface into contact with a release layer which has little tendency to aggressively adhere to the pressure sensitive adhesive surface. Thus, a second film having a release surface is brought into contact with the pressure sensitive surface carried by the label protecting the pressure sensitive adhesive until the label is applied to its ultimate surface. It is to be understood that the pressure sensitive adhesive can be applied to the release surface and the label stock thereafter applied to the adhesive surface. On removal of the label the pressure sensitive adhesive will preferentially adhere to the label stock.

Release films are often manufactured apart from the label face stock. The release film is manufactured by applying a commercially available release material to one side of the release film and the combination is then convolutely wound into a roll stock. Ultimately this roll stock must be unrolled and slit to a width dimension suited to a particular label dimension. Next a pressure sensitive layer is applied over the release layer and this is mated with the underside of a sheet of label stock. Alternatively the label stock can have the pressure sensitive adhesive applied to its undersurface which in turn is mated with the release label. Following this, label indicia are printed onto the surface of the label which is thereafter die cut so that it can be separated from the release sheet-label stock combination.



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Suitable films for use in these applications include polyethylene terephthalate (PET) and biaxially oriented polypropylene (BOPP). Conventional BOPP liners, while exhibiting cost advantages over polyethylene terephthalate can experience problems due to poor printing registration during label converting and a lack of support during die cutting procedures.

It is an object of the present invention to present a release film which is capable of being cleanly cut by a die at high velocity operation, e.g., at 500 feet per minute or greater. Another object of the invention is to provide a release film which is capable of less elongation under tension and excellent printing registration during label converting. Moreover, it is an object of the invention to provide a release film of high thermal stability, an advantage of particular importance where the silicone release agent is thermally cured.

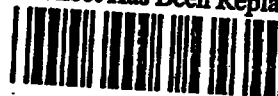
The present invention relates to a film which comprises a film substrate having on at least one side thereof a coating of a silicone release material wherein the film substrate comprises an oriented high crystallinity polypropylene (HCPP) having intermolecular stereoregularity greater than 93% as determined by IR spectroscopy.

This invention also relates to the use of a film of this invention as a release film for label stock.

Figure 1 depicts elongation (%) at 2 PLI (pounds per linear inch) tension in machine direction (MD) over temperature (°F) for release liners of the present invention (biaxially oriented HCPP) and release liners of conventional (lower crystallinity) BOPP, 1.5 mil polyethylene terephthalate (PET) and 42# SCK (super calendered Kraft) paper.

Figure 2 depicts elongation (%) at 3 PLI tension in machine direction (MD) over temperature (°F) for release liners of the present invention (biaxially oriented HCPP) and release liners of conventional (lower crystallinity) BOPP, 1.5 mil polyethylene terephthalate (PET) and 42# SCK paper.

In preparing the release film of the present invention the substrate can be derived from an oriented high crystallinity



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polypropylene (HCPP) having intermolecular stereoregularity greater than 93%, preferably from 94 to 99%, more preferably from 94 to 98%, as determined by IR spectroscopy. Suitable high crystallinity polypropylene (HCPP) resins (film grade) include

5 Amoco 9117 and Amoco 9119, available from Amoco Chemical Co. of Chicago, IL; Chisso HF5010 and Chisso XF2805, available from Chisso Chemical Co., Ltd. of Tokyo, Japan; Himont 7054, available from Himont U.S.A., Inc. of Wilmington, DE; and Exxon SP301 and SP 303, available from Exxon Chemical Co. of Houston,

10 TX. The high crystallinity polypropylene has a higher intermolecular stereoregularity giving an increase in isotactic polymers and decrease in atactic and syndiotactic polymers. HCPP exhibits higher crystallinity than conventional polymers resulting in higher stiffness, surface hardness, lower

15 deflection at higher temperatures and better creep properties. Further information relating to HCPP, including methods for preparation of the resin is disclosed in US 5,063,264.

For purposes of the present invention, intermolecular stereoregularity can be determined by IR spectroscopy according

20 to the procedure set out in "Integrated Infrared Band Intensity Measurement of Stereoregularity in Polypropylene," J. L. Koenig and A. Van Roggen, Journal of Applied Polymer Science, Vol. 9, pp. 359-367 (1965) and in Chemical Microstructure of Polymer Chains, Jack L. Koenig, Wiley-Interscience Publication, John

25 Wiley and Sons, New York, Chichester, Brisbane, Toronto.

This substrate material can, in turn, be composed of one or a plurality of individual layers designed to improve the overall quality of the substrate. The substrate can be transparent or opaque. In one embodiment, the HCPP can be

30 coextruded with another suitable polyolefin. Suitable individual layers which can be employed to prepare multilayer release substrates include polyolefins other than HCPP, e.g. one or more of polypropylene homopolymer, ethylene-propylene copolymer, and high density polyethylene (HDPE).

35 Any release material effective for use in protecting the back side of label stock prior to label application is contemplated for use in the present invention, e.g., silicones.



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A particularly preferred class of release materials are those broadly identified as "silicone acrylate" release materials. A description of these materials and how they are made are found in US 4,678,846 and US 4,306,050.

5 The release material of the present invention can include (meth)acrylate ester modified organopolysiloxane mixtures, comprising essentially equilibrated organopolysiloxanes with, on the average, more than 25 to fewer than 200 silicone atoms and which additionally contain 2 to 30 weight percent of
10 organopolysiloxanes with, on the average, 2 to 25 silicone atoms and 2 to 30 weight percent of organopolysiloxanes with, on the average, 200 to 2,000 silicone atoms.

As used herein, the organopolysiloxane fractions having more than 25 to less than 200 silicone atoms are sometimes
15 referred to as the first fraction, those having 2 to 25 silicone atoms are referred to as the second fraction, and those having 200 to 2,000 silicone atoms are referred to as the third fraction.

Especially preferred are those (meth)acrylate ester
20 modified organopolysiloxane mixtures which contain, besides the essentially equilibrated organopolysiloxane with, on the average, more than 25 to fewer than 200 silicone atoms, 5 to 20 weight percent of organopolysiloxanes with, on the average, 5 to 25 silicone atoms and 5 to 20 weight percent of
25 organopolysiloxanes with, on the average, 200 to 2,000 silicone atoms.

The organopolysiloxanes contained in the organopolysiloxane mixtures preferably correspond to the formula:



in which R is an alkyl radical with 1 to 4 carbon atoms,
35 preferably, the methyl radical. R may, however, also be a vinyl or phenyl radical. Moreover, the R radical may also represent different moieties in the molecule, so that some R radicals represent methyl radicals and the other R radicals may, for example, represent a vinyl or a phenyl radical. Preferably, at



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least 90% of the R radicals are alkyl radicals, especially methyl radicals.

Q is an organic radical which contains the acrylate or methacrylate ester groups. Preferably, the acrylate or methacrylate ester radical is linked to the silicone atom through an SiOC bridge. The acrylate or methacrylate radical may moreover be derived from pentaerythritol triacrylate, pentaerythritol trimethacrylate, dipentaerythritol pentaacrylate, dipentaerythritol pentamethacrylate, ditrimethylolpropane triacrylate, ditrimethylolpropane trimethacrylate, ditrimethylolethane triacrylate, ditrimethylolethane trimethacrylate, trimethylolpropane di(meth)acrylate, trimethylolethane di(meth)acrylate, glycerin di(meth)acrylate, hydroxyethyl acrylate, hydroxypropyl acrylate and neopentyl glycol monoacrylate.

The acrylate or methacrylate ester radical may, however, also be linked through an SiC bridge with the organopolysiloxane.

a has a value of 1.0 to 2.2; b has a value of 0.001 to 1.6. The fractions of different average molecule weight contained in the inventive acrylate or methacrylate ester modified organopolysiloxane mixtures may differ in respect to the R and Q radicals and the a and b subscripts.

Organosilicone species in the above-referenced silicone acrylate release coatings are believed to migrate from the coating to adjacent contacting surfaces. The cause of this migration may be nonfunctionalized silicone remaining in the release coating. These migratable species are not bound or fixed in the cured coating and thus will migrate to adjacent contacting surfaces. US 5,232,784 teaches that by including a quaternary ammonium salt in the silicone acrylate material prior to applying it to the release substrate that by some reaction the migratable material is either prevented from migrating or converted to a material which has no adverse effect on label printing. US 4,933,124 describes a process of applying silicone release coating to oriented polymer film which is suitable for use in the present invention.



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The silicone release coating normally is applied to the substrate in a quantity of from about 0.2-1.2 grams/1000 in², preferably about 0.7 g/1000 in². After application the silicone release coating can be subjected to a conventional curing
5 process, depending on the type of silicone release coating used, e.g., thermal, ultraviolet, or electron beam radiation.

The substrate can be of any suitable thickness, say from 0.45 to 10 mils thick, say 1 to 2.2 mils, after coating. The use of HCPP in the substrate provides films of reduced
10 thicknesses, even below 1 mil, e.g., 0.45 to 1 mil, than are obtainable with conventional polypropylenes of reduced crystallinity.

The film can be oriented prior to application of the silicone release coating either uniaxially or biaxially.
15 Preferably the film is biaxially oriented prior to said application. Uniaxially oriented film can be stretched 4 to 10 times, preferably 5 to 6 times. Biaxially oriented film can be stretched 4 to 8 times, preferably 4.5 to 6 in the machine direction (MD), and 6 to 10 times, preferably 7 to 8 times in
20 the transverse direction (TD).

After the silicone release material is applied to one side of the high crystallinity BOPP film, the combination can then be convolutely wound into a roll stock. Ultimately this roll stock can be unrolled and slit to a width dimension suited to
25 a particular label dimension. In one embodiment, a pressure sensitive adhesive layer is applied over the release layer which can be mated to the underside of a sheet of label stock. Alternatively, the label stock can have the pressure sensitive adhesive applied to its undersurface which in turn is mated with
30 the release label. Following this, label indicia are printed onto the surface of label and the label then can be die cut so that it can be separated from the release sheet-label stock combination.

The pressure sensitive adhesive is any suitable pressure
35 sensitive adhesive, e.g., emulsion-based, solvent-based, or hot melt PSAs. Suitable emulsion-based acrylics include: Nacor 4525 and Nacor 4544, available from National Starch and Chemical



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Corp. of Bridgewater, NJ, LC-31 and GP-2, available from Air Products and Chemicals, Inc. of Allentown, PA, PS-60 and PS-51 available from Rohm and Haas Co. of Philadelphia, PA. Suitable solvent-based PSAs include: GMS 263 and GMS 250, available from
5 Monsanto Co. of St. Louis, MO. Suitable hot melt PSAs include Duro-Tak 4138 and Duro-Tak 4134, available from National Starch and Chemical Corp. of Bridgewater, NJ.

The label stock can be of any suitable material including paper or thermoplastic films, e.g., polyethylenes, polyethylene
10 terephthalate (PET), polypropylene, e.g., biaxially oriented polypropylene (BOPP). In particular, the use of high crystallinity oriented polypropylene is contemplated as a label stock for use in the present invention, especially oriented material, e.g., biaxially oriented high crystallinity
15 polypropylene. The high crystallinity BOPP is particularly suited to use as label stock in applications where the labels are die-cut labels or sheet labels owing to the enhanced stiffness of HCPP.

The following Examples illustrate the invention.

20 EXAMPLES 1 AND 2 Preparation of HCPP Release Liners

2.0 mil release liner film of the present invention was obtained using high crystallinity polypropylene Amoco 9119 having a stereoregularity of 96% as measured by IR spectroscopy (or m-pentad of 94% as measured by NMR spectroscopy) was melted
25 in an extruder to provide a film of 97 mil thickness which was oriented in the machine direction 5.4 times and in the transverse direction 9 times, to provide a 2 mil film which was then coated with 0.6 g/1000in² of an electron beam curable silicone release agent, Silicone-Acrylate, available from T.
30 H. Goldschmidt AG of Essen, Germany. The release liner containing the silicone release agent was then subjected to electron beam cure. The resulting release liner was tested for machine direction elongation over temperature at 2 PLI and 3 PLI tension and the results are set out in Figures 1 and 2,
35 respectively.

The resultant release liner was then laminated to polyethylene terephthalate (PET) OR polyethylene (PE) facestocks



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using GP-2, an acrylic emulsion PSA available from Air Products Co. of Philadelphia, PA.

The resulting release liner/adhesive/facestock composites had a label facestock of polyethylene terephthalate (PET---
5 Example 1) and polyethylene (PE--Example 2). The composites were die-cut with a die having a die gap of 1.8 mils and subjected to label converting operation at 500 feet per minute (FPM). Unlike conventional BOPP liners, the high crystallinity BOPP liners were also able to maintain 1/64" printing
10 registration in the label press. The results set out in the Table below show that the HCPP-based film performed well at levels above conventional BOPP-based film. High crystallinity BOPP liner provide better support for die-cutting and label conversion procedures.

15

EXAMPLES 3 TO 8 (COMPARATIVE)

Conventional release films were made from conventional, lower crystallinity BOPP (Examples 3 to 6), 42# SCK (super calendered kraft) paper (Example 7) and 1.5 mil polyethylene
20 terephthalate (PET) (Example 8). Examples 3 to 7 were used to make release liner/adhesive/facestock composites using a label facestock of polyethylene terephthalate (PET--Examples 3, 5, 6, and 7) and polyethylene (PE--Example 4). Examples 3 and 4 were made from a conventional BOPP coextruded film with electron beam
25 curable silicone coating. Examples 5 and 6 were made from conventional BOPP film with electron beam curable silicone coating available from T. H. Goldschmidt AG. Example 7 was made from 50# SCK paper release liner. The composites were die-cut with dies having a die gap of 1.6 to 2.0 mils and subjected to
30 label converting operation at the same conditions as in Examples 1 and 2. Further details are provided in the Table.



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TABLE

EX.	LINER/PSA/FACESTOCK	LINER GA.	DIE GAP	COMMENT
1	HCPP/GP-2/PET	2.0 mil	1.8 mil	Die-cut well Label conv.at 500 ft/min
5				
2	HCPP/GP-2/PE	" "	" "	" "
3	BOPP/GP-2/PET	" "	1.6 mil	Did not cut cleanly
10				
4	BOPP/GP-2/PE	" "	" "	" "
5	BOPP/GP-2/PET	" "	1.8 mil	" "
15				
6	BOPP/GP-2/PET	" "	1.6 mil	Die-cut well Label conv. at 500 ft/min.
7	50#SCK/GP-2/PET	2.7 mil	2.0 mil	" "

20

Example 8 was a release liner similar to the others in the Examples but having a substrate of 1.5 mil polyethylene terephthalate (PET).

25 Figures 1 and 2 depict elongation (%) at 2 and 3 PLI (pounds per linear inch), respectively, in machine direction (MD) over temperature (°F) for release liners of the present invention and the comparative Examples.



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CLAIMS:

1. A film which comprises:
 - (i) a substrate having on at least one side thereof
 - (ii) a coating of a silicone release material,
- 5 wherein the substrate comprises an oriented high crystallinity polypropylene (HCPP) having intermolecular stereoregularity greater than 93% as determined by IR spectroscopy.
2. A film according to claim 1 wherein the HCPP has an IR
10 stereoregularity ranging from 94% to 98%.
3. A film according to claim 1 or 2 which is uniaxially or biaxially oriented.
- 15 4. A film according to claim 3 which is uniaxially oriented from 4 to 10 times.
5. A film according to any of claims 1 to 4 which is uniaxially or biaxially oriented from 4 to 8 times in the
20 machine direction (MD).
6. A film according to any of claims 1 to 5 which is uniaxially or biaxially oriented from 6 to 10 times in the transverse direction (TD).
- 25 7. A film according to any preceding claim wherein the substrate (i) comprises HCPP coextruded with a polyolefin other than HCPP.
- 30 8. A film according to claim 7 wherein the polyolefin comprises polypropylene homopolymer, ethylene-propylene copolymer, or high density polyethylene (HDPE).
9. A film according to any preceding claim wherein the
35 coating of a silicone release material (ii) is cured by electron beam radiation; by thermal radiation; by ultraviolet radiation.

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10. Use of a film according to any preceding claim as a release film for label stock.

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